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A low-angle, close-up photograph of a mechanical testing device, likely a penetrometer or similar turf strength measurement tool, positioned on a green artificial football pitch. The device features a vertical metal pole with a stack of five thick, dark, circular weights. A horizontal arm extends from the pole, and the entire assembly is supported by a tripod-like structure. The background shows a chain-link fence and some trees under a clear sky.

FIFA Quality Programme for Football Turf

Handbook of Test Methods

October 2015 Edition

The FIFA Quality logo, which includes the word "FIFA" in blue, "QUALITY" in blue, and a blue horizontal bar below.The FIFA Quality Pro logo, which includes the word "FIFA" in blue, "QUALITY" in blue, and "PRO" in blue below a blue horizontal bar.

FIFA Quality Programme for Football Turf

Handbook of Test Methods

October 2015 Edition

V3.1 (16.03.2020)

Contents

1.	Introduction	4
2.	Normative references	4
3.	Laboratory test specimens	4
	Table 1 - minimum size of test specimens.....	4
	Table 2- Coordinates of stud positions (centre of stud)	6
4.	Field test positions.....	7
5.	Test conditions	7
6.	Field (site) tests	7
7.	Balls used for test.....	8
8.	Football studs used for test	8
9.	Determination of ball rebound (FIFA Test Method 01)	10
10.	Determination of Angle Ball Rebound (FIFA Test Method 02)	12
11.	Determination of Ball Roll (FIFA Test Method 03).....	13
12.	Determination of Shock Absorption (FIFA Test Method 04a)	15
13.	Determination of Vertical Deformation (FIFA Test Method 05a).....	22
14.	Determination of Energy of Restitution (FIFA Test Method 13).....	24
15.	Determination of Rotational Resistance (FIFA Test Method 06)	25
16.	Determination of Light Weight Rotational Resistance (FIFA Test Method 06a).....	27
17.	Determination of Skin / Surface Friction and Abrasion (FIFA Test Method 08)	30
18.	Procedure for Artificial Weathering (FIFA Test Method 10).....	41
19.	Assessment of synthetic infill (FIFA Test Method 11)	43
20.	Procedure for the assessment of surface planarity (FIFA Method 12)	44
21.	Procedure for the determination of heat on artificial turf products (FIFA Test Method 14)...	46
22.	Procedure for the determination of wear on artificial turf (Lisport XL) (FIFA Test Method 15) 50	
23.	Procedure to determine the quantity of infill splash (FIFA Test Method 16)	56
24.	Procedure for determination of reduced ball roll (FIFA Test Method 17).....	60
25.	Procedure for measuring free pile height (FIFA Test Method 18)	64
26.	Procedure for the determination of UV stabilizer content in artificial turf yarn (FIFA Test Method 19).....	65
27.	Procedure to determine the particle size distribution of granulated infill materials (FIFA method 20).....	67
28.	Procedure for the measurement of infill depth (FIFA Test Method 21)	69
29.	Procedure for the measurement of differential scanning calorimetry (DSC) (FIFA Method 22) 70	
30.	Procedure for the determination of decitex (Dtex) of yarns (FIFA Method 23)	73
31.	Procedure for the determination of infiltration rate of artificial turf systems (FIFA Method 24) 74	
32.	Procedure for the measurement of yarn thickness (FIFA Method 25)	77

33.	Procedure for Determination of tuft withdrawal force (FIFA Method 26).....	80
34.	Minimising infill migration into the environment – field design (FIFA Method 27)	81
35.	List of International and European Standard test methods adopted by FIFA	88
36.	Appendix I Lisport XL Sample preparation procedure.....	89
37.	Appendix II Determination of excess Spin Oil on synthetic grass fibres (Not mandatory)....	90

Whilst every effort has been made to ensure the accuracy of the information contained in this Handbook any party who makes use of any part of this Handbook in the development of a football turf pitch (a "User") does so at its own risk and shall indemnify FIFA, their officers, directors, servants, consultants and agents against all claims, proceedings, actions, damages, costs, expenses and any other liabilities for loss or damage to any property, or injury or death to any person that may be made against or incurred by FIFA arising out of or in connection with such User's use of this Handbook.

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FIFA reserve the right to amend, update or delete sections of this manual at any time as they deem necessary.

Changes in the 2015 FQP Test Method Manual (compared to 2012 edition):

- New methodology for advanced wearing
- New methodology for reduced ball roll measurement
- New methodology for heat measurement
- New methodology for the determination of infill splash
- New methodology for measuring UV stabilizer content in artificial turf yarns
- New methodology for measuring free pile height
- Methodology for measurement of infill depth
- Methodology for measurement of Dtex
- Methodology for measurement of permeability
- Methodology for measurement of granulated infills
- Methodology for DSC assessment
- New methodology for measuring the tuft withdrawal force
- New methodology for Spin Oil removal (not mandatory)
- Introduction of the Light Weight Rotational Resistance apparatus

The following tests have been removed from the handbook of test methods:

- Stud slide and stud deceleration removed from laboratory testing
- Wear simulation using the original Lisport apparatus removed from laboratory testing
- Ball roll in laboratory

1. Introduction

This Handbook describes the procedures for assessing artificial turf football surfaces under the FIFA Quality Programme. Although the manual has been written to specify how Football Turf (artificial turf surfaces) should be tested the ball/surface and player/surface tests can also be used to assess the qualities of natural turf fields.

This edition of the manual supersedes previous editions with effect from 15 October 2019.

2. Normative references

This Handbook incorporates by dated or undated reference provisions from other publications. For dated references, subsequent amendments to or revisions of any of these publications will apply to this Handbook only when incorporated into it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

3. Laboratory test specimens

3.1. Definitions

A Football Turf is defined as the synthetic surface, infill, any shockpad and all supporting layers that influence the sports performance or biomechanical response of the surface that meets the requirements of the FIFA Quality Programme.

Tests shall be made on all elements of the construction that influence the sports performance or biomechanical response of the surface.

Unless a Football Turf is laid on a base that is designed to contribute to the dynamic performance of the surface laboratory tests shall be carried out on tests specimens laid on a rigid flat concrete floor.

If a Football Turf is laid on a base that is designed to contribute to the dynamic performance of the surface the measurements of ball rebound, angle ball rebound, shock absorption and vertical deformation shall be made on a test specimen comprising the Football Turf and the base, laid to the depth specified by the manufacturer or supplier.

Laboratory tests for ball roll, rotational resistance, skin / surface friction and skin abrasion shall be made on all elements that influence the response - this does not normally include the supporting layers.

3.2. Size of test specimen

Test specimens shall be equal to or greater than the sizes stated in Table 1.

Table 1 - minimum size of test specimens

Test	Minimum length of test specimen	Minimum width of test specimen
Ball rebound	1.0m	1.0m
Angle ball rebound	1.0m	1.0m
Reduced Ball roll	4.0m	1.0m
Shock absorption	1.0m	1.0m
Vertical deformation	1.0m	1.0m
Rotational resistance	1.0m	1.0m
Surface Friction / Abrasion	1.0m	1.0m
Sub-ambient & Elevated Temperature tests	0.4m	0.4m
Simulated wear	4.0m	1.0m
Heat testing	0.4m	0.4m
Splash testing	1.0m	1.0m
Artificial weathering: carpet pile yarn(s)	20m length	
UV stabiliser assessment	1m length	

Unless specified in the test method laboratory test specimens shall not include joints or inlaid lines.

3.3. Preparation of test specimens

Following filling, filled test specimens shall be conditioned prior to test by passing a hand-pulled roller over the test specimen for 50 cycles (one cycle comprises one outward and one return pass of one roller) in 2 different directions (split into 25 passes lengthwise and 25 passes in the transverse direction) or 5 cycles of the Lisport XL. The barrel of the roller shall weigh (28.5 ± 0.5) kg, and (118 ± 5) mm in diameter and have plastic studs mounted as shown in Figure 1 and detailed in Table 1. The studs shall be as shown in Figure 2, be manufactured from plastic and have a Shore A hardness of 96 ± 2 .

Note a manufacturing tolerance of ± 1 mm for the stud positions has been found satisfactory.

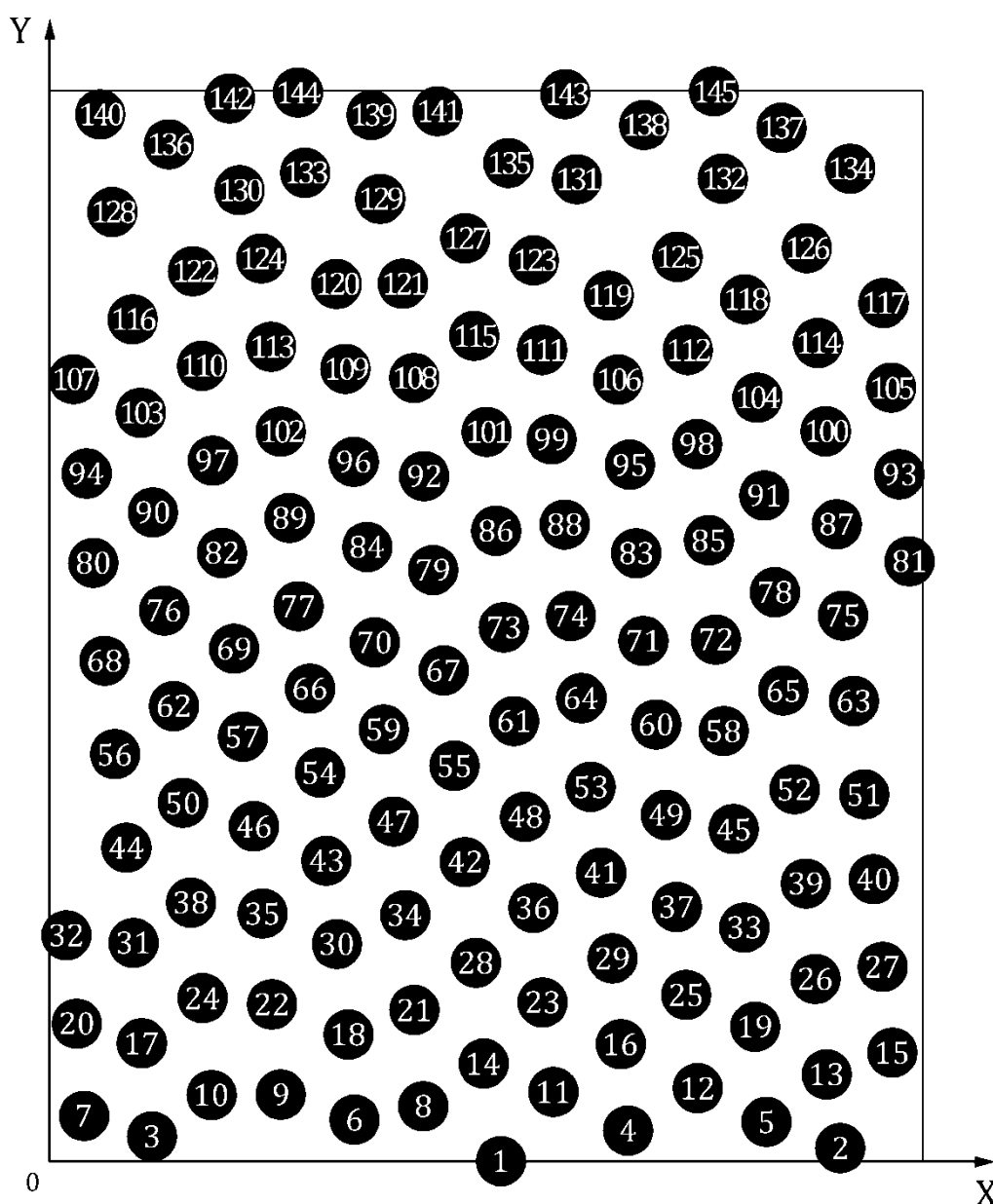


Figure 1: Pattern of studs Table

Table 2- Coordinates of stud positions (centre of stud)

STUD - X AXIS - Y AXIS			STUD - X AXIS - Y AXIS			STUD - X AXIS - Y AXIS		
	mm	mm		mm	mm		mm	mm
1	154.5	0.0	51	279.5	127.5	101	150.0	252.5
2	271.5	4.5	52	255.5	128.5	102	78.5	252.5
3	35.0	8.5	53	185.5	129.5	103	31.0	259.0
4	198.5	10.5	54	92.5	134.5	104	242.5	264.5
5	246.0	13.5	55	139.0	136.5	105	289.0	268.0
6	105.0	14.0	56	22.0	141.0	106	195.0	270.5
7	11.5	16.0	57	65.5	146.5	107	7.5	271.0
8	128.5	19.0	58	231.5	149.0	108	125.0	271.0
9	79.0	23.0	59	114.5	149.5	109	101.0	274.5
10	55.0	23.0	60	208.0	151.0	110	51.5	275.5
11	173.0	24.0	61	159.5	152.5	111	169.5	280.5
12	222.0	25.0	62	42.0	157.5	112	219.0	280.5
13	267.0	30.0	63	276.0	158.5	113	76.0	282.0
14	149.0	33.5	64	182.5	160.0	114	263.5	284.0
15	289.5	37.0	65	252.5	162.5	115	145.5	285.0
16	196.0	40.0	66	89.0	164.0	116	28.0	291.5
17	31.0	41.0	67	135.0	170.0	117	286.0	297.0
18	102.0	43.5	68	18.5	173.0	118	239.0	298.5
19	242.0	46.0	69	63.0	177.5	119	192.0	300.0
20	8.5	47.0	70	111.0	179.5	120	98.0	304.0
21	125.0	52.5	71	204.5	180.0	121	121.0	304.0
22	76.0	54.0	72	229.0	180.5	122	48.5	308.0
23	169.0	55.0	73	155.5	184.5	123	166.0	312.0
24	52.0	56.0	74	178.5	188.5	124	72.0	312.5
25	218.5	57.5	75	272.5	189.0	125	215.0	313.5
26	263.0	63.0	76	38.5	190.5	126	260.0	316.0
27	286.0	67.0	77	85.0	192.5	127	142.0	319.5
28	146.0	68.5	78	249.0	196.5	128	21.0	329.0
29	193.0	70.5	79	131.5	204.5	129	113.0	333.0
30	98.5	75.0	80	14.5	207.0	130	64.5	336.0
31	28.0	75.5	81	294.5	208.0	131	180.0	340.0
32	5.5	78.0	82	58.5	210.5	132	231.0	340.0
33	239.0	81.0	83	201.0	210.5	133	87.0	342.5
34	122.0	85.0	84	108.5	212.5	134	275.0	343.5
35	73.0	85.5	85	226.0	215.0	135	157.5	345.5
36	166.0	88.0	86	153.0	218.0	136	40.0	352.0
37	215.0	88.0	87	270.0	220.0	137	251.0	357.5
38	48.5	89.5	88	176.5	220.5	138	204.0	358.5
39	259.5	96.0	89	82.0	222.5	139	110.0	362.5
40	283.0	97.5	90	34.5	224.5	140	16.5	362.5
41	189.0	100.0	91	246.0	231.0	141	133.0	363.5
42	142.0	103.0	92	128.5	237.5	142	61.0	368.0
43	94.5	104.0	93	292.0	237.5	143	177.5	369.0
44	25.5	109.0	94	12.0	238.5	144	84.5	370.0
45	235.0	114.5	95	199.0	241.0	145	228.0	370.0
46	69.5	116.0	96	104.0	242.0			
47	118.5	117.5	97	55.0	243.0			
48	162.5	119.5	98	222.0	248.0			
49	211.5	119.5	99	172.5	250.0			
50	46.0	123.5	100	266.5	252.5			

4. Field test positions

Unless otherwise specified, tests on site shall be made in the positions shown in Figure 2.

All field tests, when not otherwise specified, shall be undertaken in positions 1 – 6. The orientation of the test positions shall be determined by the test institute.

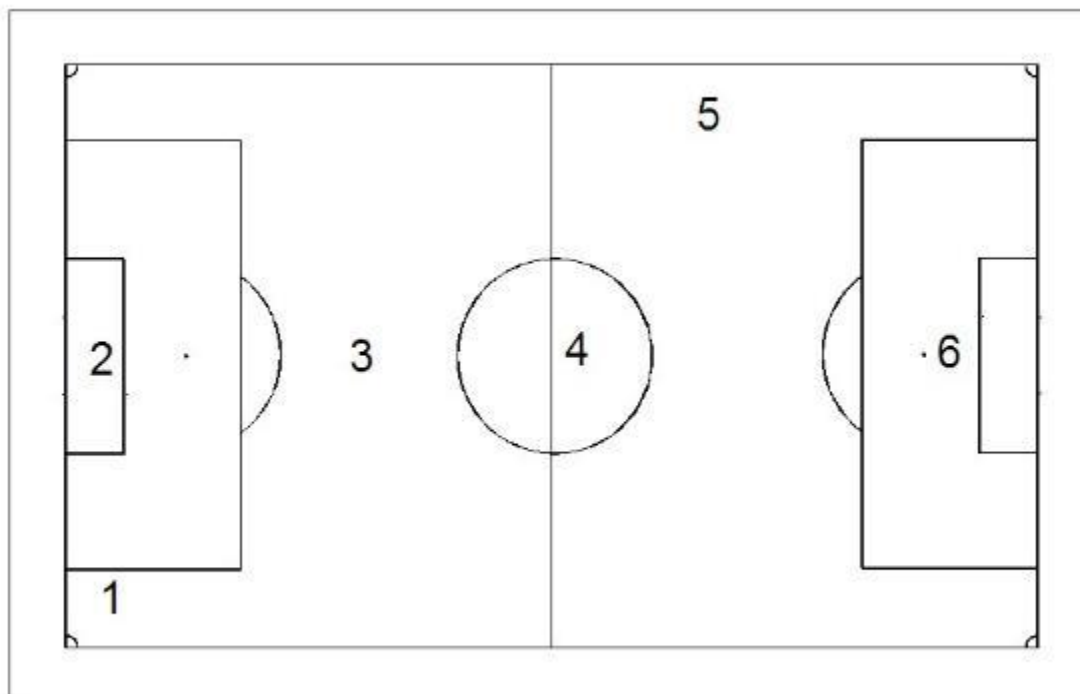


Figure 2: Field test positions

Field tests should not be made on joints or inlaid lines, other than ball roll that will traverse them.

5. Test conditions

5.1. Laboratory tests

Laboratory tests shall be made at an ambient laboratory temperature of $23 \pm 2^\circ \text{C}$.

Test specimens shall be conditioned for a minimum of 3 hours at the laboratory temperature prior to testing.

Laboratory tests shall be made on dry and wet test specimens as specified in the appropriate test procedure.

5.2. Preparation of wet test specimens

Wet specimens shall be prepared by evenly applying to the test piece a volume of water that thoroughly soaks the specimen (if in doubt this should be equal to the volume of the test specimen). Following wetting the test specimen shall be allowed to drain for 15 minutes and the test carried out immediately thereafter.

6. Field (site) tests

Tests on site shall be made under the prevailing meteorological conditions, but with the surface temperature in the range of -5°C^1 to $+50^\circ\text{C}$. If weather conditions make it impossible to undertake tests within the specified temperature range the deviation from the specified test conditions shall be

¹ The field may be tested at temperatures as low as -5°C provided there is no ice on the field at time of testing.

clearly noted in the test report. In cases of failure a retest shall be undertaken within the specified range.

The surface and ambient temperatures and the ambient relative humidity at the time of test shall be reported.

Ball roll and ball rebound tests (unless the test area is screened from the wind) shall be made when the maximum prevailing wind speed is less than 2 m/s. The wind speed at the time of test shall be reported.

If weather conditions make it impossible to undertake ball roll tests within the specified wind speed range and as a consequence the ball roll is found to exceed the relevant requirement a reduced test programme may be carried out where screening (e.g. by means of a plastic tunnel) is used to reduce the maximum wind speed to less than 2 m/s providing the free pile height (height of pile above any infill) is consistent (± 3 mm of the mean for the pitch) and the pile over the entire field is predominately vertical in each of the standard Field Test Positions. In the reduced test programme ball roll shall be measured in four directions (0° , 90° , 180° and 270°) on at least one area of the pitch, three ball rolls in each direction. If the free pile height is found to be inconsistent ($> \pm 3$ mm of the mean for the pitch) or not predominately vertical in each test position ball roll shall be measured in each of the standard Field Test Positions using screening as necessary. The Mean Free Pile Height for the pitch shall be calculated by measuring the free pile height at each of the field test positions at 0m, 5m and 8m spacings at 0° , 90° , 180° and 270° (twelve readings at each of the six test positions).

7. Balls used for test

Tests shall be made with a FIFA QUALITY PRO football². Immediately prior to any test, the pressure of the ball shall be adjusted so the ball gives a rebound on concrete to the underside of the ball, at the prevailing ambient temperature, of 1.35 ± 0.03 m, from a drop height of 2.0 ± 0.01 m. If the pressure adjustment is excessive and exceeds the ball pressure of its manufacturer's recommended range, the ball should be rejected.

To prevent damage to the skin of the ball, the ball used to measure ball roll shall not be used for any other tests.

Note: To minimise the effect on results of the inherent variations found in footballs, FIFA accredited test laboratories are supplied with specially selected test balls.

8. Football studs used for test

The studs used on the Rotational Resistance (Methods FIFA 06 and FIFA 06a) and the sample conditioning roller shall be in accordance with Figure 3. They shall be manufactured from plastic and have a Shore A Hardness of 96 ± 2 .

² 'FIFA Approved' footballs (designated prior to 2014) are permitted for testing.

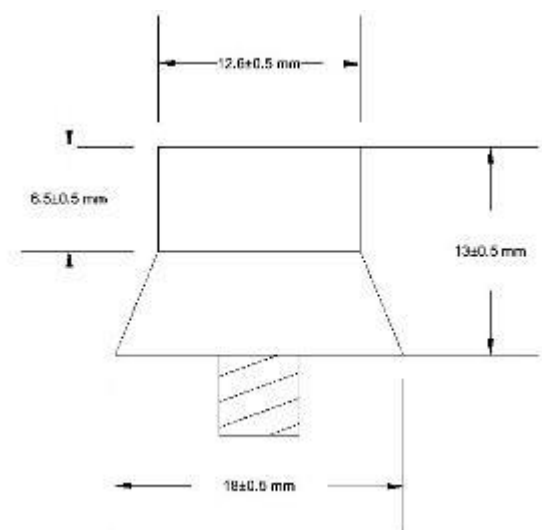


Figure 3: Profile of football stud (new)

8.1. Stud replacement – Rotational Resistance

After a maximum of fifty tests, the length of the studs shall be determined. If any stud is found to be less than 11.0mm all studs shall be replaced.

9. Determination of ball rebound (FIFA Test Method 01)

9.1. Principle

A ball is released from 2.00 m and the height it rebounds from the surface is calculated.

Laboratory tests are also undertaken to assess the effects on this property of compaction of the surface due to simulated use of the surface.

9.2. Test apparatus

9.2.1. *Measuring device*

The test apparatus comprises:

- An electromagnetic or vacuum release mechanism that allows the ball to fall vertically from $2.00 \pm 0.01\text{m}$ (measured from the underside of the ball) without imparting any impulse or spin.
- Vertical scale or laser distance measuring devices to allow the drop height of the ball to be established.
- Timing device, activated acoustically, capable of measuring to an accuracy of 1ms.
- Football as specified in section 7. Balls used for test.
- Means of measuring wind speed to an accuracy of 0.1 m/s (field tests only).
- A thermometer capable of recording from a minimum range of -10°C to $+60^{\circ}\text{C}$ accurate to $\pm 0.5^{\circ}\text{C}$ to record the surface temperature

9.3. Test procedure

Validate the vertical rebound of the ball on concrete immediately before testing and adjust accordingly until it meets the specified value on concrete.

Check the wind speed is in accordance with section 6 Field (site) tests.

Release the ball from $2.00 \pm 0.01\text{m}$, underside of the ball to the above the top of the infill (in filled systems) or on the top of the pile on unfilled systems of the Football Turf surface and record the time between the first and second impact in seconds.

Note: To limit the influence of the valve, it will be preferentially positioned at the top of the ball when the ball is attached.

9.4. Calculation and expression of results

For each test calculate the rebound height using the formula:

$$H = 1.23 \times (T - \Delta t)^2 \times 100$$

Where:

- H = rebound height in cm
- T = the time between the first and second impact in seconds
- $\Delta t = 0.025\text{s}$

Report the value of ball rebound to the nearest 0.01m as an absolute value in metres e.g. 0.80m.

Quote the uncertainty of measurement as $\pm 0.03\text{m}$.

9.5. Laboratory tests at $23 \pm 2^{\circ}\text{C}$

9.5.1. *Procedure*

Determine the ball rebound of the test specimen in five positions, each at least 100mm apart and at least 100mm from the edges of the test specimen. Re-condition the sample to its original state as per the manufacturer's declaration prior to each individual ball rebound.

Undertake tests under dry and wet conditions, as appropriate.

9.5.2. Calculation of results

Calculate the mean value of the ball rebound from the five tests.

9.6. Laboratory tests after simulated-use (Lisport XL)

9.6.1. Procedure

Condition the test specimen in accordance with Appendix I Lisport XL | Sample preparation procedure.

Leave the sample in place and perform the tests below with the sample in the Lisport XL machine. Record the temperature of the surface to the nearest whole degree.

Determine the ball rebound of the test specimen in a minimum of five positions. Each measurement shall be made on the fully conditioned area of the test specimen at least 250mm from any edge and 150mm from any other test position. Remove any displaced infill from adjacent tests prior to making a test.

Undertake tests under dry conditions except when moisture is an inherent constituent of the system.

9.6.2. Calculation of results

Calculate and report the mean value of ball rebound from the five tests.

9.7. Field tests

9.7.1. Test Conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of section 6 Field (site) tests. The conditions shall be reported.

9.7.2. Procedure

Record the maximum wind speed during the test.

At each test location make five individual measurements, each at least 300mm apart.

9.7.3. Calculation of results

Calculate the mean value for ball rebound from the five tests for each test location and report these.

10. Determination of Angle Ball Rebound (FIFA Test Method 02)

10.1. Principle

A ball is projected, at a specified speed and angle, onto the surface. The angle ball rebound is defined as the ratio of the ball's velocity just after impact to the velocity just prior to impact.

10.2. Test apparatus

The test apparatus comprises:

- A pneumatic cannon capable of projecting the ball onto the surface at the specified angle and velocity.
- Radar gun capable of determining the horizontal speed of the ball before and after its impact with the test specimen. The radar gun must read to 0.1 km/h.
- Football as specified in section 7. Balls used for test.

10.3. Test procedure

Validate the vertical rebound of the ball on concrete immediately before the testing and adjust accordingly until it meets the specified value on concrete.

Adjust the pneumatic cannon so that the vertical height of the lowest point of the diameter of the cannon mouth is $0.90 \pm 0.02\text{m}$ above the top of the infill (in filled systems) or on the top of the pile on unfilled systems so the ball departs the cannon at an angle of $15 \pm 2^\circ$ to the horizontal and has a velocity of $50 \pm 5\text{ km/h}$ immediately prior to impacting the surface.

Position the radar gun so it is adjacent to the cannon, parallel to the surface, aligned in the direction the ball will be fired and at a vertical height to the middle of the radar gun of $475\text{mm} \pm 25\text{mm}$ from the test surface.

Project the ball onto the surface and record the velocity of the ball immediately before and immediately after impact with the surface.

Repeat the procedure five times, ensuring that ball does not strike within 100mm of the same position twice.

10.4. Calculation and expression of results

Calculate the angle ball rebound using the formula:

$$\text{Angle Ball Rebound}(\%) = \frac{S_2}{S_1} \times 100$$

Where:

S_2 = velocity immediately after rebound in km/h to the nearest 0.1km/h

S_1 = velocity immediately before rebound in km/h to the nearest 0.1km/h

Report the angle ball rebound as a percentage to the nearest whole number e.g. 55%.

Quote the uncertainty of measurement as $\pm 5\%$ absolute.

10.5. Laboratory tests

10.5.1. Procedure

Determine the angle ball rebound of the test specimen, ensuring each test position is each at least 100mm apart and at least 100mm from the sides of the test specimen.

Rotate the test specimen by 90° and repeat

Undertake tests under dry and wet conditions, as appropriate.

10.5.2. Calculation of results

Calculate the mean value of angle ball rebound from the five tests for each direction of test.

Calculate the mean value of angle ball rebound from the two directions of test.

11. Determination of Ball Roll (FIFA Test Method 03)

11.1. Principle

A ball rolls down a ramp and traverses the surface until it comes to rest. The distance the ball has travelled across the surface is recorded.

11.2. Test apparatus

The test apparatus comprises:

- A ball roll ramp as shown in Figure 4 consisting of two smooth parallel rounded bars with a maximum diameter of the contact area with the ball of 40mm, whose inside edges are 100 ± 10 mm apart. The ball shall transfer from the ramp to the surface without jumping or bouncing.
- Method of measuring the distance the ball rolls to an accuracy of ± 0.01 m (e.g. steel tape, laser).
- Football as specified in section 7. Balls used for test.
- Means of measuring wind speed to an accuracy of 0.1 m/s (field tests only).
- A thermometer capable of recording from a minimum range of -10°C to $+60^{\circ}\text{C}$ accurate to $\pm 0.5^{\circ}\text{C}$ to record the surface temperature.

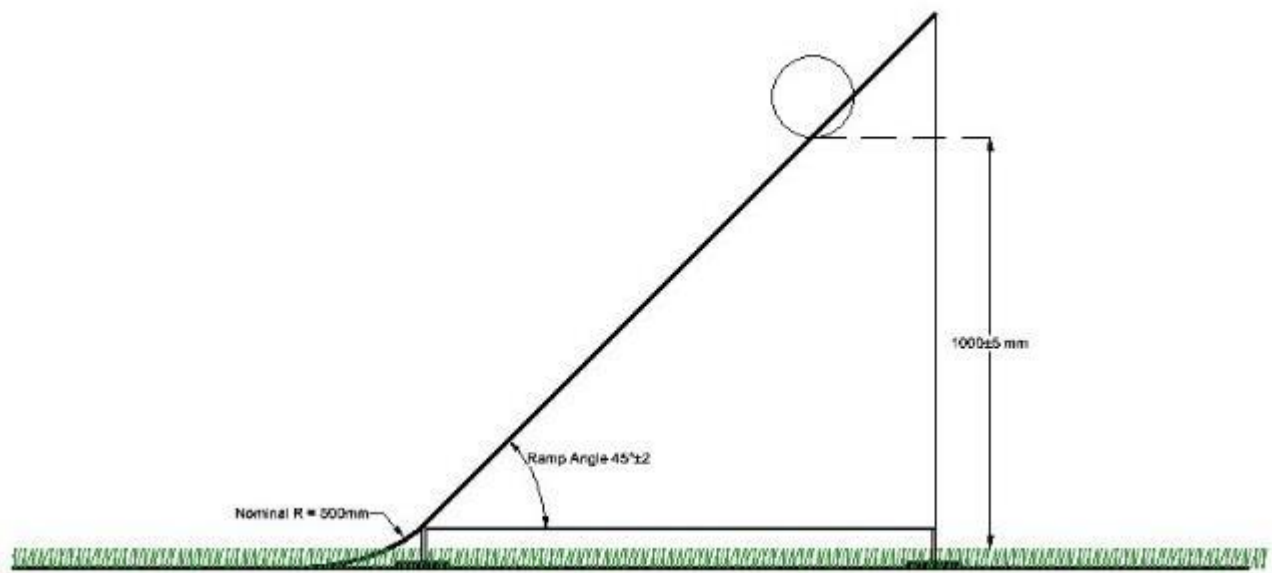


Figure 4: Ball Roll ramp

11.3. Test procedure

Validate the vertical rebound of the test ball on concrete immediately before the testing and adjust accordingly until it meets the specified value on concrete.

Adjust the ramp so that it is perpendicular to the surface and so the end of the guide rails are resting on the top of the infill (in filled systems) or on the top of the pile on unfilled systems, in practice the

ramp is likely to be resting on the “thatch” of the non-filed system rather than on top of the pile, so that the ball rolls smoothly from the ramp onto the surface without jumping or bouncing.

Place the ball on the ball roll ramp so the point approximately below the centre of the ball sitting on the ramp is 1000 ± 5 mm above the test specimen.

Check the wind speed is in accordance with section 6 Field (site) tests.

Release the ball and allow it to roll down the ramp and across the test specimen until it comes to rest.

Measure the distance from the point the ball first comes into contact with the test specimen (top of carpet pile) to the point below the centre of the ball resting on the test specimen at the position the ball came to rest.

11.4. Expression of results

Report the Ball Roll value to the nearest 0.1m e.g. 6.9m

Quote the uncertainty of measurement as ± 0.05 m.

11.5. Field tests

11.5.1. Test conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 6 Field (site) tests. The conditions shall be reported.

11.5.2. Procedure

Record the wind speed during the test.

At each test location make three individual measurements, each at least 100mm apart.

Undertake the tests in at least four directions (0° , 90° , 180° and 270°) with three individual measurements in each direction to determine if the result is influenced by factors such as slope or turf direction.

If there is slope ensure that the ball roll is carried out up and down the slope, and if there is a crown(s) do not perform the test in a location resulting in the ball rolling over the crown in any direction.

11.5.3. Calculation of results

For each test position/direction calculate the mean value of ball roll from the three tests in each direction.

Calculate the mean value of ball roll from all four directions at each test position.

12. Determination of Shock Absorption (FIFA Test Method 04a)

12.1. Principle

A mass with a spring attached to it is allowed to fall onto the test specimen.

The acceleration of the mass is recorded, from the moment of its release until after its impact on the test specimen. The Shock Absorption is calculated by comparing the maximum force on the test specimen with the reference force of impact on concrete. The Shock Absorption is calculated as a reduction of the impact force on the sample compared to a reference force. Reference force (F_{ref}) is fixed to 6760N (theoretical value calculated for a concrete floor.).

12.2. Test Apparatus

The apparatus used to measure the Shock Absorption is called the **Advanced Artificial Athlete, AAA**. The schematic design of the AAA apparatus is depicted in Figure 5 below, together with a list of its main components. These essential components are then further specified below.

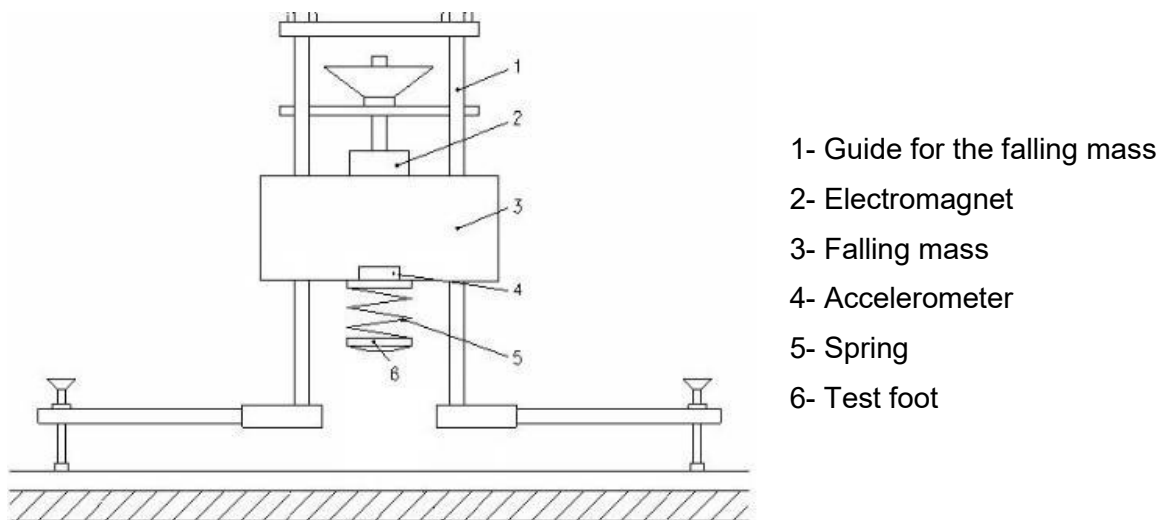


Figure 5: AAA test apparatus

12.2.1. *Electromagnet (2)*

The Electromagnet holds the mass (3) at the specified height which can be set to an accuracy of ± 0.25 mm.

12.2.2. *Falling mass (3)*

The falling mass incorporates an accelerometer, a spiral metal spring (5) and a steel test foot (6).

The total mass of (3) + (4) + (5) + (6) shall be $20,000 \text{ g} \pm 100 \text{ g}$.

12.2.3. *Piezo-resistive accelerometer (4)*

The accelerometer has a 50g full scale capacity ($= 50 \times 9.80665 \text{ m.s}^{-2}$), with the following characteristics:

Minimum cut-off frequency of 1000Hz (attenuation of -3db)

Linearity: 2% over the operating range.

The g-sensor should be positioned on the vertical line of gravity of the falling mass over the spiral steel spring. The g-sensor should be firmly attached to the mass to avoid natural filtering or extraneous vibrations of the accelerometer.

12.2.4. *Spiral steel spring (5),*

The spring rate is $2000 \pm 100 \text{ N/mm}$ and is linear over the range 0.1 to 7.5 kN.

The linear characteristic of the spring is controlled with maximum increment of 1000 N.

The spring shall be positioned centrally below the point of gravity of the falling mass.

The spring shall have three coaxial coils rigidly fixed together at their ends.

The mass of the spring shall be $800\text{ g} \pm 50\text{ g}$.

12.2.5. Test foot (6)

The test foot has a diameter $70 \pm 1\text{ mm}$ and a minimum thickness of 10 mm.

The lower side part of the test foot is rounded with a radius of $500\text{ mm} \pm 50\text{ mm}$ and has an edge radius of 1 mm.

The mass of the test foot shall be $400\text{g} \pm 50\text{g}$.

12.2.6. Test apparatus frame

The frame consists of three adjustable supporting feet.

- The feet are at a distance of not less than 250 mm from the point of impact of the falling mass on the test specimen.
- The frame is designed to ensure that the mass of the apparatus is equally distributed on its three feet.
- For the apparatus with the mass, the pressure resulting on each foot must be less than 0.020 N/mm^2 . For the apparatus without the mass, the pressure resulting on each foot must be more than 0.003 N/mm^2 .

12.2.7. Signal recording

A means of filtering and recording the signal from the accelerometer and a means of displaying the recorded signal (see the figure 6).

Sampling rate: minimum 9600 Hz

Electronic A/D converter with a minimum resolution of 16 bits

Signal filtration with a 2nd order low-pass, Butterworth filter with a cut-off frequency of 600 Hz.

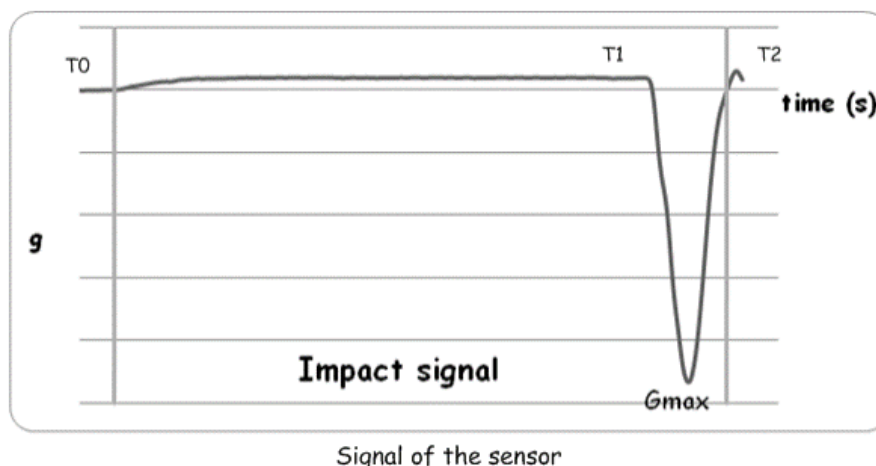


Figure 6: Example of curve representing falling mass acceleration versus time

Where:

- T0: time when the mass starts to fall
- T1: time when the test foot makes the initial contact with the surface (it corresponds with the maximum velocity of the falling mass V_{\max}^* , see figure 7)

- T2: time at the maximum velocity of the mass after it rebounds from the impact on the test specimen (determined by V_{min}^* , see figure 7)

* V_{max} and V_{min} could be positive or negative values, depending on the accelerometer set-up.

A means of calculating the velocity and the displacement of the falling mass during its travel by integration and double integration of the accelerometer signal (see figure 7).

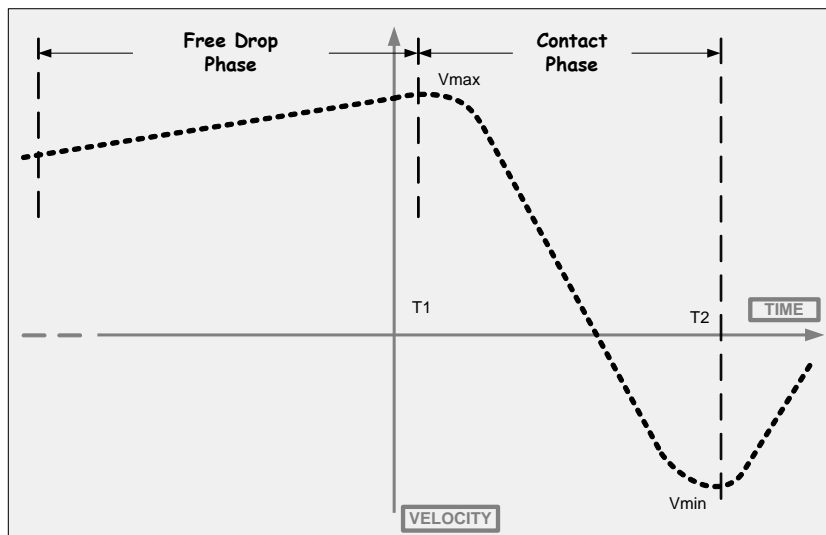


Figure 7: Example of curve representing velocity of the falling mass versus time

12.3. Auxiliary equipment for tests at -5°C

A conditioning cabinet capable of maintaining a temperature of -8°C to -12°C.

A tray for test specimens with the following design specifications:

Internal dimensions of at least 450 mm by 450 mm.

Depth at least 10 mm higher than the test specimen thickness.

Base of rigid mesh, to allow the free draining of water from the test specimens.

A thermometer capable of recording from a minimum range of -15°C to + 60°C accurate to $\pm 0.5^\circ\text{C}$ to record the surface temperature.

12.4. Auxiliary equipment for tests at 50°C

An air circulating oven compliant with ISO 188.

A thermometer capable of recording from a minimum range of -15°C to + 60°C accurate to $\pm 0.5^\circ\text{C}$ to record the surface temperature.

A thermometer capable of recording from a minimum range of -10°C to + 60°C accurate to $\pm 0.5^\circ\text{C}$ to record the surface temperature for site testing.

12.5. Verification of the apparatus: falling mass impact velocity and lift height

This verification is essential to ensure the correct functioning of the apparatus and is compulsory:

For lab tests: at regular intervals, in accordance with the intensity of usage of the apparatus. The recommendation is one verification for every day of testing.

For field tests: before any on-site field testing.

The verification procedure consists of four steps and must be carried out on a stable and rigid floor (this is defined as a floor with no significant deflection under a pressure of 5 kg/cm²).

Step 1

Set up the apparatus for a vertical free drop. Verticality tolerance: maximum 1°.

Set the height of the lower face of the test foot at 55.00 ± 0.25 mm above the rigid floor.

Drop the mass on the concrete floor and record the acceleration of the falling mass.

Step 2

Repeat Step 1 two more times, creating a total of three impacts.

Step 3

For each impact, integrate the acceleration signal from T0 to T1 and calculate the initial impact velocity. Calculate the mean impact velocity of the 3 impacts.

The mean impact velocity shall be in the range of 1.02 m/s to 1.04 m/s.

Step 4

After verification of the impact velocity, place the falling mass on the rigid floor.

Measure the height between a static reference point on the apparatus (for example the underside of the magnet) and the top of the falling mass.

This height will be a reference and shall be used for all subsequent measurements; it is designated as the “**lift height**”.

12.6. Test procedure

Set up the apparatus vertically ($90^\circ \pm 1$ degree) on the test specimen.

Lower the test foot smoothly onto the surface of the test specimen.

Within 10 seconds, set the reference “lift height” described in Step 4 of the verification of the apparatus above and attach the falling mass to the electromagnet.

First impact:

After 30 (± 5) seconds (to allow the test specimen to relax after removal of the test mass) release the mass and record the acceleration signal.

Within 10 seconds after the impact, check the lift height and re-attach the mass to the electromagnet.

Second impact:

After 30 (± 5) seconds, release the mass and record the acceleration signal.

Within 10 seconds after the impact, check the lift height and re-attach the mass to the electromagnet.

Third impact:

After 30 (± 5) seconds, drop the mass and record the acceleration signal.

Do not brush or adjust the surface in any way between impacts.

12.6.1. Shock absorption calculation

Calculate the peak force (F_{\max}) at the impact with the following formula,

$$F_{\max} = m \times g \times G_{\max} + m \times g$$

Where

- F_{\max} , is the peak force, expressed in Newton (N).
- G_{\max} , is the peak acceleration during the impact, expressed in g (1 g = 9.81 m/s²).
- m, is the falling mass including spring, test foot and accelerometer, expressed in kg.
- g, is the acceleration by gravity (9.81 m/s²).

Calculate the Shock absorption, SA, using the following formula:

$$SA = \left[1 - \frac{F_{max}}{F_{ref}} \right] \times 100$$

Where:

- SA, is the Shock Absorption in %.
- F_{max} , is the Force max measured on the sport surface, in N.
- F_{ref} , is the reference force fixed to 6760 N (theoretical value calculated for a concrete floor).

Expression of the results:

Report the Shock Absorption value to the nearest 0.1%, e.g. 56.9%.

Quote the uncertainty of measurement as $\pm 1.8\%$ absolute.

12.7. Laboratory tests

The laboratory test floor must be a concrete floor with the following requirements:

A minimum thickness of 100mm

Concrete hardness of minimum 40 MPa, verified according to EN 12504-2 “Testing concrete in structures – Part 2: Non-destructive testing – Determination of rebound number”.

12.7.1. Laboratory tests at $23 \pm 2^\circ\text{C}$

Make three impacts on the same spot of the test specimen according to Test Procedure 11.4.

Do not brush or adjust the surface in any way between impacts.

Repeat the procedure in three positions, each at least 100mm apart and at least 100mm from the edges of the test specimen.

Calculate the mean value of Shock Absorption of the three positions.

Undertake tests under dry and wet conditions, as appropriate.

12.7.2. Laboratory tests at -5°C

Place the tests specimen in the sample tray and immerse in water to a depth of at least 10 mm above the top of the artificial turf pile.

After a minimum of one hour, remove the tests specimen from the water and place it on a free draining base to allow it to drain by gravity for 30 ± 2 minutes.

Place the test specimen and sample tray in a conditioning cabinet at a temperature of maximum -8°C .

After a minimum of 24 hours, remove the tests specimen and tray from the conditioning cabinet. Unless the test specimen includes an unbound mineral base, carefully remove it from the tray ensuring any infill materials are not disturbed.

Place the test specimen on the test floor and allow it to warm. Monitor its temperature using a temperature probe inserted into the top of the performance infill on filled systems or on the top of the primary backing for non-filled systems.

When the temperature probe reads -5°C , record the Shock Absorption (Force Reduction) (only one impact). Move the AAA and repeat to obtain three results.

The temperature of the test specimen shall not rise above -3°C during the test.

Do not brush or adjust the surface in any way before impacts.

Undertake tests under dry conditions only.

Calculate the mean value of Shock Absorption (Force Reduction) (-5°C) of three initial impacts.

Note: cooling a concrete slab in the freezer and using this as the test floor will extend the length of time available to undertake the tests. The concrete slab must be flat and not move during the tests.

12.7.3. Laboratory tests at 50°C

Preheat the oven at a temperature of 50 °C + 2°C.

Place the tests specimen inside the oven.

Inside the oven the test specimen shall be stable, unrestrained and exposed to circulating air on all sides.

After 240 ± 5 min, remove the test specimen from the oven and place it on the test floor.

Monitor its temperature using a temperature probe inserted into the top of the performance infill on filled systems or on the top of the primary backing for non-filled systems.

Determine the Shock Absorption, making three impacts on one location, according to test procedure 12.6.

The temperature of the test specimen shall not fall below 48°C.

Undertake tests under dry conditions only.

Calculate the Shock Absorption (Force Reduction) (50°C).

If the result of this initial first position fails the requirement, repeat the procedure on two other locations, at least 100mm apart from each other and at least 100mm from the edges of the test specimen.

Calculate the mean value of Shock Absorption (Force Reduction) (50°C) of the second and third impacts for each test position.

Calculate the mean value of the second and third impacts of Shock Absorption (50°C) of the three test positions.

Note: heating a concrete slab in the oven and using this as the test floor will extend the length of time available to undertake the tests. The concrete slab must be flat and not move during the tests.

12.7.4. Laboratory tests after simulated use (Lisport XL)

Condition the test specimen in accordance with Section 36.Appendix I Lisport XL | Sample preparation procedure for the specific Quality level.

Whenever possible, perform the tests with the test specimen inside the Lisport XL machine or carefully remove the test specimen from the Lisport XL machine and place it on the test floor.

Determine the Shock Absorption (Force Reduction) of the test specimen in five positions.

Each measurement shall be made on the fully conditioned area of the test specimen, at least 250mm from any edge and 150mm from any other test position.

Undertake tests under dry conditions only.

Calculate the mean value of Shock Absorption (Force Reduction) of the second and third impacts for each test position.

Calculate the mean value of Shock Absorption (Force Reduction) (simulated use) from the five test positions.

12.8. Field tests

12.8.1. Test conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 6 Field (site) tests. The conditions shall be reported.

12.8.2. Procedure

Tests shall be made in the 19 test positions shown in Figure 8: Field test positions; 15 test Positions are essentially fixed and shall be in the general positions shown. Positions – F, R, N and B may be in the positions shown or other locations selected at the discretion of the accredited technician. Bonded carpet joints should be avoided unless they are the cause of complaint or concern.

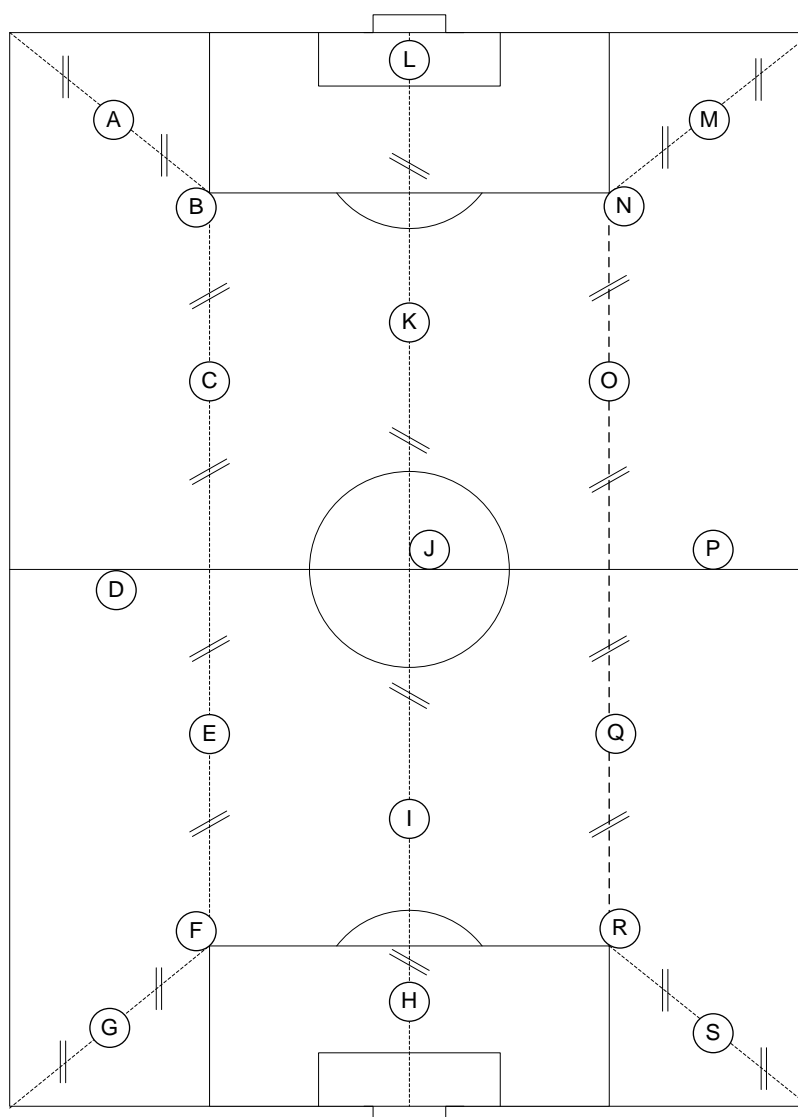


Figure 8: Field test positions

12.8.3. Calculation of results

Calculate the mean values (second and third impacts) of Shock Absorption (Force Reduction) for each test location.

13. Determination of Vertical Deformation (FIFA Test Method 05a)

13.1. Principle

A mass with a spring attached to it is allowed to fall onto the test specimen.

The acceleration of the mass is recorded, from the moment of its release until after its impact on the test specimen. The vertical deformation of the test specimen is calculated by the displacement of the falling mass into the test specimen after its impact on it.

13.2. Test Apparatus

See description in 12.2

13.3. Verification of the apparatus

See description in 12.5

13.4. Test procedure

See description in 12.6

13.4.1. Calculation and expression of Vertical Deformation

The displacement of the falling mass $D_{\text{mass}}(t)$ is calculated by integration of $V(t)$ on the interval $[T_1, T_2]$. Integration starts at (T_1) , the moment when the mass has reached its highest velocity.

On the time interval $[T_1 - T_2]$, the vertical deformation (VD) of the test specimen is defined as:

$$VD = D_{\text{mass}} - D_{\text{spring}}$$

Where:

- $D_{\text{mass}} = \int_{T_1}^{T_2} g \, dt$, with $D_{\text{mass}} = 0$ mm at T_1
- $D_{\text{spring}} = \frac{(m \times g \times G_{\text{max}})}{C_{\text{spring}}}$
- F_{max} is the peak force, expressed in Newton, N
- G_{max} is the peak acceleration during the impact, expressed in g (1 g = 9.81 m/s²)
- m is the falling mass, including spring, base plate and accelerometer expressed in kg
- g is the acceleration by gravity (9.81 m/s²)
- C_{spring} is the spring constant (given by the certificate of calibration)

Expression of the results:

Vertical Deformation is reported to the nearest 0.1mm

Quote the uncertainty of measurement as ± 0.1 mm.

13.5. Laboratory tests

13.5.1. Laboratory tests at $23 \pm 2^\circ\text{C}$

The Vertical Deformation is calculated for the three positions tested for the Shock Absorption (see 11.5.1).

Calculate the mean value of Vertical Deformation of the second and third impacts for each test position.

Calculate the mean value of the second and third impacts of Vertical Deformation of the three test positions.

Undertake tests under dry and wet conditions, as appropriate.

13.5.2. Laboratory tests at -5°C

The Vertical Deformation is calculated for the position tested for the Shock Absorption (see 11.5.2). Calculate the mean value of Vertical Deformation (-5°C) of the three first impacts.

13.5.3. Laboratory tests at 50°C

The Vertical Deformation is calculated for the position tested for the Shock Absorption (see 11.5.3). Calculate the mean value of Vertical Deformation (50°C) of the second and third impacts for initial test position.

If required calculate the mean value of the second and third impacts of Vertical Deformation (50°C) of the three test positions.

13.5.4. Laboratory tests after simulated use (Lisport XL)

The Vertical Deformation is calculated for the position tested for the Shock Absorption (see 11.5.4). Undertake tests under dry conditions only.

Calculate the mean value of Vertical Deformation of the second and third impacts for each test position.

Calculate the mean value of Vertical Deformation (simulated use) from the five test positions.

13.6. Field tests

13.6.1. Test conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 6 Field (site) tests. The conditions shall be reported.

13.6.2. Procedure

The Vertical Deformation is calculated for the position tested for the Shock Absorption (see 11.6.2).

13.6.3. Calculation of results

Calculate the mean values (second and third impacts) of Vertical Deformation for each test location.

14. Determination of Energy of Restitution (FIFA Test Method 13)

14.1. Principle

A mass with a spring attached to it is allowed to fall onto the test specimen. The acceleration of the mass is recorded, from the moment of its release until after its impact on the test specimen.

The energy of restitution is given by the comparison of energy of the falling mass before and after impact on the test specimen.

14.2. Test Apparatus

See description in 11.2

14.3. Verification of the apparatus

See description in 11.3

14.4. Test procedure

See description 11.4

14.4.1. Calculation and expression of test results

Calculate the energy restitution ER (%) defined by the formula:

$$ER(\%) = \frac{E_2}{E_1} \times 100$$

Where:

- E_1 is the energy before impact. $E_1 = 0.5 \times mV_{\max}^2$
- E_2 is the energy after impact. $E_2 = 0.5 \times mV_{\min}^2$
- V_{\max} is the velocity before impact at T1 (see figure 7) in m/s
- V_{\min} is the velocity after impact at T2 (see figure 7) in m/s
- m , is the falling mass including spring, base plate and accelerometer, expressed in kg

14.5. Laboratory tests

14.5.1. Laboratory tests at 23 ±2°C

The Energy Restitution is calculated for the three positions tested for the Shock Absorption (see 11.5.1).

Undertake tests under dry and wet conditions, as appropriate.

Calculate the mean value of Energy of Restitution of the second and third impacts for each test position.

Calculate the mean value of Energy of Restitution of the three test positions.

14.5.2. Laboratory tests after simulated use (Lisport XL)

The Energy Restitution is calculated for the position tested for the Shock Absorption (see 11.5.4).

Undertake tests under dry conditions only.

Calculate the mean value of Energy of Restitution of the second and third impacts for each test position.

Calculate the mean value of Energy of Restitution (simulated use) from the five test positions.

14.6. Field tests

14.6.1. Test conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 6 Field (site) tests. The conditions shall be reported.

14.6.2. Procedure

The Energy Restitution is calculated for the position tested for the Shock Absorption (see 11.6.2).

14.6.3. Calculation of results

Calculate the mean values (second and third impacts) of Energy of Restitution for each test position. Quote the uncertainty of measurement as $\pm 0.7\%$ absolute.

15. Determination of Rotational Resistance (FIFA Test Method 06)

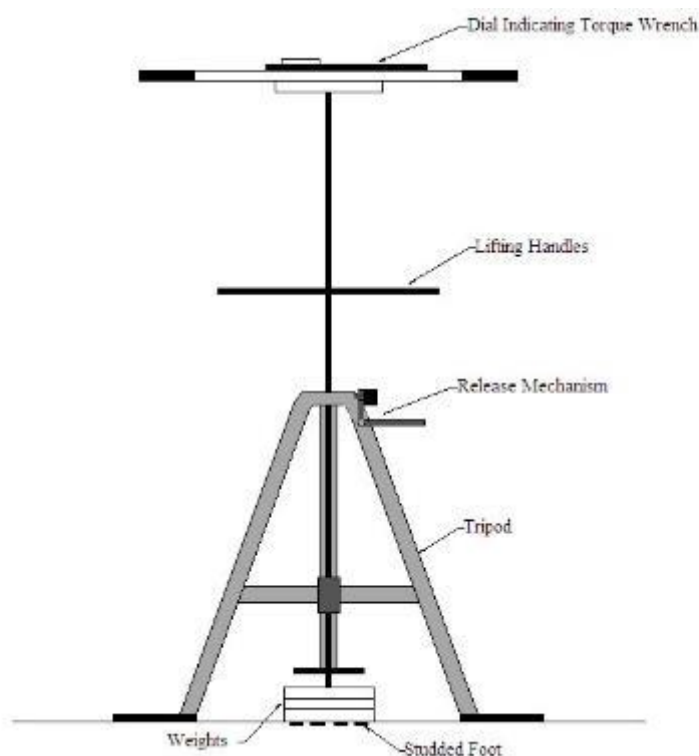
15.1. Principle

The Rotational Resistance of the surface is defined as the torque measured using a torque wrench when a loaded foot is allowed to horizontally rotate when in contact with the surface.

Laboratory tests are also undertaken to assess the effects on this property after simulated mechanical abrasion of the surface during use.

15.2. Test apparatus

- The principle of the apparatus is shown in Figure 7. It consists of the following:
- A test foot comprising a metal disc - 150 ± 2 mm in diameter with six football studs equally spaced on the underside surface each 46 ± 1 mm from the centre of the disc.
- A shaft with attached lifting handles that are attached centrally to the centre of the studded disc.
- A two-handed mechanical or digital torque wrench with a scale of 0 to a minimum of 60Nm in maximum 2 Nm increments, which attaches to the top of the shaft. Maximum weight for the torque wrench: 4.5kg.



- e. A set of annular weights which rest centrally on the upper surface of the studded disc and are able to freely rotate. The total mass of the apparatus (test foot, shaft, torque wrench and weights) shall be 46 ± 2 Kg.
- f. Tri-pod and guide to minimise lateral movement of the test foot during tests. The tri-pod shall not restrict the free rotation of the shaft and the guide shall incorporate a means of dropping the weighted test foot onto the test specimen from a height of 60 ± 5 mm.

15.3. Test procedure

Before conducting each test ensure that the disc and studs are cleared of any in-fill/detritus.

Assemble the apparatus and ensure the free movement of the test foot. Remove the torque wrench and drop the weighed test foot from a height of 60 ± 5 mm onto the surface. Reattach the torque wrench.

Zero the torque wrench indicator needle or tare the digital torque wrench.

Without placing any vertical pressure on the torque wrench and applying minimum rotational torque to the torque wrench, turn the wrench and test foot smoothly, without jerking, at a nominal speed of rotation of 12 ± 2 rev/min until movement of the test foot occurs and it has rotated through at least 45° .

Record the maximum value displayed on the torque wrench to the nearest Nm.

15.4. Calculation & expression of results

Calculate the mean value of Rotational Resistance.

Figure 9: Rotational Resistance apparatus

Report the mean result to the nearest 1Nm, e.g. 40Nm.

Quote the uncertainty of measurement as ± 2 Nm.

15.5. Laboratory tests

Determine the Rotational Resistance in five positions ensuring each test position is, at least 100mm (outside edge of test foot to outside edge) apart and at least 100mm (outside edge of test foot) from the edges of the test specimen. Calculate the mean from the five test positions.

Undertake tests under dry and wet conditions, as appropriate.

15.6. Laboratory test after simulated use (Lisport XL)

Whenever possible, perform the tests with the test specimen inside the Lisport XL machine or carefully remove the test specimen from the Lisport XL machine and place on the test floor. Determine the Rotational Resistance of the test specimen in five positions. Each measurement shall be made on the fully conditioned area of the test specimen, at least 250mm from any edge and 150mm from any other test position. Calculate the mean from the five test positions.

15.7. Field tests

15.7.1. Test Conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 6 Field (site) tests. The conditions shall be reported.

15.7.2. Procedure

At each test location make five individual measurements, each at least 100mm (outside edge of test foot to outside edge of test foot) apart.

16. Determination of Light Weight Rotational Resistance (FIFA Test Method 06a)

This test method can be used as an alternate to FIFA Method 06. Research has proven that both Lightweight and conventional Rotational Resistance devices provide highly comparable results.

16.1. Principle

The Rotational Resistance of a surface is defined as the measured torque required to rotate a loaded foot placed flat upon a test surface with an axis of rotation central to the test foot and perpendicular to the surface.

Laboratory tests are conducted to assess the expected Rotational Resistance characteristics of a surface during use.

16.2. Test apparatus

A schematic presenting the mechanical configuration of the apparatus is provided in Figure 10: Light Weight Rotational Resistance apparatus. It comprises of the following components:

- A circular test foot of diameter $150 \pm 2\text{mm}$ with six football studs (as described in Section 8. Football studs used for test of the Handbook of Test Methods) equally spaced on the underside of the test foot on a pitch radius of $46 \pm 1\text{mm}$ from the centre of the disc.
- A shaft is rigidly attached to the test foot and supported by a minimum of two low-friction bushings or bearings positioned at least 200mm from one another. The shaft-foot assembly must freely rotate around the vertical (z) axis only. When in operation, the shaft-foot assembly slides linearly in the vertical axis facilitating compression of the internal spring.
- The body of the device is rigidly attached to a baseplate upon which the operator stands or kneels. A minimum of six football studs (as described in Section 8. Football studs used for test of the Handbook of Test Methods) are arranged on the underside of the baseplate to minimise any counter-rotation during operation.
- A digital torque meter, of minimum range 5-60Nm and resolution of at least 0.1Nm is mounted on the top of the shaft-foot assembly. During operation, torque shall be applied using a single handled torque bar of length $500 \pm 10\text{mm}$.

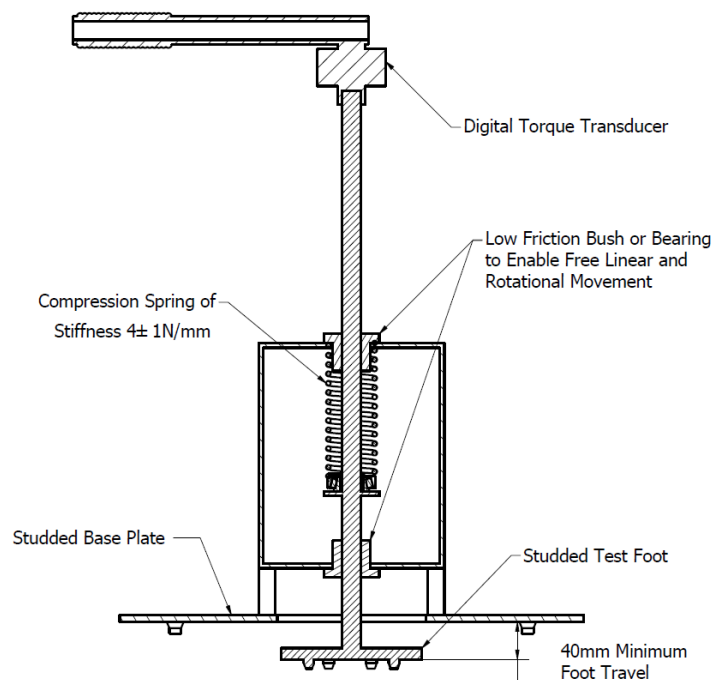


Figure 10: Light Weight Rotational Resistance apparatus

- The device houses a spring of stiffness $4 \pm 1\text{N/mm}$. The springs stiffness must remain within this tolerance over a compressed distance of at least 50mm following any pre-compression or 150mm when no-precompression is used.

The device applies a force of $450\text{N} \pm 20\text{N}$ through the test foot onto the surface when compressed by the operator standing mounting the baseplate. The spring shall compress by a minimum of 40mm when the device is mounted at which point the underside of the test foot shall align horizontally with the underside of the baseplate.

The applied force must include the force generated by the compression spring in addition to any downward force resulting from the mass of the shaft-foot assembly and any rigidly affixed components thereof.

When standing on the baseplate, the technician must take extra care to ensure the underside of the studded disk is parallel to the underside of the baseplate and no counterrotation of the baseplate occurs whilst applying torque to the shaft foot assembly.

Thought must be afforded in the equipment design to reduce to a minimum, any source of rotational friction not resulting from the interaction between the test foot and surface including but not limited to the shaft support mechanism, spring support mechanism and any other mating surface that may affect the peak torque value measured.

16.3. Test procedure

Before conducting each test ensure that the disc and studs are cleared of any in-fill/detritus.

Assemble the apparatus and ensure the free movement of the shaft and test foot. Place the test foot onto a representative area of the surface and avoid any large particles that may be present that could affect the stability of the baseplate or the values recorded by the test foot. The technician stands or kneels on the baseplate forcing the baseplate studs into the surface ensuring that it is both flat and stable upon the surface.

Without placing any vertical pressure on the torque wrench and applying minimum rotational torque to the torque wrench, turn the wrench and test foot smoothly, without jerking, a minimum of 120 degrees over a duration of approximately 4 seconds.

Record the maximum value displayed on the torque meter to the nearest 0.1Nm.

16.4. Laboratory tests

Determine the Rotational Resistance in five positions ensuring each test position is, at least 100mm (outside edge of test foot to outside edge) apart and at least 100mm (outside edge of test foot) from the sides of the test specimen. Calculate the mean from the five test positions.

Undertake tests under dry and wet conditions, as appropriate.

16.5. Laboratory test after simulated use

Whenever possible, perform the tests with the test specimen inside the Lisport XL machine or carefully remove the test specimen from the Lisport Wear machine and place on the test floor. Determine the Rotational Resistance of the test specimen in five positions. Each measurement shall be made on the fully conditioned area of the test specimen, at least 250mm from any edge and 100mm from any other test position. Calculate the mean from the five test positions.

16.6. Field tests

16.6.1. *Test Conditions*

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of section 6 Field (site) tests. The conditions shall be reported.

16.6.2. Procedure

At each test location make five individual measurements, each at least 100mm (outside edge of baseplate to outside edge of baseplate) apart.

16.7. Calculation & expression of results

Calculate the mean value of Rotational Resistance.

Report the mean result to the nearest 0.1Nm, e.g. 40.3Nm.

Quote the uncertainty of measurement as $\pm 1.6\text{Nm}$.

17. Determination of Skin / Surface Friction and Abrasion (FIFA Test Method 08)

17.1. Principle

A rotating test foot on which a silicon skin is mounted is allowed to move across a test specimen in a circular motion and the coefficient of friction between the silicon skin and the test specimen is calculated. The silicon skin is abraded during this circular motion on the surface. Skin Abrasion is defined as the relative difference in force required to pull the test foot with the silicon rubber over a metal plate before and after conditioning on the surface.

17.2. Apparatus

The test apparatus comprises:

- a. Securisport ® Sports Surface Tester.
- b. Test foot as detailed in Figure 10
- c. Silicon Skin Article Code #13110952 1mm thickness, ERIKS SAS, Lyon, 28 rue Wilson, 69150 Décines-Charpieu France
- d. Spirit level
- e. Polished steel test plate ($0.2\mu\text{m} < \text{Ra} < 0.4\mu\text{m}$).

17.3. Conditioning of samples by removal of excess spin oil

17.3.1. *Apparatus*

A shower with a water temperature of $40 \pm 5^\circ\text{C}$

A ventilated oven compliant to ISO 188

17.3.2. *Procedure*

Cut out the sample size required for the test.

The sample is rinsed in a shower for 5 minutes for a sample of 50x50cm.

If the sample size is larger, the rinsing time needs to be adjusted accordingly, so for example a 1x1m requires 20 minutes.

During the shower action, the shower head is moved in a way to distribute the water uniformly over the sample.

After the rinsing action, the sample needs to dry for a minimum of 24 hours, until a constant mass is achieved. A constant mass is defined as the mass attained when successive weighings at hourly intervals over a period of 3h do not vary more than 1%. (Definition ISO 8543)

Note: This can be speeded up by drying in a ventilated oven at maximum temperature of 50°C .

17.4. Procedure

17.4.1. *Silicon skin preparation*

Cut three silicon skins from the roll with dimensions 150mm x 80mm ($\pm 1\text{mm}$) using a sharp blade (a cutter is suitable) being careful to keep the surface that will be in contact with the product facing upwards. More precisely the smooth surface of the silicon skin, is the test face and will have to be kept facing upwards while the grooved side has to be attached to the test foot and can be in touch with the surface where the silicon skin will be cut.



Figure 11: Roll of silicon skin with smooth side upward



Figure 12: Measuring and cutting of the silicon skins



Figure 13: Silicon skins cutted and ready to be cleaned

17.4.2. Skin cleaning

Skin cleaning is one of the most important point of the test phase and must be done properly as following described.

Since the skins are cut, they must be handled using dust free nitrile gloves. Take a plastic (preferable) container and fill it with demineralized water.



Figure 14: Container with demineralized water

Using the gloves take the skins and immerse them in the water for 5 minutes taking care to keep the smooth side upward.



Figure 15: Silicon skin handled with dust free nitrile gloves

Take care the skins would not be superposed so the entire surface is exposed to water.



Figure 16: Skins immersed in water with smooth surface upward

Take each of the skins and remove, by rubbing with the hands the smooth surface, all the talcum powder present from the production process. Keep the skin immersed in the water while doing it.



Figure 17: Cleaning the silicon skins

Once all the skins have been cleaned, remove them from the water and hang them using clamps, letting them air dry for 24 hours at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$.



Figure 18: Drying of the skins

17.4.3. Test foot preparation

Once the skins are dried, they have to be mounted on the test foot. Test foot has to be realized in aluminium and fully in accordance with the following technical drawing.

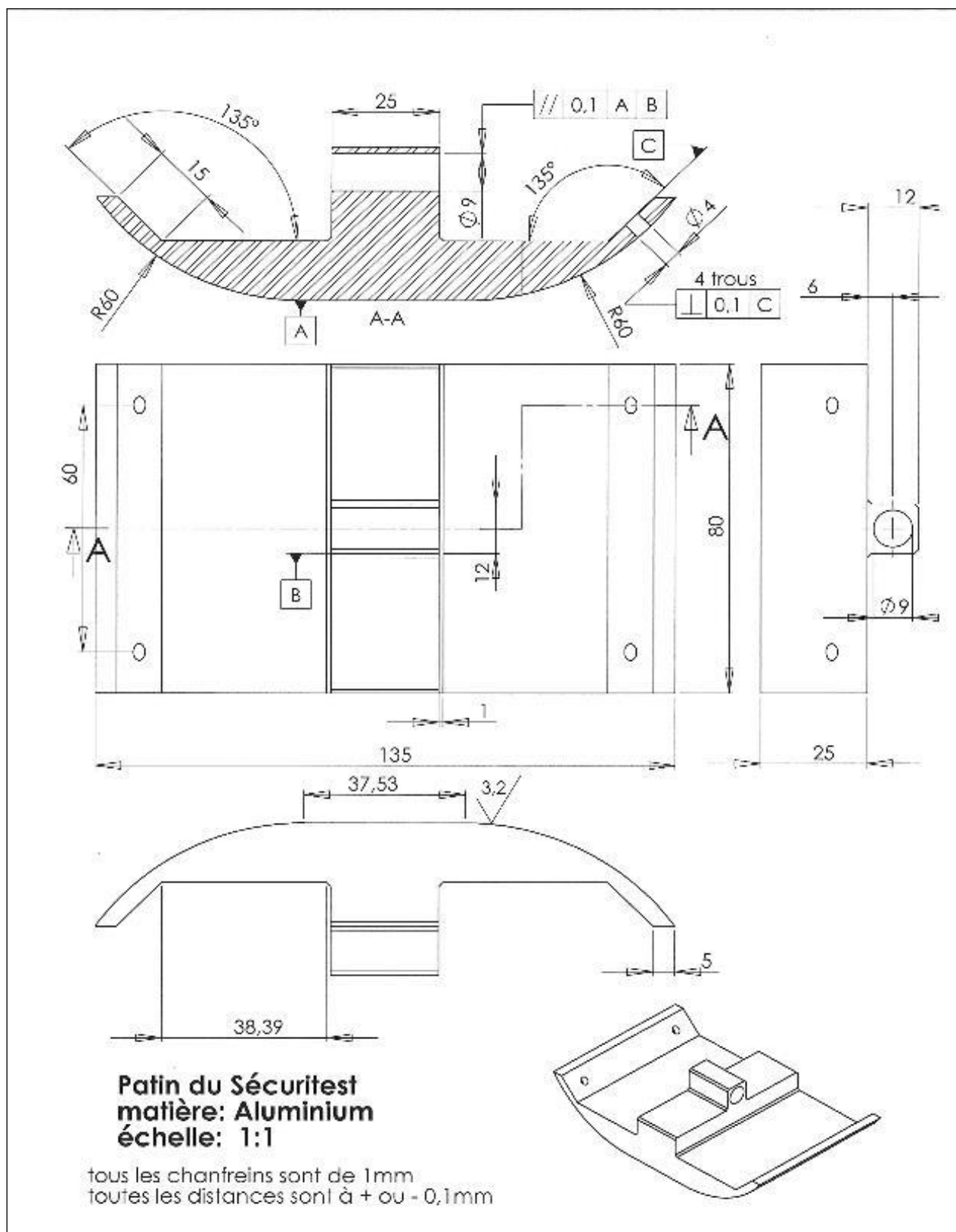


Figure 19: Test foot drawing

Take the test foot and clean it with acetone to remove any residue where the skin will have to be placed.



Figure 20: Photo of a test foot

Apply double-sided tape to the test foot as from the picture below.



Figure 21: Test foot with double-sided tape

Leave some spaces at the edges to avoid the double-sided tape's glue, would touch the carpet surface generating wrong readings.

Remove the protection and apply carefully the skin always using the gloves paying attention not to touch the test surface.



Figure 22: Test foot with the silicon skin taped

Perfor the holes on the silicon skin to apply the fixing screws using a die cutter or a suitable tool.

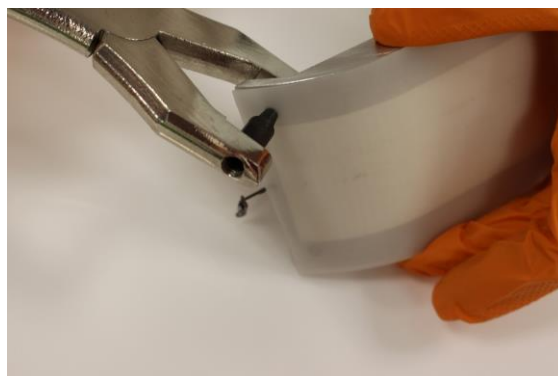


Figure 23: Holes perforation

Insert the screws to well fix the skin.



Figure 24: Test foot ready for testing

17.4.4. Set-up of the tensile machine

To measure the sliding force, use a dynamometer to have a constant pulling velocity.

Please ensure the traction rope is metallic or in any case not subject to stretching.

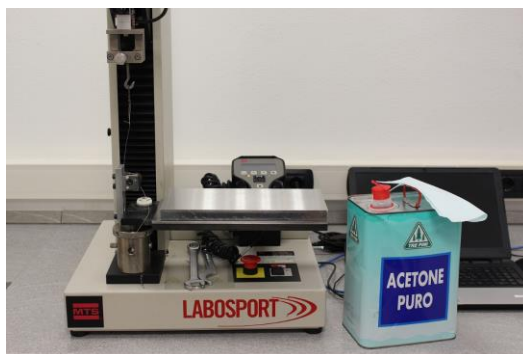


Figure 25: Tensile machine set-up

The metal reference plate shall be mounted on a rigid frame, perpendicularly to the pulling direction.

Make sure the weight of the complete test foot would have a total mass (test foot + additional mass + screws) of $1700\text{g} \pm 50\text{g}$. The additional mass shall be realized to ensure the test foot remain stable on the reference metal plate during sliding without jolts and oscillations.



Figure 26: Total mass of the test foot with additional mass

17.4.5. Determination of sliding distance force (Validation of the skins)

Thoroughly clean the entire surface of the metal plate with acetone using a non-woven cloth to leave no residue and allow it to evaporate for at least 5 minutes. Do not touch the surface after to have cleaned it.



Figure 27: Cleaning of the metal reference plate

Position the first test foot with the silicon skin applied as described before, on the metal plate after to have fixed the pulling rope. Pay attention to position it in the centre of the plate with the rope in tension.



Figure 28: Positioning of the test foot

Apply the additional mass on the test foot and make sure to adjust the height of the rope so that it is parallel to the plane of the metal plate and that you pull the test foot without generating vertical loads that can affect the sliding force. The test foot must not “oscillate” during pulling.

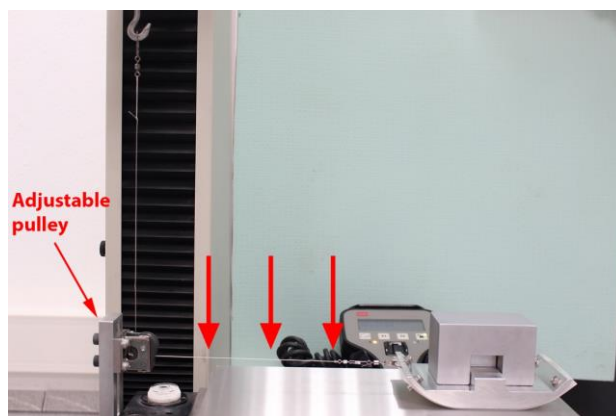


Figure 29: Test foot in position with the additional mass and aligned rope in tension

Now start the machine pulling the test foot on the reference metal plate over a sliding distance of 100mm +5mm at a speed of 500mm/min \pm 10mm/min. Repeat the force measurement at least ten times without to clean the metal reference plate between one measurement and another of the ten.

Determine the average force over a sliding distance from 40mm to 80mm.

Calculate the average force ($F_{\text{new skin}}$) of the ten measurements. Ensure the standard deviation is less than 0,3 and the average force is 6,0N \pm 1,5N.

Repeat the same procedure on two further sample of silicon skin for a total of three samples always cleaning the reference metal plate with acetone before to start the ten measurements.

Undertake the tests under laboratory condition of 23°C \pm 2°C before and after the appropriate number of cycles in the artificial wear machine (Lisport XL).

17.4.6. Determination of skin friction

Undertake the tests under laboratory condition of 23°C \pm 2°C.

Attach the test specimen to the laboratory floor to prevent movements during test.



Figure 30: Securisport Sport Surface Tester positioned, stabilized and ready to test

Ensure the machine is not moving and fluctuating during the test when the test foot is rotating. This will affect the results. The machine must be stabilized by means of a structure, or weights sufficient to avoid movements.

Pay attention to the infill of the samples to be tested. A uneven distribution of the infill may cause wrong readings. It is extremely important having the stabilizing infill layer (where applicable) and the performance infill layer applied in a proper way to avoid a difference of \pm 1mm for the stabilizing infill and \pm 2mm for the performance infill.

A minimum of 4 readings on the area of the test must be done before the test using the infill depth probe. If the difference is greater than the values admitted, the sample has to be discarded and a new one has to be infilled.

Position the Securisport Sport Surface Tester over the test specimen and adjust it to level it in all directions.

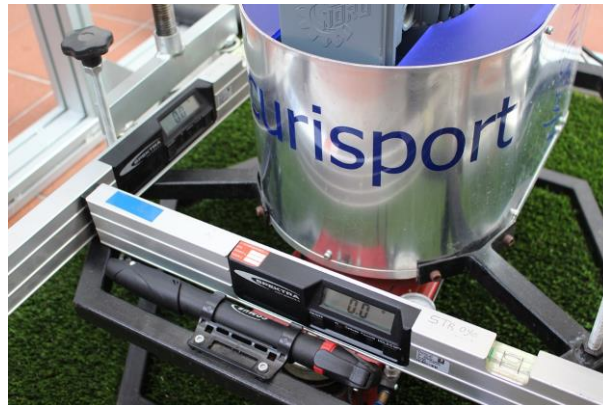


Figure 31: Machine levelled

Check the reset of the machine parameters.

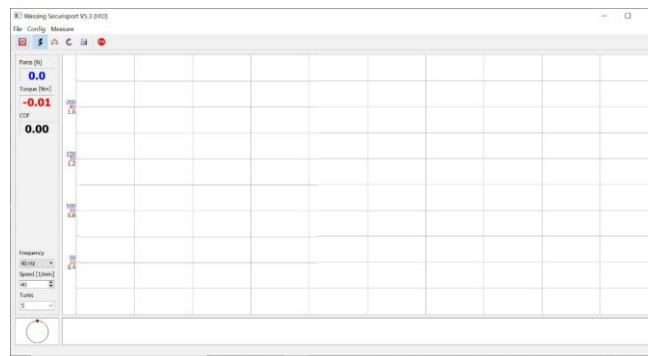


Figure 32: Zero of the Securisport before the tests

Attach the first of the three tests foot, to the machine. The direction of rotation must correspond to the direction of traction of the skin during the measurement of the sliding force.

Apply, by means of the cylinder, a vertical force to the test foot of $100\text{N} \pm 10\text{N}$.



Figure 33: Applying pressure to obtain $100\text{N} \pm 10\text{N}$



Figure 34: Test foot in position having the load applied

Start the rotation of the test foot. Allow the test foot to make 5 complete revolutions at a speed of 40rev/min \pm 1rev/min, sampling at a minimum frequency of 40Hz.

Ignoring any peak value occurring as the test foot starts to rotate, calculate the mean coefficient of friction value as displayed on the Securisport software.

Repeat the same procedure on two further sample of silicon skin for a total of three samples replacing any infill between tests.

17.4.7. Determination of skin abrasion

Carefully remove the test foot from the Securisport without touching the test skin. Remove

Any detritus from the test skin using DRY compressed air. Do not use air compressors that can bring water (from ambient) and oil (from engine) with the air.



Figure 35: Cleaning with DRY compressed air

Place the test foot with the silicon skin onto the cleaned metal reference plate adding the additional mass to arrive to a total mass of 1700g \pm 50g.

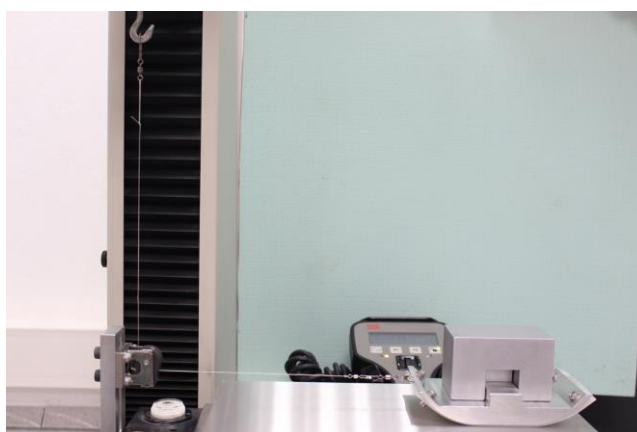


Figure 36: Starting position to measure the sliding force after Securisport

Determine the average force over a sliding distance of 40mm to 80mm.

Calculate the skin abrasion using the following formula:

$$\text{Skin abrasion} = 100 \times [F_{\text{new skin}} - F_{\text{abraded skin}}] / F_{\text{new skin}}$$

where:

- $F_{\text{(new skin)}}$ = the mean average force of the second to fourth tests prior to the Skin Friction test
- $F_{\text{(abraded skin)}}$ = the mean average force of the second to fourth tests after the Skin Friction test
- Report the result to the nearest 1% e.g. 10%
- Repeat the test three times.

Note: Values of uncertainty for this test are yet to be established.

18. Procedure for Artificial Weathering (FIFA Test Method 10)

18.1. Principle

Test pieces of pile yarn and polymeric infill are exposed to artificial weathering by fluorescent UV lamps under controlled environmental conditions and the resulting changes in colour, appearance and selected physical properties are determined.

18.2. Apparatus

Artificial weathering cabinet using fluorescent UV lamps and environmental controls having the following features:

- a. UVA-340 nm lamps (Type 1A), in accordance with EN ISO 4892-3:2016 and with a spectrum in accordance with EN ISO 4892-3:2006 and capable of uniformly applying radiation to the test specimen at an irradiance of 0.80 W/m²/nm at 340 nm.
- b. Exposure chamber, constructed from inert material and that provides uniform irradiance in accordance with item a) and that includes a means of controlling and measuring the relevant parameters.
- c. Wetting mechanism, either condensation or water spray, to wet the exposed face of the specimen, in accordance with EN ISO 4892-3:2006,
- d. An apparatus designed to wet the exposed faces of the specimens by means of a humidity-condensing mechanism, the water vapour shall be generated by heating water in a container located beneath and extending across the whole area occupied by the specimens. Specimen holders (filled with specimens) shall constitute the sidewall of the exposure chamber, so that the backs of the specimens are exposed to the cooling effect of the ambient room air. If wetting is provided by spraying the specimens, the water shall conform to EN ISO 4892-3:2006,
- e. Radiometer, conforming to EN ISO 4892-1:2000, 5.1.7, to monitor irradiance and radiant exposure.
- f. Black-panel thermometer, conforming to EN ISO 4892-1:2000.
- g. Specimen holders, made from inert materials that will not affect the results of the exposure.

18.3. Exposure conditions

The exposure cycle shall comprise 240 ±4 min of dry UV exposure at a black-standard temperature of 55°C ± 3°C, followed by 120 ±2 min of condensation exposure, commencing once equilibrium has been attained, without radiation, at a black-standard temperature of 45°C ± 3°C.

18.4. Test specimens

For otherwise identical products³ with different yarn thicknesses, only the thinnest product needs to be tested. The results from this test can apply to the entire range of the thicker products.

18.5. Procedure

Wrap, without strain, a specimen of the yarn around the specimen holders such that the exposed strands do not overlap and mount each other in the test cabinet with the flattened test surface facing the lamps. Fill any spaces, using blank panels, to ensure uniform exposure conditions.

Expose the specimen, measuring the irradiance and radiant exposure at the surface of the specimen. The exposure cycle shall comprise 240 ± 4 min of dry UV exposure at a black-panel temperature of 55 ± 3 °C, followed by 120 ± 2 min of condensation exposure, without radiation, at a black-panel temperature of 45 ± 3 °C. If sample wetting is by condensation, allow at least 120 min per interval to ensure a state of equilibrium exists. This time does not form part of the exposure cycle. After an exposure of $9,600 \pm 125$ kJ/m²/340nm, carefully remove the specimen from the exposure cabinet and test as required by the product specification.

Note: An exposure of (9600 ± 125) kJ/m²/340nm will require approximately 5000 h with cycling to complete to moisture cycling.

18.6. Assessment of test specimens

18.6.1. *Pile yarn(s)*

Assess the change in colour of the exposed test specimen when compared to an unexposed test specimen using the grey scale in accordance with EN ISO 20105-A02.

Determine the peak breakage force of the exposed pile yarn(s) in accordance with EN 13864 (minimum gauge length 100mm) and calculate the percentage change in peak breakage force (in N) compared to unexposed yarn.

18.6.2. *Polymeric infill materials (rubbers, thermoplastics, etc.)*

Assess the change in colour of the exposed test specimen (minimum 38cm²) when compared to an unexposed test specimen using the grey scale in accordance with EN ISO 20105-A02.

Photograph specimens of exposed and unexposed polymeric infills to show any visual effects of the artificial weathering.

Note: Organic infills or organic parts of mixed infills do not need to be exposed to artificial weathering.

³ Products with the same DSC trace (no more than ± 3 °C difference of the peak(s)), the same percentage of UV stabiliser and the same cross-sectional shape.

19. Assessment of synthetic infill (FIFA Test Method 11)

19.1. Principle

Synthetic infill is analysed to determine the ratio of organic to inorganic material present. To take account of different types of materials used as performance infill, this test is divided into two procedures depending on the infill used.

Organic (vegetal) infills don't have to be tested for TGA.

19.2. Apparatus

19.2.1. Thermogravimetric Analyzer (TGA) which has the following features:

- a. Heating rate up to 40°C/min
- b. nitrogen purge gas with a flow rate in the range 10ml/min to 50ml/min
- c. the analyzer should be maintained and calibrated in accordance with the manufacturer's instructions

19.2.2. Analytical balance with accuracy of ± 0.01 mg

19.2.3. Nitrogen supply.

19.3. Conditioning of samples

19.3.1. Ensure the sample is dry before placing it in the apparatus.

19.3.2. Switch on apparatus and allow to equilibrate for at least 30 min.

19.3.3. Use the same purge gas flow rate that was used to calibrate the instrument.

19.4. Procedure

19.4.1. Thermogravimetric Analysis (TGA) of SBR infill (from recycled tyres coated or uncoated)

Nitrogen purge gas flow rate within the range of 10 ml / min to 50 ml /min to be applied during the entire test

Sample weight should be between ≥ 40 mg and ≤ 100 mg

Heating programme:

- Heating from 50°C to 300°C with a heating rate of 15°C / min
- Maintain the sample at 300°C for 8 minutes
- Heating from 300°C to 650°C at a heating rate of 15°C / min
- Heating from 650°C to 850°C at a heating rate of 25°C / min

19.4.2. TGA of EPDM, TPE and other polymer infill types

Nitrogen purge gas flow rate within the range of 10 ml / min to 50 ml /min to be applied during entire test

Sample weight should be between ≥ 40 mg and ≤ 100 mg

Heating programme: 50°C to 850°C with a heating rate of 10°C / min

19.5. Assessment of test specimens

19.5.1. TGA on SBR infill

Measurement:

Organics: mass loss up to 650°C

Inorganics: 100% - % of organics

Elastomers: mass loss between 300°C and 650°C

19.5.2. TGA on EPDM, TPE and other polymer infill types

Measurement:

Organics: mass loss up to 650°C

Inorganics: 100% - % of organics

Elastomers (for EPDM only): mass loss between beginning of second peak (usually around 400°C) and 650°C

20. Procedure for the assessment of surface planarity (FIFA Method 12)

20.1. Principle

The evenness of the playing surface is measured with the aid of a straightedge pulled over the surface longitudinally and transversely between the play lines. Deviations beneath the straightedge are measured using a calibrated graduated wedge known as a slip gauge.

20.2. Apparatus

20.2.1. Straight edge design:

- a. Length 3000 ± 10 mm, Width $75\text{mm} \pm 5$ mm, Height $40\text{mm} \pm 5$ mm
- b. Minimum Weight 6.6 kg^4
- c. Linearity of the straight edge: ± 2 mm
- d. Rigidity of the straight edge: 2 mm minimum
- e. Sliding side on the surface: 75 mm x 3000 mm
- f. A means to pull the straightedge along, typically a rope. This can be attached to the straightedge directly or passed through a hollow core in the straightedge. The length of the rope should be sufficient as to allow the technician to pull the straightedge in a straight line and observe the potential deviations under it. The technician shall be at a distance of a minimum of 3.0m and a maximum of 5.0m from the straightedge when pulling it.

20.2.2. Wedge (slip gauge):

- a. Length $250 \pm 5 \text{ mm}^5$,
- b. Width 15 ± 2 mm.
- c. Height ranges from 2 to 18mm
- d. Angle of the wedge: $5 \pm 1^\circ$

The slip gauge should be graduated on its upper surface at intervals corresponding to a 1.0mm increase in height.

20.3. Procedure

⁴ The weight of the test device may need to be increased if the straight edge is not sitting on top of the infill due to resilient yarn. Add enough weight for the straight edge to be sitting on the top of the infill.

⁵ Where the 250mm wedge is too big, a small wedge or small ruler may be used to assess the deviation

- Starting from one of the corners with the centre of the straightedge on the centre of the touchline, the straightedge should be dragged across the playing surface parallel to the longitudinal lines.
- The straightedge should be pulled along the surface at such a speed and without sudden movements to ensure that it remains in contact with the surface and does not bounce off the surface.
- To ensure the playing surface is completely checked a minimum overlap of 0.5m between each successive pass is recommended.
- All deviations $\geq 10\text{mm}$ should be recorded on a site plan. It should be made clear whether the deviation is a high or low spot.
- Upon completion of the surface check parallel to the longitudinal lines the procedure should be repeated perpendicularly to the longitudinal lines.

20.4. Additional Remarks

Other defects may present themselves including (but not exclusively) open seams, open play lines, differing fibre lengths et cetera. All such defects should also be recorded on the site plan.

21. Procedure for the determination of heat on artificial turf products (FIFA Test Method 14)

21.1. Principle

A conditioned test specimen is exposed to surface infrared radiation.

Over a period of three hours the gain in surface temperature and backing of the specimen is recorded by means of infrared pyrometer and K-type thermocouple respectively. The test is conducted in a partial enclosure to reduce the effects of cross wind.

21.2. Apparatus

The primary components of the surface temperature apparatus are presented in Figure 37: Sectional Schematic of Apparatus for measuring heat (temperature increase) below, together with a list of the principle components.

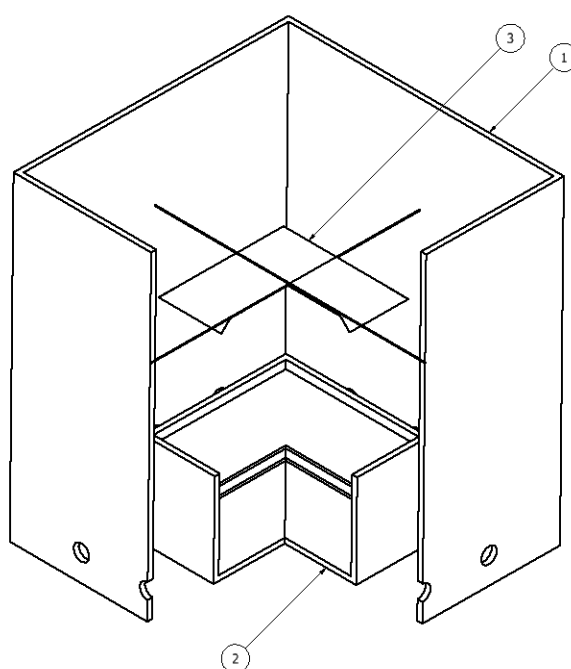


Figure 37: Sectional Schematic of Apparatus for measuring heat (temperature increase)

21.2.1. Apparatus Enclosure marked as 1 in Figure 37: Sectional Schematic of Apparatus for measuring heat (temperature increase)

The apparatus consists of an external box of internal dimensions: length 1000mm, breadth 1000mm and height 1200mm constructed from an unpainted wood-based material of thickness 15mm. All internal dimensions have a tolerance of ± 10 mm.

Three holes of diameter 60 ± 5 mm should be cut into each face of the enclosure at a height of 250 ± 5 mm from its base. Holes must be positioned on and 250 ± 5 mm either side of the centre of the enclosure panel.

21.2.2. Sample Container marked as 2 in Figure 37: Sectional Schematic of Apparatus for measuring heat (temperature increase)

The sample container positioned within 19.2.1 has internal dimensions: length 500mm, breadth 500mm and height 350mm constructed from an unpainted wood-based material of thickness 15mm. All dimensions carry a tolerance of ± 5 mm.

21.2.3. Infrared Lamp & Reflector as marked 3 in Figure 37: Sectional Schematic of Apparatus for measuring heat (temperature increase)

A square profile reflector of dimensions shown in Figure 38: Lamp and Reflector Arrangement.

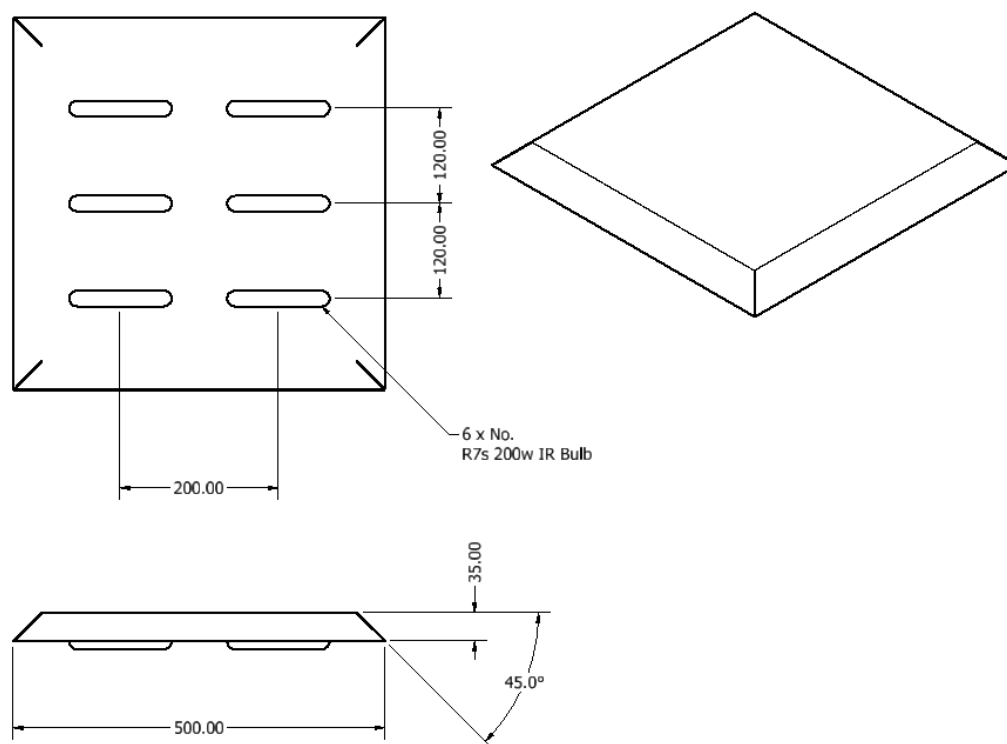


Figure 38: Lamp and Reflector Arrangement

Six bulbs are mounted in the positions shown in Figure 38: Lamp and Reflector Arrangement. Each bulb must have a rated output of 200W and of clear glass type. All bulbs should be replaced after a maximum of 150 hours of operation.

21.2.4. Infrared Pyrometer

An infrared pyrometer or similar equipment such as an infrared camera which meets the following specification:

- Minimum temperature range: 0 - 100°C
- Accuracy: $\pm 1^\circ\text{C}$ or 1.5% (whichever is greater)
- Resolution: 0.1°C
- Response time: 1 second
- Spectral response: 8 - 14 μm
- Emissivity value: 95%

21.2.5. Thermocouple

A thermocouple of the following specification:

- Minimum temperature range: 0 - 100°C
- Sensitivity: 0.1°C
- Type: K-Type
- Resolution: 0.1°C

21.2.6. Luxmeter

A luxmeter of the following or higher specification:

- a. Minimum measurement range: 0 – 1000lx
- b. Resolution: 0.01lx
- c. Accuracy: Class C in accordance to appendix B of EN13032-1

21.3. Sample preparation

Condition all sample material for 24 hours at $23\pm 2^{\circ}\text{C}$ prior to testing, for samples containing organic infill material; refer to section 21.3.3. Organic Infill Material for specific requirements.

21.3.1. Stone Sub-base Preparation

A sub-base of the following properties should be constructed within the sample container:

Moisture content of 0% by oven-drying the stone base

Particles size of 0/40mm when tested in accordance to EN 933-1

Layer thickness of $250\text{mm} \pm 5\text{ mm}$ (approximately 100kg of aggregate)

Stone should be manually compacted using a 10kg tamper to produce a density >90% calculated from the mass of the material and the measured volume.

Level with 2kg of oven dried 0.4 - 0.8mm sand

21.3.2. Test Specimen preparation

A 500x500mm sample of the turf to be tested should be placed directly onto the levelled stone sub-base material within the sample container.

The K-Type thermocouple should be attached by adhesive tape to the centre of the carpet backing in both samples with and without shockpads.

The infill should be evenly distributed into the carpet sample in accordance with the manufacturer's specification. Where samples require shockpads, the shockpad should be placed into the sample container onto the prepared stone base prior to the carpet sample.

21.3.3. Organic Infill Material

Organic infill material must be prepared and conditioned in the following stages:

Organic infill must be oven dried to a moisture content of 0%

Dried infill should be placed in a moisture proof bag or other appropriate airtight container and water added via mist spray to achieve the suppliers specified moisture content

Moistened infill must be sealed and conditioned within its container for a period of 24 hours at $23\pm 2^{\circ}\text{C}$

Carpet sample should be filled immediately prior to testing to avoid loss of moisture in the infill

21.4. Procedure

The test must be conducted at an ambient laboratory temperature of $23\pm 2^{\circ}\text{C}$.

Care should be taken not to conduct testing in close vicinity to sources of turbulent airflow such as doorways, air conditioning units, heavy machinery or windows.

The sample container is placed in the centre of the test enclosure.

The infrared reflector should be positioned centrally at a height of 675mm above the infill of the test specimen. The lamp must be positioned by such means as to avoid significantly reducing airflow from the top of the test enclosure e.g. steel wire.

Measurement of ambient air, specimen surface, carpet backing temperatures in addition to relative humidity should be recorded at the following time periods:

Phase	Elapsed Time (min)
1	0
	5
	10
	15
	20
2	30
	40
	50
	60
3	75
	90
	105
	120
	135
	150
	165
	180

Three surface temperature measurements are recorded at each period taken from the central portion of the specimen surface using the IR pyrometer. The IR pyrometer should be held at 500 ± 10 mm above the specimen surface when taking measurements.

A measurement of the bulb Lux output should be measured after an elapsed time of 180 minutes. The luxmeter sensor should be positioned in the centre of the sample surface and a measurement recorded. Where the intensity of the light falling upon the surface falls below (To be determined during current phase of testing), all bulbs must be replaced and any recorded data discarded.

21.5. Expression of results

21.5.1. Reporting

Test report must include the following information:

- Maximum surface temperature reached and relevant categorisation
- All temperature measurements of specimen surface, carpet backing and ambient air in addition to relative humidity in graphical and tabulated formats
- Final lux measurement after 180 minutes elapsed time

21.5.2. Categorisation

Category	Temperature Range °C
Category 1	<50
Category 1-2	50-54
Category 2	55-59
Category 2-3	60-65
Category 3	> 65

22. Procedure for the determination of wear on artificial turf (Lisport XL) (FIFA Test Method 15)

22.1. Principle

A trolley onto which is mounted two rotating plates and two studded rollers moves back and forth along a test specimen of the Football Turf to replicate the mechanical wear of the synthetic turf and compaction of the infill observed in practice on synthetic turf playing surfaces.

22.2. Apparatus

The Lisport XL shall comprise a trolley (or other means) onto which is mounted two rotating plates in the x,y plane and two bladed rollers (rollers must be dragged by the trolley and not be motorised). The trolley traverses the test specimen with a velocity of $0.15 \pm 0.01 \text{ m/s}$.



Figure 39: Overview of Lisport XL machine

22.2.1. *Rotating plates*

Each rotating plate shall have mechanical degree of freedom $\begin{Bmatrix} Tx \\ Ty \\ Tz \end{Bmatrix} \begin{Bmatrix} 0 \\ 0 \\ Rz \end{Bmatrix}$ and the following characteristics:

- The rotating plates shall be vertically independent of each other (see Figure 39: Overview of Lisport XL machine as an example) and be spaced (centres of each plate) from 250 to 350 mm apart⁶. Each rotating plate shall be fitted with a rectangular piece of rubber of $89 \times 900 \pm 1 \text{ mm}$ (x,y) and have a circular-translational movement based on a radius of $10.0 \text{ mm} \pm 0.25 \text{ mm}$, with a rotational speed of $540 \pm 10 \text{ rpm}$ rotating in the same direction but 180° out of phase.
- The rotating plates shall be designed to ensure a constant pressure of $30 \pm 1 \text{ g/cm}^2$ is applied over the whole test specimen. To ensure this, the 2 rotating plates shall:
- Be designed with one degree of freedom (Z axis),
- Be independent of each other so that any vertical movement of one plate shall not influence the vertical movement of the other plate,
- Be free to move vertically up to 10 mm above the level of the test specimen.

⁶ this large range is due to the 40 mm movement between the two plates and 60 mm tolerance for conception

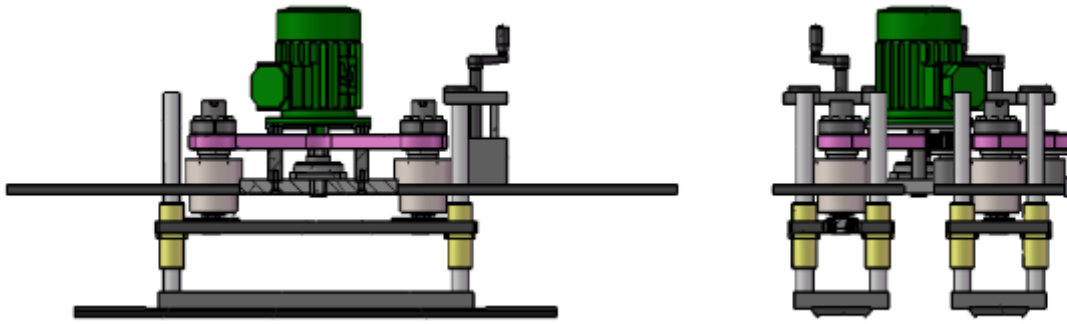


Figure 40: Configuration of machine

To avoid damage generated by the metal frame supporting the rubber sole, a 45°x10 mm chamfer shall be attached on the edge of the frame (see Figure 40: Configuration of machine as an example)

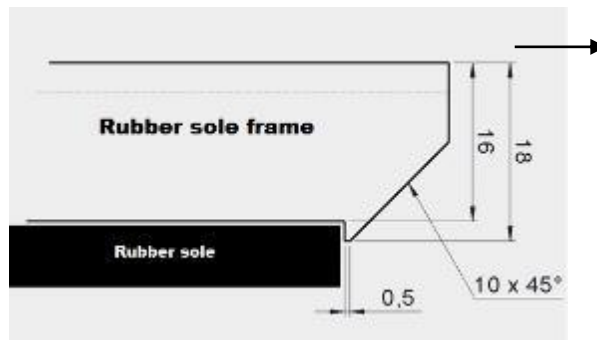


Figure 41: Rubber sole configuration

22.2.2. Rubber test sole

The wearing surface of each vibrating plate shall be *Autosoler 6mm, Profile 26 Fine Crepe* as supplied by Nora Systems GmbH; 2 -4 Höhnerweg, 69469 Weinheim, Germany www.nora-shoe.com. The test sole shall have a Shore hardness of 93 ± 2 .

22.2.3. Bladed roller

Each Bladed roller shall comprise a metal cylinder measuring 955 ± 10 mm length with a diameter of 120 ± 1 mm fitted with a polyamide (PA 12) moulded profile of studs / blades as shown in Figure 42: Bladed roller. The total weight of each roller shall be 95 ± 5 kg.

Note: in practice, it is recommended to manufacture the sleeve in two half cylinders which are then screwed on to the metal roller.

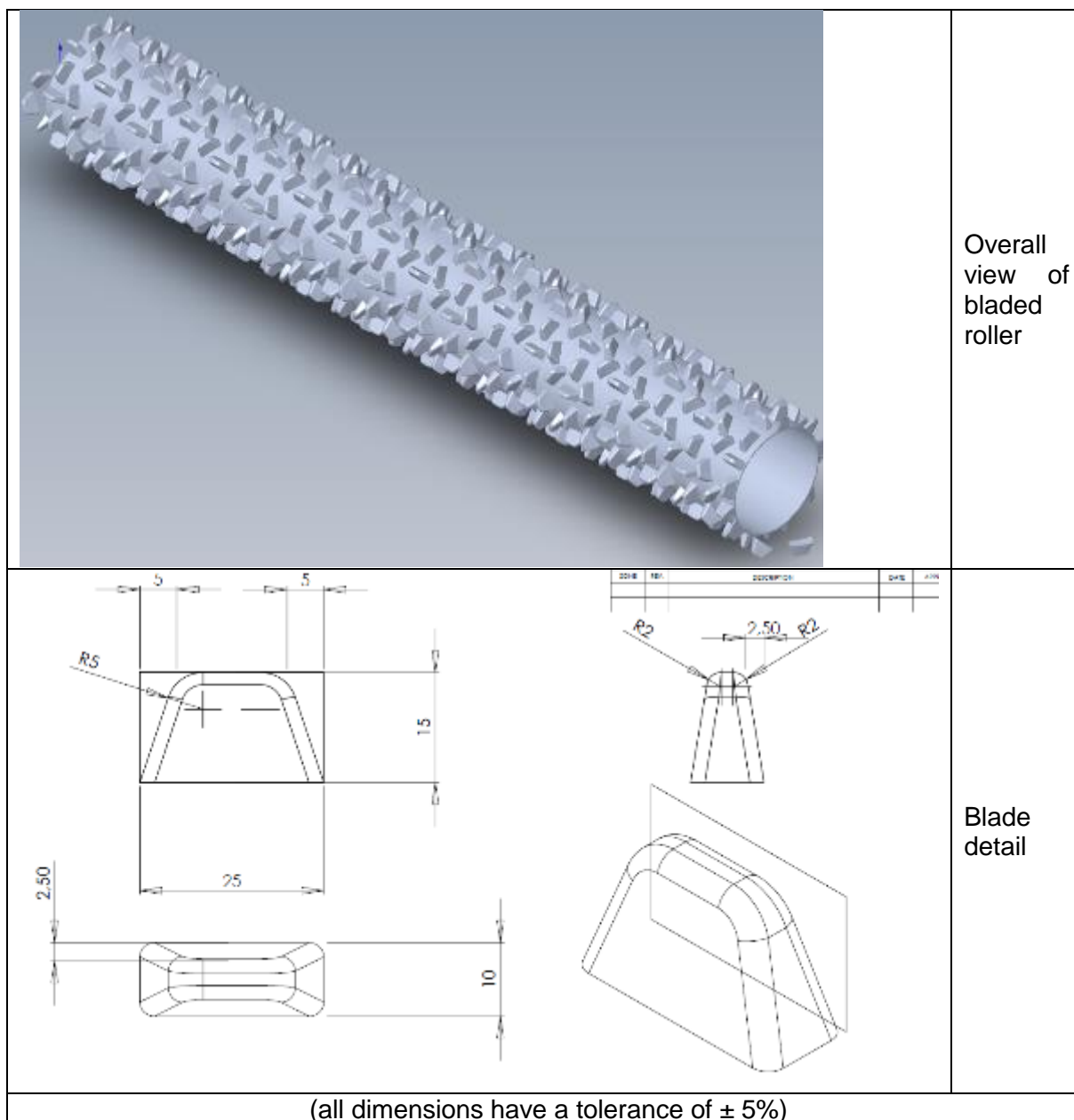


Figure 42: Bladed roller

Note: A digital 3D file suitable for the manufacturing of the roller sleeve is available from FIFA at football.turf@fifa.com. A recommended way of manufacturing is with professional 3D printing method.

The rollers shall be fitted adjacent to the vibrating plates within the trolley carriage. They shall be designed to roll in the direction of the Z-axis only to ensure the full weight of the roller applies to the surface. The distance between each roller axis and the middle of each nearest vibrating plate shall be from 200 to 300 mm.

The design of the machine shall ensure unrestricted rotation of the leading roller at the end of traverse of the test specimen to ensure the studs do not repeatedly impact the same position on the sample.

Note: The vibrating plates shall remain in contact with the test specimen at the end of each traversal.

22.3. Procedure

22.3.1. *Test specimen*

The test specimen shall be fixed to the floor to ensure no movement during the wear simulation.

Note 1: To minimise heterogeneous wearing of the sample it is recommended to put the sample on a floor with a maximum deviation under a 3.0m straightedge of 2.0mm

Note 2: Double tape, flanges, etc... could be used to do so. It is necessary to seal perforation holes before filling-in the sample to avoid slippage between the floor and the backing usually due to sand.

The test specimen of the Football Turf system shall be as specified by the manufacturer. It shall include the specified performance and stabilising infill and where appropriate any shockpad or elastic layer.

The dimensions of test specimen shall ensure a uniformly conditioned area of at least 2.5m by 0.9 m to allow the necessary performance measurements to be made.

22.3.2. Test base

The test specimen shall be laid on a flat smooth rigid solid concrete floor with a minimum thickness of 100mm and a minimum stiffness of 40MPa when measured in accordance with EN 12504-2 Part 2.

22.3.3. Testing procedure

22.3.4. Preparation of the test specimen

Check the condition of the studded rollers for signs of stud wear. If significant damage or burring of the stud profile is observed or if the height of at least ten studs is 14mm or less, replace the stud sleeve.

Replace the rubber sole by a new one before each new sample.

Test specimen preparation & pre-tests

Within the Lisport XL build the test specimen strictly in accordance with the manufacturer's specification, EN 12229 and the instructions in Appendix I.

Unless the performance infill is designed to have a specific moisture content (e.g. an organic infill) all FIFA product assessment tests shall be undertaken on a dry test specimen. Consolidate the infill with 5 conditioning cycles (one cycle comprises one pass up and down of the test specimen and undertake the initial performance tests). Check that the initial performance tests results correspond with the values normally associated with the system to be tested.

Notes:

- 1. All other FIFA performance tests shall be made on separate tests specimens to eliminate the effects of wetting the test specimens;*
- 2. If a manufacturer requires wet or damp tests to be made this shall be noted in the test report and the results shall not be used in any official FIFA test report.*
- 3. All performance testing shall be carried out at least 250mm from the edge of the sample*

22.3.5. Conditioning procedure

Undertake 500 cycles of continuous conditioning and stop. Maintain the test specimen using the procedure described in Appendix 1 Section 7.a.Maintenance after each 500 cycles.

Repeat at 500-cycle continuous intervals until the specified number of cycles are complete. Carry out a final maintenance procedure (re-introduce the infill and ensure it is evenly distributed) and run the Lisport XL for a further 5 cycles using the procedure described in Appendix 1 Section 5 conditioning cycles in the Lisport XL. Undertake the performance tests without any further maintenance on the test specimen.

For **FIFA QUALITY PRO** product assessment tests undertake a total of 3000 cycles as follows:

- 5 consolidation cycles prior to initial performance tests
- to be conditioned at 500-cycle intervals

- Re-fill any dislodged infill in accordance with 22.3.6
- 5 cycles following surface maintenance after the final 500 cycles and prior to performance tests
- The surface shall be maintained sufficiently with a hard rake to de-compact the performance infill (as described in Appendix I Section 8. 5 conditioning cycles in the Lisport XL).

For **FIFA QUALITY** product assessment tests undertake a total of 6000 cycles as follows:

- 5 consolidation prior to initial performance tests
- to be conditioned at 500-cycle intervals
- Re-fill any dislodged infill in accordance with 22.3.6
- 5 cycles following surface maintenance after the final 500 cycles and prior to performance tests
- The surface shall be maintained sufficiently with a hard rake to de-compact the performance infill (as described in Appendix I Section 8. 5 conditioning cycles in the Lisport XL).

22.3.6. Performance infill replacement

Using a vacuum cleaner collect any infill; material that has dislodged from the test specimen (see Figure 43: Examples of infill dispersion and infill collection and Figure 44: Examples of infill collection). Re-fill the test specimen with material that has been dislodged from the test specimen.

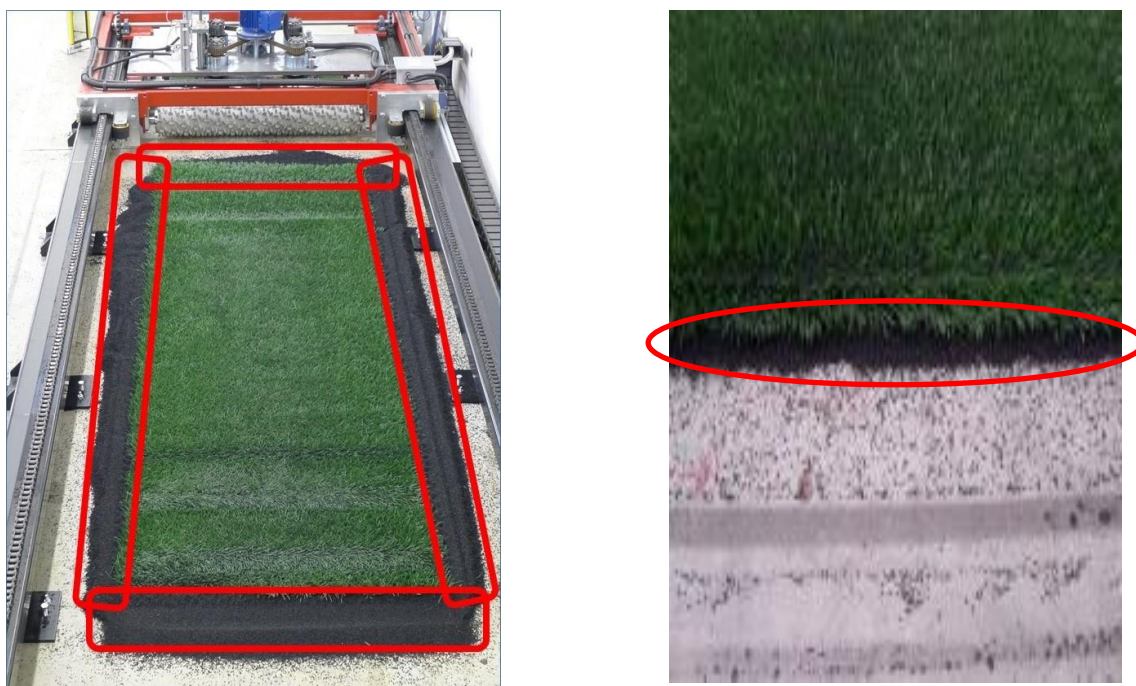


Figure 43: Examples of infill dispersion and infill collection

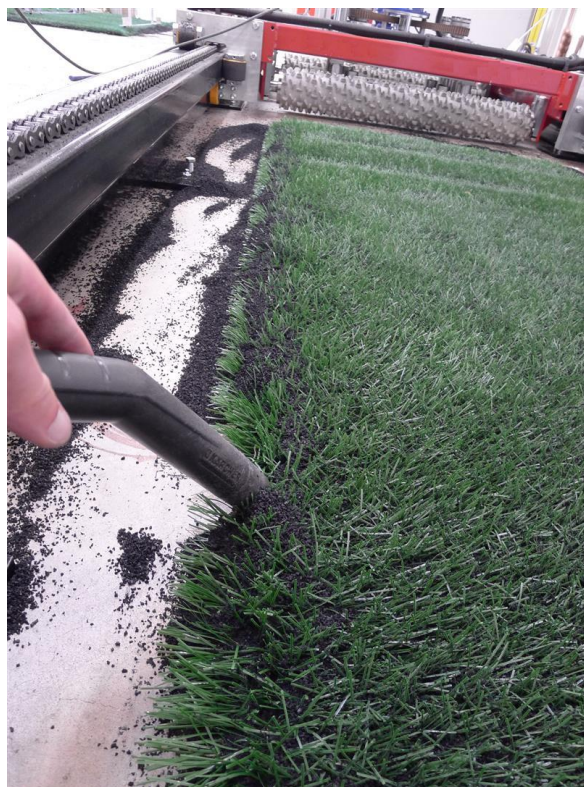
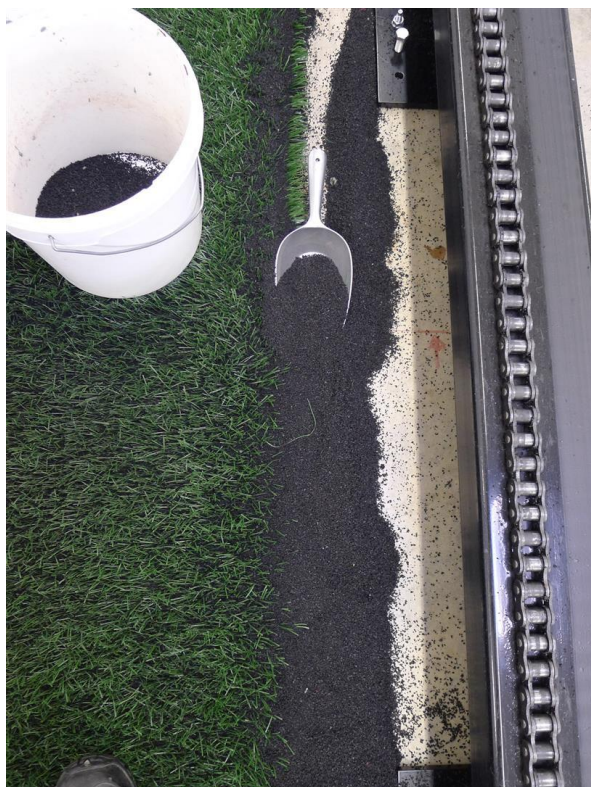


Figure 44: Examples of infill collection

Carefully redistribute over the conditioned area the infill material collected; ensuring a homogeneous distribution using an appropriate application device as showed in Figure 45: Redistribution of dispersed infill.

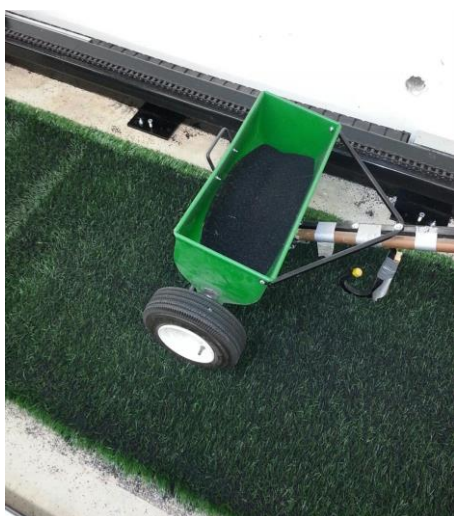


Figure 45: Redistribution of dispersed infill

23. Procedure to determine the quantity of infill splash (FIFA Test Method 16)

23.1. Principle

A high-speed camera is used to film the impact of a ball onto a test sample. The images of the surface interaction with the ball are then analysed as 2 colour images in high contrast where the infill appears on the image as black pixels against a completely white background. From this HD camera sized image (1280x1024) the density of infill splash can be mathematically evaluated as a percentage of black to white pixels. This method is designed to give a visual representation of splash, which can be assigned, to a mathematically calculated number to rank splash characteristics of the turf system. This allows both qualitative and quantitative data analysis.

23.2. Scope

The current test method is considered a laboratory-based test.

23.3. Test Apparatus

- A Ball Cannon used to project the ball at an angle of $45 \pm 2^\circ$ onto test locations at a speed of 50 ± 2 km/h. The cannon must not impart spin of greater than 3 Rev/s to be verified on the images of the high-speed camera.
- A High-Speed Camera capable of recording images at 1280x1024 pixels at a minimum rate of 300Hz. Attached to the camera sensor aperture shall be an optical lens which has a focal length of 50mm and F-stop range of minimum $f/1.4 - f/16$.
- A uniform light source that will provide strong white backlighting. The device must be considered flicker free.
- FIFA approved football with pressure adjusted to ensure ball rebound of 1.35 ± 0.03 m on concrete when released from 2.00 ± 0.01 m
- Measuring device for distance to an accuracy of ± 0.01 m and ability to angle to $\pm 0.1^\circ$
- Ball speed as it leaves the cannon should be measured using the high-speed camera.

23.4. Test Specimens

In order to conduct this test method two Football Turf samples to be tested of minimum dimensions 1x1m must be prepared and in-filled in accordance with EN 12229:2014. The test specimen must be filled evenly and conform to a consistent procedure to ensure repeatability of test values Sample movement must be minimised to ensure the prepared test specimen is not disturbed.

To ensure the homogeneity of the test specimen during testing sample drainage holes must be sealed prior to adding infill material.

23.5. Apparatus Setup

23.5.1. Equipment Positioning

The ball cannon must be positioned to ensure the ball impacts a specific location on the turf sample at an angle of $45 \pm 2^\circ$. The locations are specified in section 23.6.1. Test Procedure for a Single Location.

A high-speed camera must be placed perpendicular to the direction the ball strikes the surface. The distance between the location to be tested and the lens of the camera shall be 2.5 ± 0.01 m. The camera may be moved if required to ensure the resultant displaced infill plume is visible whilst ensuring that the specified distance and perpendicularity are unaffected.

An optional uniform light source is positioned facing the camera to provide a backlighting function. This may be required in certain types of lighting conditions to ensure a high contrast image.

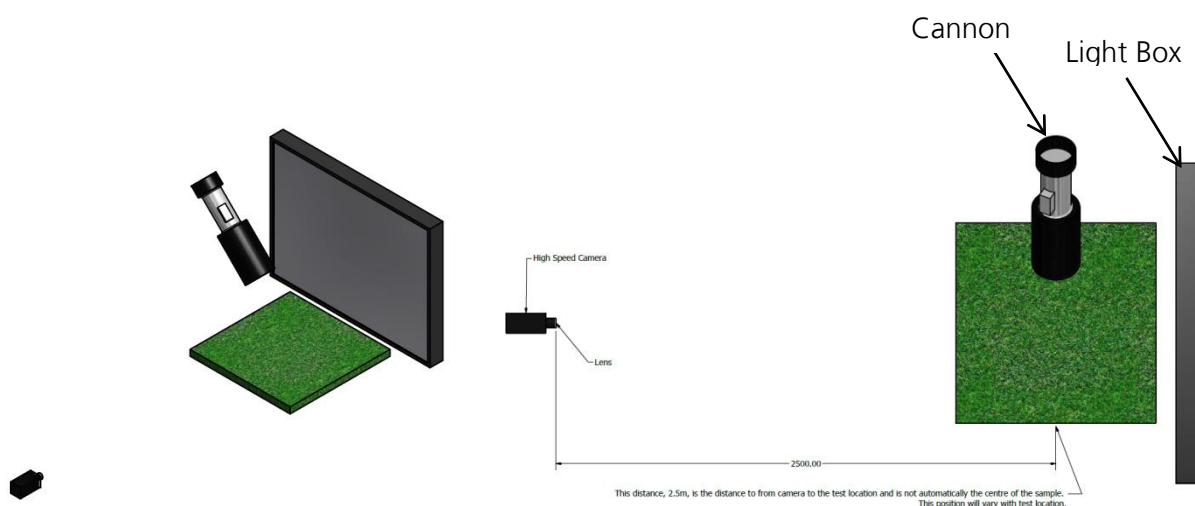


Figure 46: Pictorial representation of the setup

The camera must be angled with the lens to the horizontal at $5^{\circ} \pm 1^{\circ}$ and the height off the ground adjusted so that the cross-sectional profile of the sample is visible with as large a visible splash window as possible.

23.5.2. Calibration of Camera and Environment

The camera should be set up so that on the 2-colour image the whole usable picture is white. Image cropping can be used to remove any dark areas on the image that are not due to splash. At this stage, the camera focus, exposure and environmental lighting conditions should be adjusted to ensure that it is possible to detect a black 1mm diameter dot on the 2-colour image but nothing smaller than a 0.5mm dot. The dot should be visible from the camera to the centre of the sample where the impact will occur and should be detectable from all positions on the image during calibration.

Note: Any dark points visible on the image will distort the results producing a higher infill splash percentage.

23.6. Test Procedure

23.6.1. Test Procedure for a Single Location

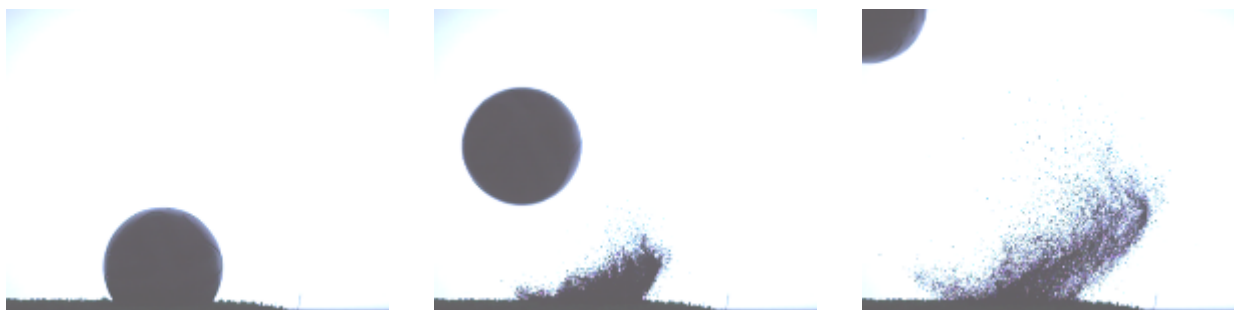




Figure 47: Images Recorded During Splash Test

The ball is projected onto the sample from the cannon and the impact on the surface is recorded using a high-speed camera. The full interaction from the point that the ball impacts the surface is captured.



Figure 48: Raw Splash Image

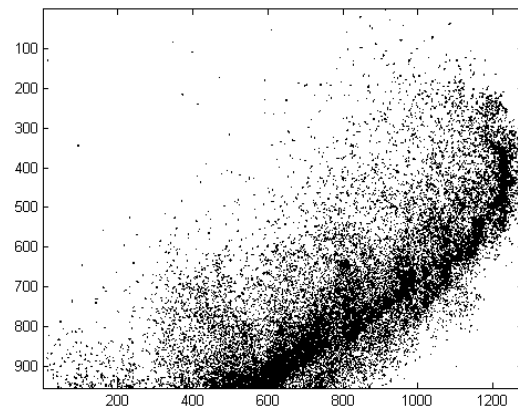


Figure 49: 2-Colour Splash Image

The frames are then transformed into 2-colour black and white images (RGB 000) and cropped to ensure none of the yarn and undisturbed infill is included in the image. The percentage of black to white pixels in the image is calculated. [1] The highest “splash percentage” is then recorded as the test result.

Note: The standard image size is 1280x1024 for analysis. The splash percentage should always be calculated using a frame size of 1280x1024 even after cropping. This method assumes that any cropped area will automatically be white space.

23.6.2. Sample Test Location Plan and Test Directions

12 test locations are spread over a total of two 1x1m samples to complete a test. The test must be carried out in 2 directions on the sample:

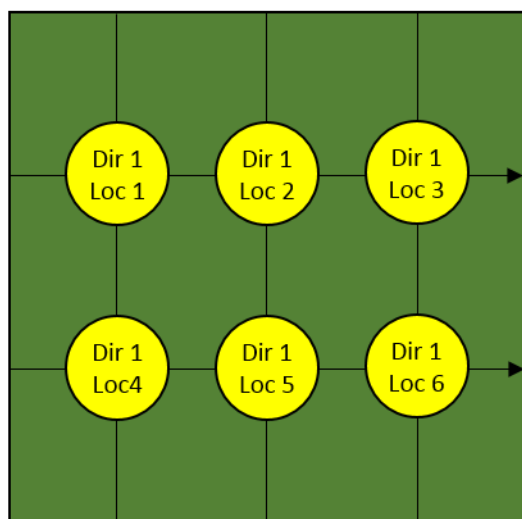
- Direction 1 - Parallel and against the direction of tufting.
- Direction 2 - Perpendicular to the direction of tufting.

6 locations will be tested for each direction totalling 12 test locations overall.

Avoid impacting the same position and do not test any area that has acquired additional infill due to displacement during previous ball impacts.

An example of sample test locations is detailed below in Figure 50: example of test locations. A distance of at least 0.2m should be maintained between any test location centre and the edge of the sample. The impact crater of test locations must not overlap other test locations. Careful attention must be given to deciding sample locations to ensure that any material dislodged from the sample cannot contaminate untested locations

SAMPLE 1



SAMPLE 2

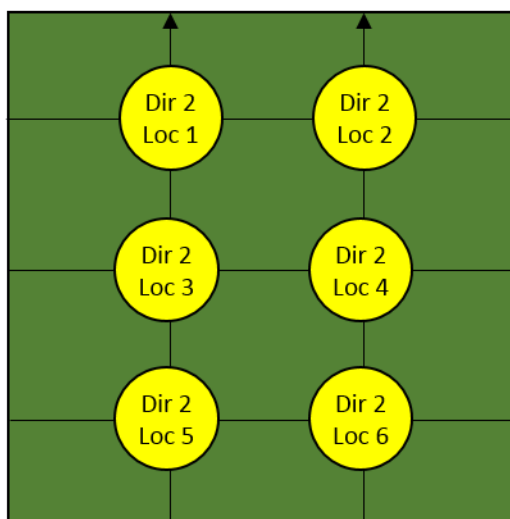


Figure 50: example of test locations

23.7. Calculation and Reporting of Results

A simple percentage calculation is derived from the images to calculate the splash percentage in each frame:

$$\text{Splash Percentage} = \frac{\text{No of Black Pixels}}{\text{Resolution of the image in pixels}} \times 100 = \frac{\text{No of Black Pixels}}{(1280 * 1024)} \times 100$$

The highest splash percentage calculated from all the captured frames is the splash percentage that is recorded for that location.

The 6 splash percentages are collected for direction 1 and then averaged to create an overall splash percentage for that direction. This process is repeated for direction 2 and then a final splash percentage is calculated from an average of all 12 results with the intention of building an approximation of peak splash from the highest splash directions.

The splash test report should include the image from the highest density splash impact recorded during testing.

24. Procedure for determination of reduced ball roll (FIFA Test Method 17)

24.1. Principle

A football is rolled down a ramp onto the surface and travels through two sets of timing gates which calculate the ball speed over a known distance.

Allowing the ball to roll from several different release heights ensures that the ball to surface interaction is assessed through all of the phases that would occur in a full-length ball roll. From this a representation of a full ball roll can be achieved. Using the two speeds and a known distance it is possible to calculate the deceleration of the ball and calculate at what distance the ball will come to rest.

24.2. Apparatus

- a. Ball roll ramp as described in section 11.2. Test apparatus

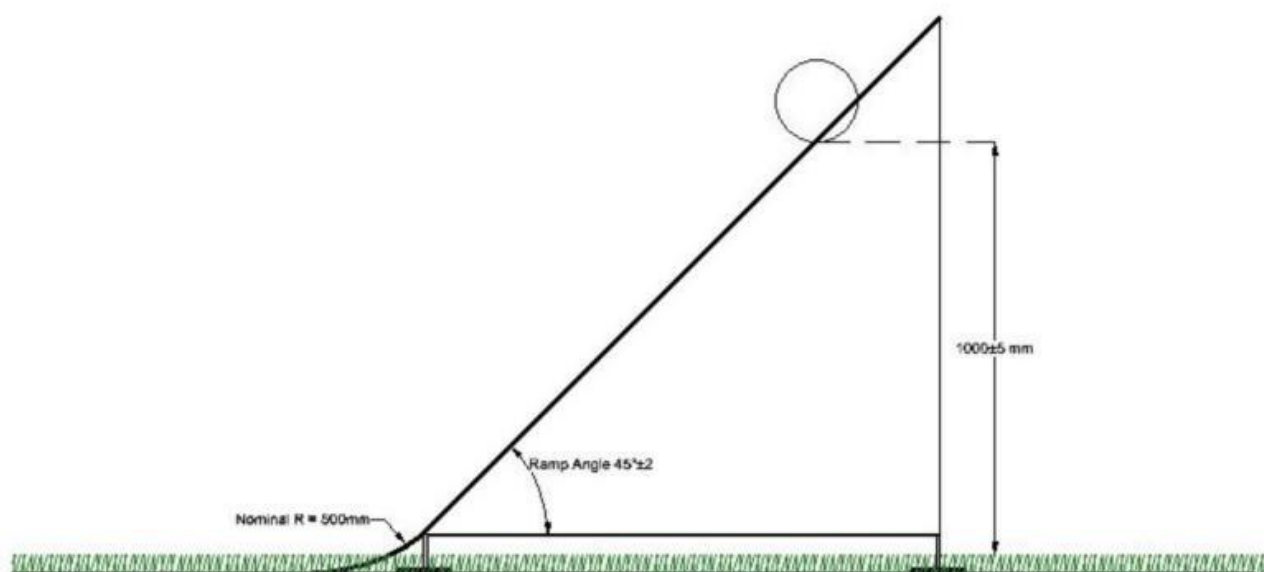


Figure 51: Ball Roll Ramp

- b. FIFA approved football as defined in section 7. Balls used for test.
- c. Distance measuring device capable of measuring up to 1mm. with accuracy to ± 1 mm
- d. Optically activated timing gate system accurate to a minimum of 1ms which will be triggered by the rolling ball travelling over a distance of 0.2 ± 0.01 m. Two sets of timing gates are required to calculate the ball speed between two points.
- e. An indoor floor brush with soft bristles used to restore the surface pile at specified intervals during the test.

24.3. Procedure

24.3.1. Apparatus setup

Position the ramp so that it is centred at one end of the test specimen ensuring the rails are parallel to the direction being tested. The end of the ramp curve should rest on the infill material, when using filled systems, or on the compressed thatch, when using unfilled systems, to ensure that the ball rolls smoothly from the ramp onto the test specimen.

Set up the apparatus as shown in Figure 51: Ball Roll Ramp.

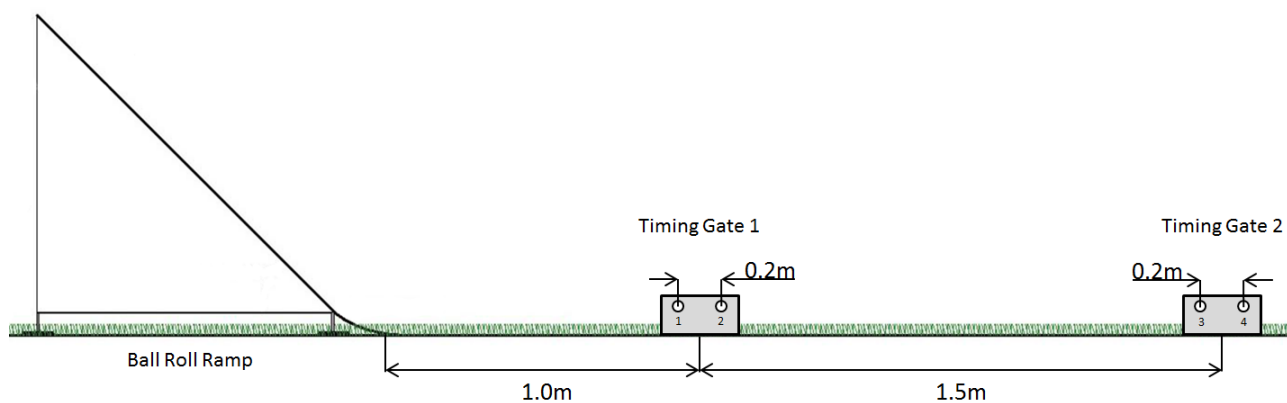


Figure 52: Ball Roll Ramp and Timing Gate Positions

Timing gates consist of 2 sensors that activate a timer as the ball passes. These sensors are spaced $200 \pm 10\text{mm}$ apart. Measure the exact distance and include this measurement in the calculation of the results. The distance from the ball roll ramp, where the ball contacts the surface, to the centre of the first timing gate must be $1.0 \pm 0.01\text{m}$. This is to ensure that the ball rolls smoothly along the surface before it passes the timing gates. The distance between the centres of timing gate 1 and timing gate 2 must be $1.5 \pm 0.01\text{m}$.

Four release heights should be selected on the ramp from which to release the ball as shown in Figure 53: Ball Release Heights. Release height one should be the lowest height selected on the ball ramp. This should be adjusted to ensure the ball stops between 0.1m and 0.25m past the second timing gate. The final release height is the highest and should be the same as a standard ball roll namely $1.0 \pm 0.01\text{m}$. The other two release heights are intermediate release heights and should be evenly incremented between heights 1 and 4. Release heights are measured vertically as the distance from the lowest point on the ball, when placed on the ramp, to the infill level on the turf using the distance measuring device specified in 3.0. All release heights must be repeatable to $\pm 0.01\text{m}$.

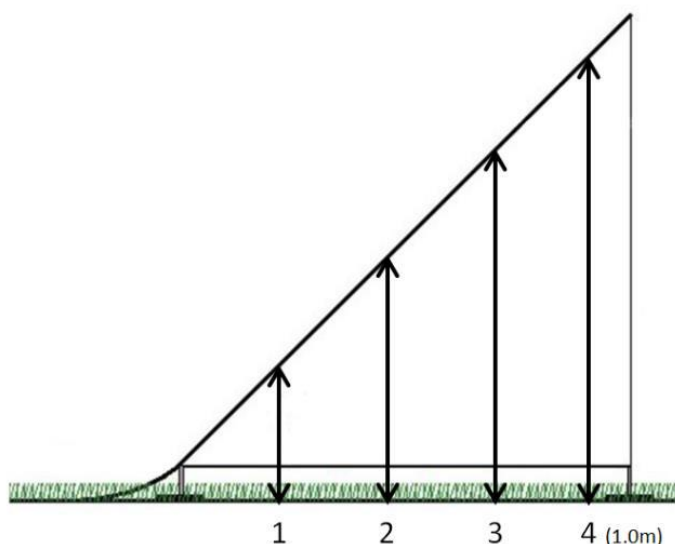


Figure 53: Ball Release Heights

24.3.2. Test specimens

For conducting this test method, a specimen of at least $3 \times 1\text{m}$ must be prepared and in-filled, where appropriate, in accordance with EN 12229:2014 to the manufacturer's specification.

24.3.3. Test procedure

Place the ball on the ramp at so that the lowest point of the ball is in contact with position 1 as defined in Figure 53: Ball Release Heights. Release the ball and allow it to roll freely across the test specimen at a minimum of 250mm from the edges of the test specimen and through the timing gates using the optically activated timing gate system specified in 22.2. Record the initial speed, “ v_{start} ,” at timing gate 1 and the final speed of the ball, “ v_{end} ,” as recorded by timing gate 2.

v_{start} and v_{end} are calculated using the relationship between speed, distance and time using t_{gate1} and t_{gate2} .

$$v = \frac{Ss}{t}$$

Equation 1 – Relationship between Speed, Distance and Time

“ Ss ,” is defined as the exact distance, between each timing sensor as measured. “ t ” is the time taken for the front of the ball to traverse between timing sensor 1 and timing sensor 2 (t_{gate1}). The same calculation is conducted for v_{end} using timing sensor 3 and timing sensor 4 (t_{gate2}).

The process is then repeated twice more to give 3 sets of results for the 3 ball release heights.

The surface shall be restored using a brush each time that 2 ball rolls have been conducted. The brushing is conducted as a drag motion and repeated only once at a walking pace.

These steps should be repeated for all 4 release heights. 3 sets of v_{start} and v_{end} must be collected for the first two lower release heights but only 2 sets of v_{start} and v_{end} must be collected for the top two heights.

24.4. Calculation and expression of results

At the completion of the test procedure, 10 combinations of v_{start} and v_{end} should have been collected for four different release heights.

The first stage of the calculation is to determine the averages of v_{start} and v_{end} for each height. This will leave 4 values of v_{start} and 4 for v_{end} . Using the 4 combinations of starting and ending speeds it is possible to represent a relationship between v_{start}/v_{end} as a second order polynomial equation which reflects the interaction between the ball and the surface over a variety of ball roll speeds.

A second order polynomial for this relationship is as follows:

$$v_{end} = a(v_{start})^2 + b(v_{start}) + c$$

Equation 2 - 2nd Order Polynomial Equation Construction

Using this relationship and the average v_{start} from height 4 on the ramp, which is the release height for standard ball roll measurements, this equation can be used to estimate v_{end} of the ball after 1.5m. The predicted v_{end} value is then used as the value, v_{start} , for another iteration of this process. This process is repeated until $v_{end} \leq 0$

To get the first part of the ball roll length:

$$S_p = \text{Number of Iterations} \times S_g$$

Equation 3- Primary Ball Roll Calculation

“ S_p ” is the distance the ball has travelled in the initial phase of the ball roll calculation. “ S_g ” is the distance measured between each set of timing gates and is defined in this method as 1.5m. The “Number of Iterations” is the number of times the polynomial equation is repeated before the iteration where $v_{end} \leq 0$.

The second part of the ball roll length, or residual ball roll, is a calculation based on predicting the time taken for the ball to come to a complete stop from the v_{start} of the last iteration – where v_{end} becomes negative. To calculate this first calculate the deceleration of the ball through the second last iteration:

$$a_1 = \frac{(v_{end})^2 - (v_{start})^2}{2S}$$

Equation 4 - Kinematic Equation for Time Independent Acceleration

This deceleration value can then be used to calculate the deceleration for the final phase of the ball roll until $v_{end} = 0$ m/s. This equation is constructed using a_1 and v_{start} from the final iteration of the polynomial process where $v_{end} \leq 0$. Equation 5 can then be used to calculate the last portion of the ball roll distance, S_r , which occurs from the end of S_p until $v_{end} = 0$ m/s where the ball would be at rest.

$$S_r = \frac{-(v_{start})^2}{2a_1}$$

Equation 5 - Rearranged Form of Equation 4 to Give Distance as the Subject

The predicted ball roll calculation, which is comparable to a standard full-length ball roll, comprises:

$$\text{Predicted Ball Roll} = S_i + S_p + S_r$$

Equation 6 - Predicted Ball Roll Calculation Using Results from Equations 3 & 5

“ S_i ” is the distance specified between the end of the ramp and the middle of the first light gate (1.0m)

Predicted ball roll results shall be reported for both test specimen directions. Each direction will be reported individually to a precision of 0.1m.

25. Procedure for measuring free pile height (FIFA Test Method 18)

25.1. Principle

As a means of verification for both laboratory and onsite testing to ensure that the free pile height is in accordance with the product declaration. If the free pile height is correct, this infers that the sum of the two infills is also correct (not necessarily the ratio). It also helps during retests to confirm whether the infill levels are consistent with previous testing.

25.2. Apparatus

- a. A steel and glass prism frame of a minimum 150 mm length; a minimum 125 mm width; and a minimum height of 70mm.
- b. The frame should contain a transparent prism with a mirrored bottom surface of reflective material which should be angled at 45 ± 0.2 degrees.
- c. A scale in 'mm' to a height of 40 ± 1 mm with a measuring resolution of 1 mm.

25.3. Procedure

Place the prism gauge on the infill of the synthetic turf surface for filled systems and on top of the primary backing for unfilled systems. Do not force the prism into the infill rather place it onto the infill without exerting additional pressure. Ensure the prism gauge is flat on the surface by means of a bubble/spirit level. Record the length of the 10 representatives yarn fibres (ignore outliers); repeat this procedure at 90° to the first test (For measurements on site alternate between longitudinal and cross pitch directions for each test position and calculate the median pile height in mm from the 10 representatives yarn fibres at each position.). Calculate the median of the highest pile fibres in mm from the 20 representatives yarn fibres.

The measurement shall be carried out at the 19 test locations as described in 12.8.1 for field tests and at 3 locations at least 100mm apart and a minimum of 100mm from the edge of an unconditioned sample.

26. Procedure for the determination of UV stabilizer content in artificial turf yarn (FIFA Test Method 19)

26.1. Principle

Test pieces of pile yarn are exposed to infrared light and the change in absorbance is determined. Samples will be collected from all product laboratory tests and field tests for Attenuated Total Reflectance (ATR) / Fourier Transform Infrared Reflection (FT-IR) analysis to be used to compare levels of UV stabiliser between original laboratory test products and samples collected on-site. The results of these samples shall be in an acceptable range between the UV stabiliser values between the original laboratory tested sample and the samples obtained from site.

Note: The FT-IR process will only be undertaken should a problem arise with a field causing FIFA to question the UV stabiliser content of an on-site product. Should the comparison of these samples reveal an unacceptable difference between the UV stabiliser values FIFA reserves the right to revoke the certification.

26.2. Sample Collection and Storage

26.2.1. *Taking the sample from the field*

If there is an area which is affected take a sample of yarn from this roll however, include samples of yarn from different tuft lines within the same roll and from along the same tuft lines.

Note the position of the affected roll for comparison with the turf site plan.

If there are multiple areas which are affected, then samples must be taken from each of these rolls including samples from different affected tuft lines.

Note the position of the affected rolls for comparison with the turf site plan.

26.2.2. *Cleaning of samples from the field.*

Samples from the field contain traces of sand and rubber that need to be washed off.

The yarn that was protected by the sand layer on the field is cut from the rest of the sample.

These yarns are put in an Erlenmeyer with water. This Erlenmeyer is put in an ultrasonic bath for 15 minutes to be cleaned. After 15 minutes samples are taken out of the water with a tweezers and wiped dry with soft tissue paper.

26.2.3. *Product Sample Storage*

For each product test the Accredited Lab Test Institute should collect and store a minimum of 10 complete filaments of each fibre type from a minimum of 3 separate tuft lines, in a cool, dark place with an appropriate label noting the date of collection and the relevant lab report number.

26.2.4. *Field Sample Storage*

During each field test the Accredited Field Test Institute should collect and store a minimum of 10 complete filaments of each fibre type from a minimum of 3 separate tuft lines, in a cool, dark place with an appropriate label noting the date of collection and the relevant field test report number.

26.3. Apparatus

- a. Fourier Transformed Infrared Reflection (FT-IR) apparatus equipped with an Attenuated Total Reflectance (ATR) unit
- b. An air circulating oven conforming to ISO 188
- c. Ultrasonic bath
- d. Demineralised water
- e. Climatic room of 23+/-2°C and 50+/-5% RH

26.4. Conditioning of samples

If samples are taken from the field, they should be stabilized in a container in a climatic room to avoid exposure to UV light for a minimum of 11 days at 23+/-2°C and 50+/-5% RH.

26.5. 24.4 Procedure

Clean the ATR crystal before every measurement according to the manufacturer's guidelines.

26.6. Procedure for laboratory samples

26.6.1. Identification of the UV stabiliser(s) peak(s)

A minimum of 5 monofilaments or tapes are put in an oven at 105 +/- 2°C for 4h+/-15 minutes. Then the samples are cooled down in a desiccator for a minimum of 2h allowing them to reach room temperature

The "heat-aged" samples are put on the ATR crystal of the FT-IR apparatus for 32 scans. The spectra are taken at 3 different positions along the fibre. Ensure the crystal is in full contact with the fibre and not sitting on the apex for example of a structured fibre.

A minimum of 5 original monofilaments or tapes are put on the ATR crystal for 32 scans and a minimum 3 spectra are taken.

The averages of the peaks associated with the UV stabiliser are compared to each other. The heat treatment produces a shift in the UV stabilisers and this will be reflected in a shift of the peak(s) of the UV- stabilisers.

26.6.2. Quantification of the peak of the original sample

A minimum of 5 monofilaments or tapes from the same tuft line are put on the ATR crystal of the FT-IR apparatus.

Every measurement consists of 32 scans.

8 different positions of the yarn are measured.

The spectrum must be normalized at the carbon peak located at 2950 cm⁻¹ for PE and the baseline correction needs to be done.

The maximum height of the absorbance peak (determined in 26.6.1) is measured. This is defined as the Absorbance of the sample, see 26.8 below.

If abnormal low values are measured, check if the sample holder of the ATR is completely filled with material. If this is not the case, these measurements should be discarded.

The average of the 8 different positions are calculated. If the coefficient of variation (ratio of the standard deviation to the mean) of these 8 measurements is higher than 10%, 8 additional samples are measured.

The measurements are done on the same samples used for the UV test (Section 18.Procedure for Artificial Weathering (FIFA Test Method 10)).

26.7. Identification and Quantification of peak(s) of the field sample

The measurement is done in accordance with 24.3.1

26.8. Calculation

% original content of UV stabiliser =
$$\frac{\text{Absorbance of the sample}}{\text{Absorbance of the samples submitted for UV}} \times 100$$

27. Procedure to determine the particle size distribution of granulated infill materials (FIFA method 20)

27.1. Scope

This procedure describes the method of test to determine the particle size distribution of granulated infill materials and to determine the consistency of samples in comparison to a manufacturer's product declaration.

27.2. Procedure

Weigh a minimum of 300ml (0.3 liter) of the granulated infill material and place on a clean tray in an oven at $105^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 2 hours. Re-weigh the sample. If the weight has reduced by more than $1.0 \pm 0.1\text{g}$ return it to the oven for a further 2 hours. Re-weigh the sample if the weight is consistent with the previous reading to within $1.0 \pm 0.1\text{g}$ then remove it from the oven, if not repeat this procedure until the weight is consistent to $1.0 \pm 0.1\text{g}$. Remove the sample from the oven and allow to cool to room temperature (minimum period 1 hour).

Determine the particle size distribution of the infill materials using the following sieves:

0.00mm, 200 μm , 315 μm , 0.5mm, 0.63mm, 0.80mm, 1.00mm, 1.25mm, 1.60mm, 2.00mm, 2.50mm, 3.15mm, and 4.00mm.

27.3. Calculation of results

d: starting from the smallest sieve dtest is the largest sieve through which 10% or less of the sample passes (i.e. between 0% and 10% of the sample is smaller than the sieve designated d)

D: starting from the biggest sieve, Dtest is the smallest sieve on with 10% or less of the sample is retained (i.e. between 0% and 10% of the sample is bigger than the sieve designated D).

Plot the results on a graph and determine the values of dtest and Dtest for the sample.

Calculate the percentage mass of the sample falling between dtest and Dtest when compared to the overall test sample mass.

27.4. Analysis of results

Validation of the manufacturer's declaration – Type Approval laboratory tests

The Manufacturer's Declaration shall define the range intended to be encompassed by d and D.

For a sample to comply with a Manufacturer's Declaration the mesh size of the dtest and Dtest sieves shall be \pm one sieve size, from the list given in 27.2 above, of the declared dm (the value for d declared by the manufacturer) and Dm (the value for D declared by the manufacturer) values and at least 60% of the total infill sample shall be within the declared range, as illustrated in Figure 54: Example of particle distribution curve.

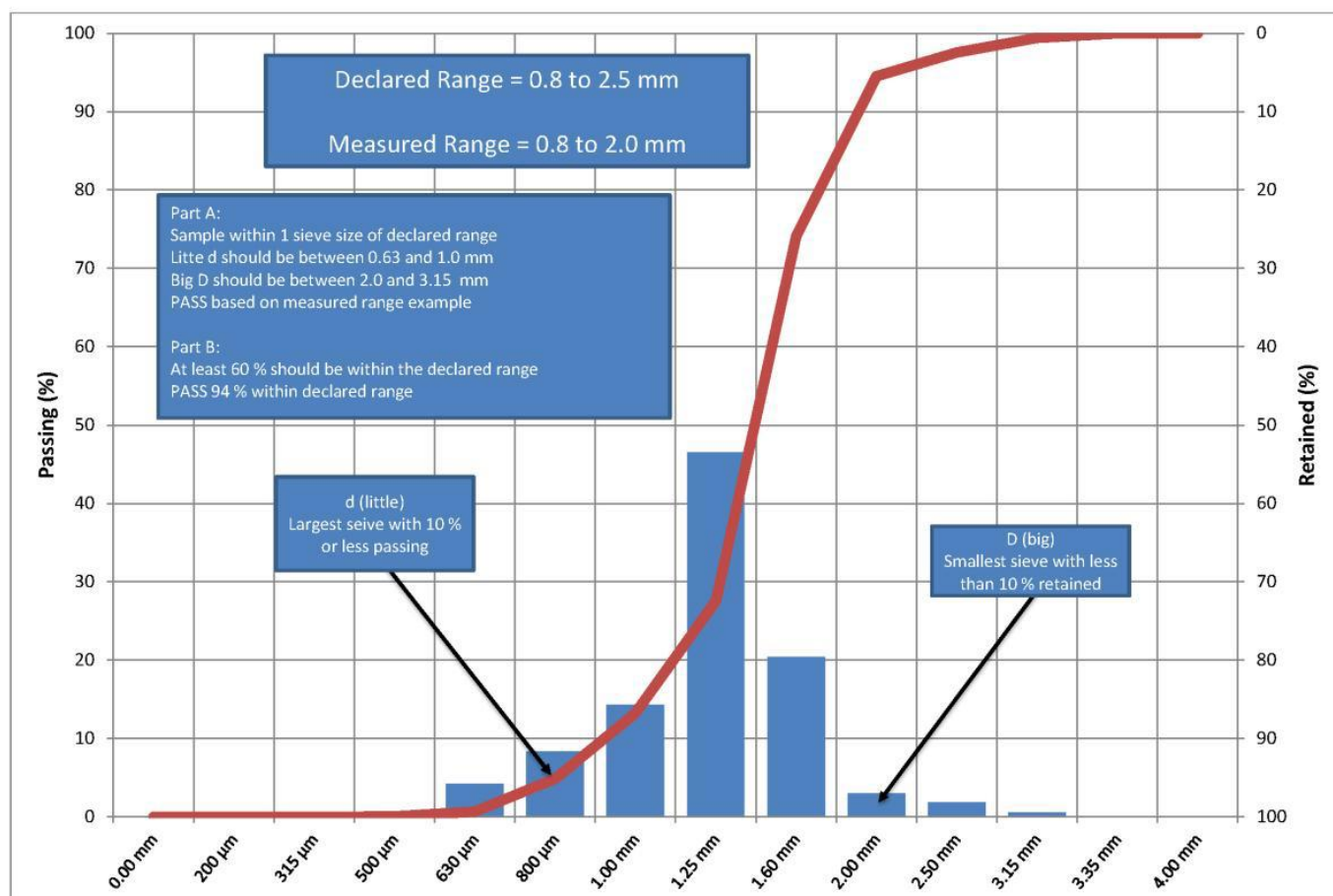


Figure 54: Example of particle distribution curve

28. Procedure for the measurement of infill depth (FIFA Test Method 21)

28.1. Scope

This test method is based-on EN 1969 with adaptation of the apparatus to cater for the softer nature of the surfacing of Football Turf to gain consistent, reproducible and repeatable results.

28.2. Apparatus

A depth measuring probe, this comprises a barrel with three flat-ended, steel prongs, circular in section, approximately 2 mm in diameter, these prongs are set in a triangular pattern with an approximate spacing of 15 mm to 20 mm apart, The prongs shall be sufficiently long that when driven into a surface under test the depth from the upper to the lower surface of the material under test (infill) can be measured by means of the calibrated, graduated barrel capable of reading between 0 and 50mm in 1mm increments. The circular base plate should be a minimum of 25 mm in diameter to reduce the compression of the infill during measurement.

28.3. Testing

Place the depth gauge on the surface of the Turf, ensuring that there are no extraneous items under the base plate. Extend the prongs from the barrel; using hand pressure push the plunger down into the infill materials whilst supporting the gauge upright with your other hand. Continue to push the prongs until resistance of the carpet backing material is felt, release the pressure on the plunger and check and slide the barrel gauge down onto the surface of the infill.

Read the depth of penetration directly from the graduated scale, record this as the infill depth.

For field testing the measurement shall be carried out at the 19 test locations as set out in 12.8.2 Procedure.



Figure 55: Infill depth gauge

29. Procedure for the measurement of differential scanning calorimetry (DSC) (FIFA Method 22)

29.1. Scope

This procedure describes the method of test to determine the melting point(s) of a fibre in the Football turf and thereby determine the consistency of the polymers used to make the fibre(s).

29.2. References

ISO 11357-3Plastics – Differential Scanning Calorimetry (DSC)

Note: The fibres used in 3rd Generation surfaces are typically produced from either a single polymer or a blend of polymers. Single polymers generally will show a specific relatively narrow melting peak as in Figure 56: Example of DSC curve with single melting peak.

Note: The sample size of the fibre should be $7.5 \pm 1.0\text{mg}$

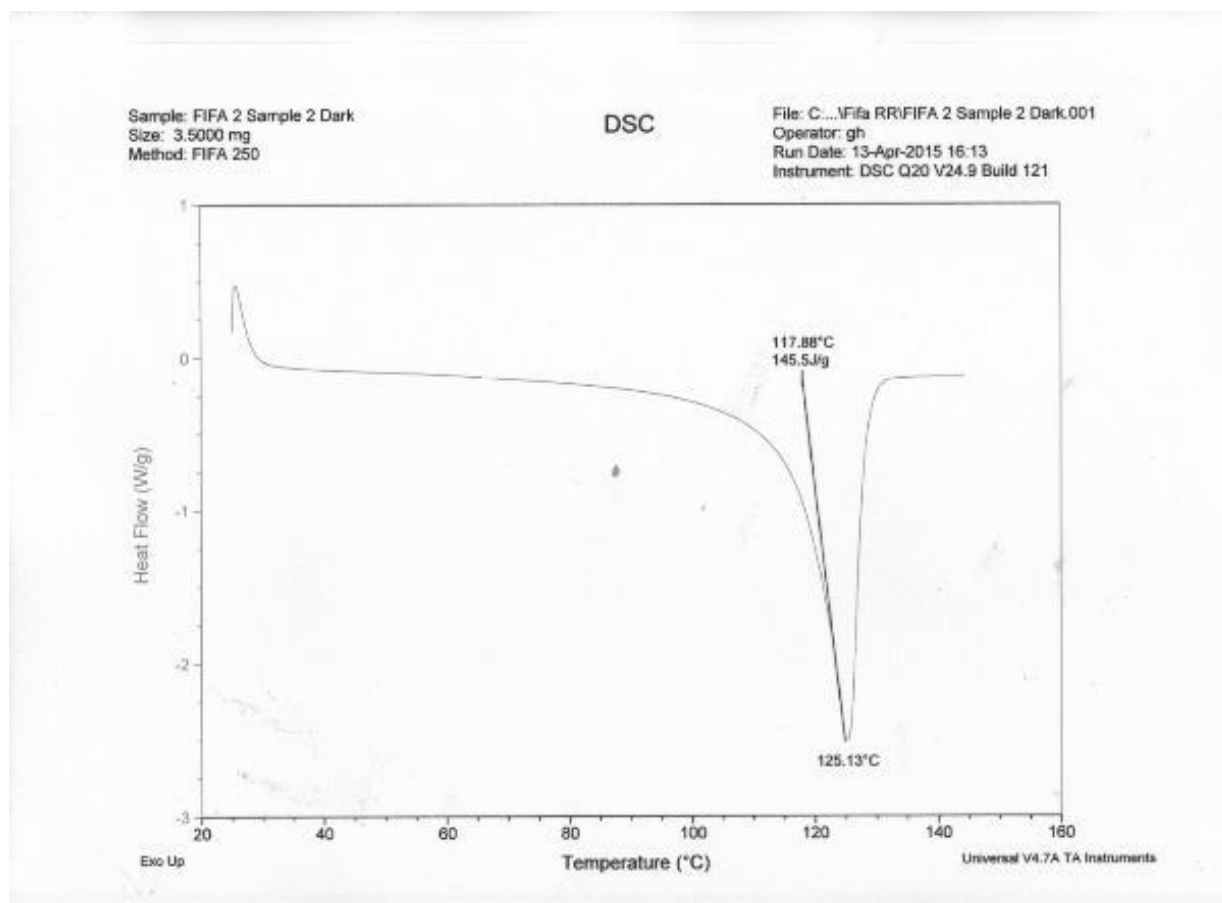


Figure 56: Example of DSC curve with single melting peak

Blends of polymers conversely will show a broad range of melting. Each individual component of the blend will have its own melting peak. These individual melting peaks will superimpose upon the other melting peaks present and where the melting peaks are close together will appear as a broader more diffuse melting peak as in Figure 56: Example of DSC curve with single melting peak. If the melting peaks of a blend of polymers are more separated, then the peak will be broadened further, or the peaks will either appear separately or a “shoulder” will appear on the overall melting peak.

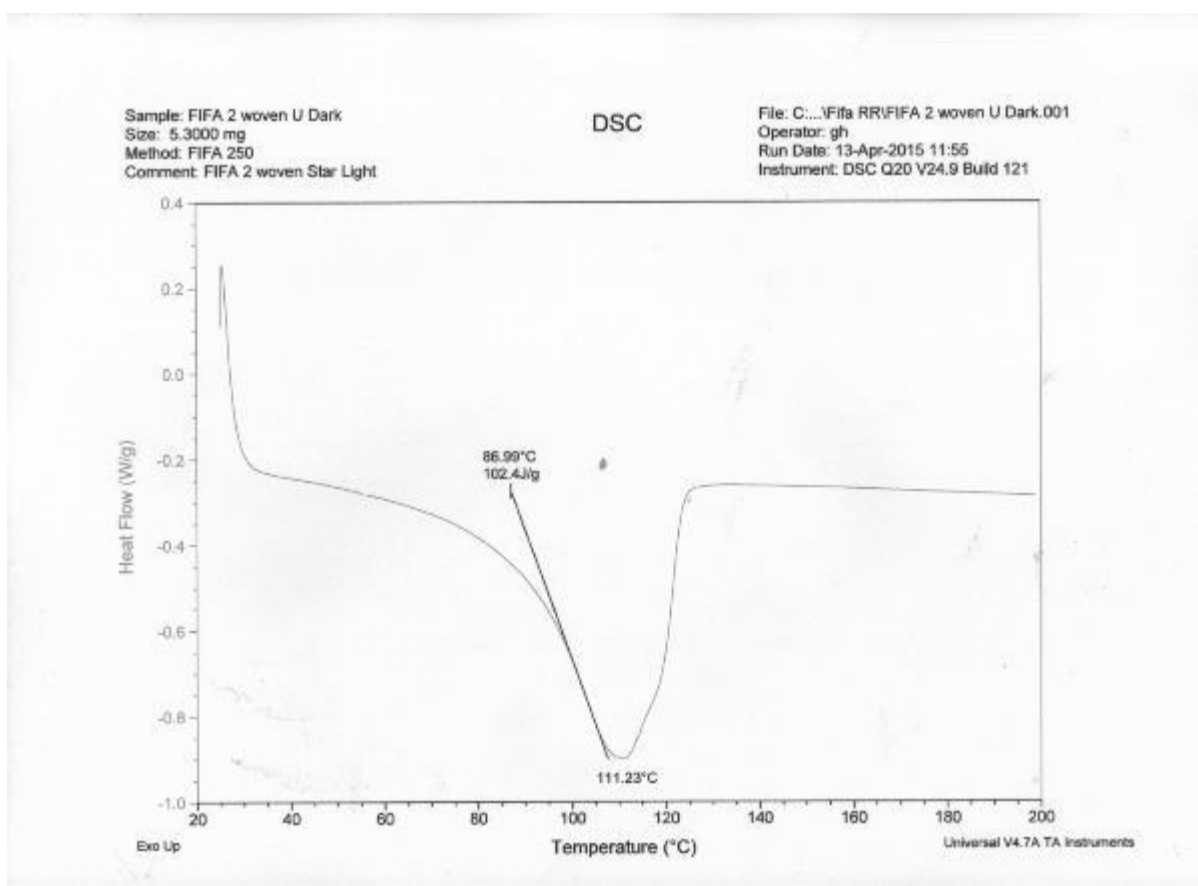


Figure 57: DSC curve representing melting behaviour of a fibre with a blend of polymers

The peak is clearly broader in Figure 57: DSC curve representing melting behaviour of a fibre with a blend of polymers and there is a shoulder approximately around 120°C however the device has only recorded a single peak at 111.23°C.

The following temperature programme is to be used for the measurement:

- Equilibrate at 20.00°C
- Heat at 20.00°C/min to 190.00°C
- Isothermal for 5 min
- Cool down at 20.00°C/min to 20.00°C
- Isothermal for 5.00 min
- Heat up at 20.00°C/min to 190.00°C

29.3. Results

29.3.1. *Melting Point(s) and Enthalpy*

Record the Melting Point(s) and Enthalpy of the peak(s) of the second heating cycle of the fibre.

29.3.2. *Peak width(s)*

Record the width of the peak, in °C, at 50% of the peak height generated in 29.3.1 Melting Point(s) and Enthalpy. If a shoulder is present its melting point should also be noted. It can be difficult to measure the precise point of the shoulder that corresponds to the associated melting point because of the diffuse shape of the shoulder. In that case, second order derivative analysis techniques shall be used to define the melting point of the shoulder.

Single polymers generally will show a specific relatively narrow melting peak as in Figure 56: Example of DSC curve with single melting peak. There are also some fibres produced from a single polymer that have a broad molecular weight distribution which will produce a single broad peak.

30. Procedure for the determination of decitex (Dtex) of yarns (FIFA Method 23)

30.1. Principle

A yarn is analysed to determine its linear density referred to as decitex (Dtex).

30.2. Apparatus

- a. Analytical balance with accuracy of $\pm 1\text{mg}$
- b. Gauge with a reading of 1mm
- c. Air circulating oven conforming to ISO 188
- d. Tweezers

30.3. Conditioning of samples

If samples are from a field that is wet, they should be dried in air-circulating oven at 70°C for 24h. After drying they should be conditioned for a minimum of 24h at 23 \pm 2°C and 50 \pm 5% RH.

30.4. Procedure

30.4.1. General method for assessing fibre Dtex

Take out 20 complete tufts with tweezers from the back of the carpet.

Scrape off any residue of latex (or coating) with the tweezers.

Remove any infill that may be “adhered” to the fibres.

Measure the length of each tuft to the nearest mm. Note down the sum of the lengths of the 20 tufts (L_{20}).

Weigh the 20 cleaned tufts (W_{20}) in grams.

30.4.2. Special cases.

Where the coating or latex can't be removed proceed as follows: Take 3 turf samples of min 200x200mm.

Shave off the pile of each piece and measure the length of the piles that have been shaved off up to the nearest mm (L_p).

Remove any infill that may be “adhered” to the fibres

Measure the length of each tuft to the nearest mm.

Calculate the number of tufts according to ISO 1743 (N_t)

Weigh the piles that have been shaved off (W_p) in grams.

30.5. Calculation of results

30.5.1. General method for assessing fibre Dtex

Calculate the total length of the 20 tufts.

$$Dtex = \frac{W_{20} \times 10^7}{L_{20}}$$

Special method

$$Dtex = \frac{W_p \times 10^7}{N_t \times 2 \times L_p}$$

30.6. Expression of results

The results should detail the dtex of each type of fibril per tuft and the number of fibrils of each type per tuft. (a) dtex X (b)

Where (a) corresponds to the linear mass (g) of the fibril per 10,000m, “X” is the multiplication sign, and (b) the number of fibrils per tuft.

*Linear mass of yarn **dtex X number of yarns***

For example: 1900 dtex X 8

When a tuft is composed of different fibrils, the sign “+” is inserted and the combined dtex result is shown between parentheses.

(Linear mass of fibril 1 **dtex X number of fibrils 1 + Linear mass fibril 2 dtex X number of fibrils 2**)

For example: (1900 dtex X 8 + 2200 dtex X 2)

In the eventuality of a different yarn composition between tufting lines, the tufting lines need to be identified.

For example: line 1 (1900 dtex X 8 + 2200 dtex X 2); line 2 (1900 dtex X 6)

31. Procedure for the determination of infiltration rate of artificial turf systems (FIFA Method 24)

31.1. Scope

This test method is based upon EN 12616:2013 and has been adapted to suit the requirements of Football Turf.

31.2. Definition

Permeability is defined as the infiltration rate when water is allowed to pass through the product due to gravity, it is calculated by measuring the time taken for the head of water to flow pass a specified height between two vertical marks. This can be measured as a component of a system e.g. shock pad or a carpet only, or as a total system.

31.3. Apparatus

- a. A ring of metallic or plastic material with an internal-diameter of 300mm ± 2mm and a method of sealing the ring to the product to be tested (either mechanically with a clamp or by use of a sealant)
- b. A support grid for underpinning the-product to prevent it distorting when water is poured into the apparatus. The maximum deformation of the product shall be 5mm from the outside of the ring to the centre once water has been added to the ring. Within the ring there should be 3 parallel horizontal wires or bars and a central bar perpendicular to the other three. These should be 2.5 +/- 0.5mm in width to prevent obstruction of any porosity holes in the carpet.
- c. Stopwatch (accurate to 0.1s)
- d. Spirit level

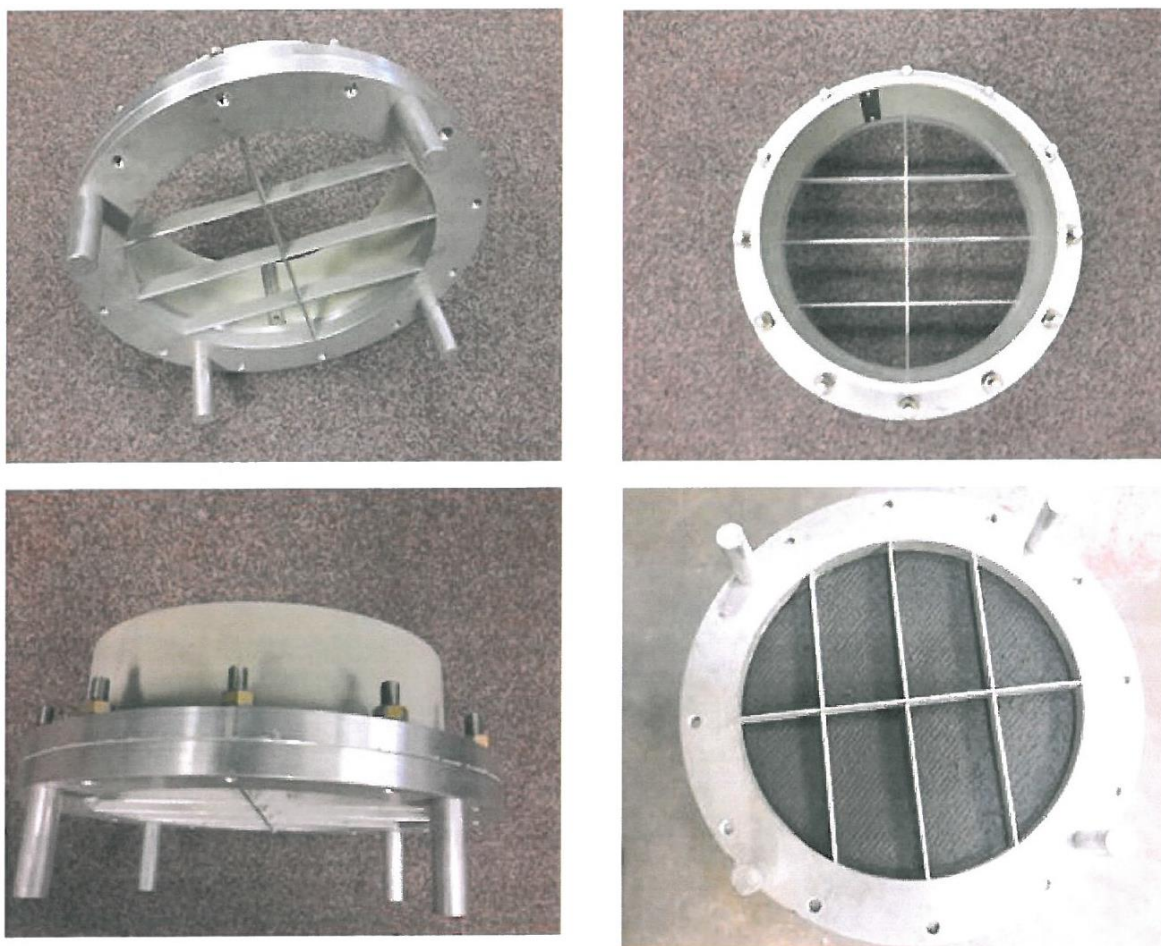


Figure 58: Example of apparatus for porosity testing

31.4. Sample preparation

Condition the test samples and any relevant infill in the laboratory at a temperature of $23 \pm 2^{\circ}\text{C}$ for a minimum period of 4 hours.

Prepare a sample of shock pad and/or carpet, sealing it by either method in the ring; ensure that the minimum number of porosity holes in the carpet are visible within the 300mm ring area. Measure the diameter and location of the holes within the test piece and record/photograph for inclusion in the report.

Fill the carpet if required to the specified infill depths. Ensure that all fibres are visible and that there are no trapped fibres beneath the infill. Each layer should be compressed by placing a round disc with a mass of $5.00\text{kg} \pm 0.25\text{kg}$ onto the turf, the disc should be rotated and contra-rotated on the surface a minimum of 5 full rotations to ensure compaction and levelling of any carpet infill, no additional pressure should be added to the disc.

If a mesh support is used, ensure that there is no sagging in the sample that would result in an uneven head of water over the sample.

Wetting of the test sample should be by the application of a minimum of 5 litres of water; the water should be applied through a disc of geotextile material of the same size as the diameter of the ring or through a similar size metal sieve with a mesh size no greater than 300 microns. Ensure there is no leaking of water laterally out of the ring joints. If there is then reseal the sample to correct this. The sample should be left to drain for a minimum of 30 minutes.

31.5. Procedure

Ensure that the test rig is level prior to the start of the test

Distribute water evenly to the consolidated samples through the mesh or geotextile. The head of water to be applied should be between 70-90mm above the infill or backing-of the sample, whichever is highest. Mark the ring at 10mm and 30mm above either the infill for filled systems, the shockpad (when testing the shockpad only) or the primary backing for non-filled systems or if measuring the turf without infill present. Time the fall in the head of water between the 30-10mm markers above the infill or backing (i.e. a 20mm drop in head) record the time to the nearest 0.1 second, ensure that any geotextile is removed prior to the start of the timer. If the infiltration rate is slow then stop the test at 30 minutes.

Repeat the test a further 2 times and average the last 2 results.

31.6. Calculation and expression of results

$$I_c = \frac{F_{wc}}{t_c}$$

Where:

- I_c is the infiltration rate in mm/hr
- F_{wc} is the height the water has fallen, normally 20mm
- t_c is the time taken for the water level to fall in hours

32. Procedure for the measurement of yarn thickness (FIFA Method 25)

32.1. Scope

This method describes how to measure the thickness of a yarn including the shape identification through an image.

32.2. Apparatus

32.2.1. *General*

Microscope with a capability of magnification in the range of 200x to 250x and able to measure the dimensions.

32.3. Samples

From a minimum of 3 different tuft lines cut at least 3 fibres to be measured and photographed (3 fibres to be measured in total). When sampling from a spool, three pieces of fibre must be measured and photographed at not less than 5 meters from each other.

32.4. Procedure

Cut a piece of fibre around 50mm \pm 10mm long from the available length from within the carpet or spool. Cool one end of the sample using an inverted compressed air bottle and cut accurately the end using a sharp blade (preferably a scalpel) against an aluminum plate.

The sample obtained will have a clean cut without burrs or distortion of the fibre.

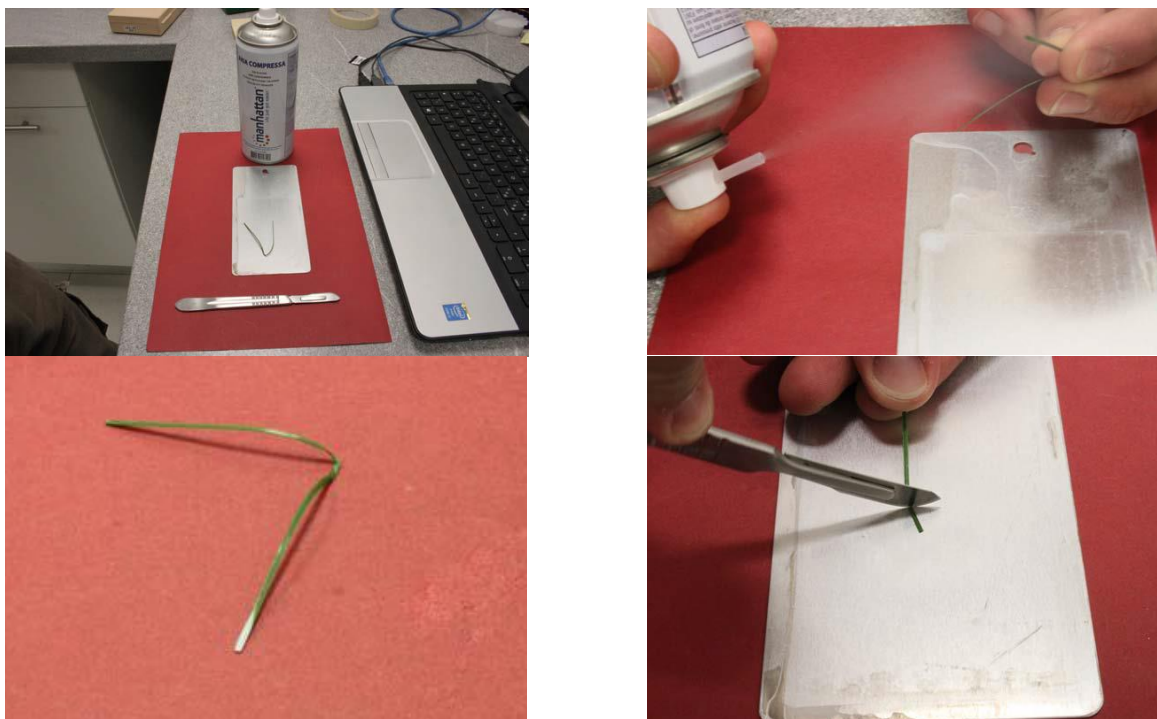


Figure 59: Sample preparation procedure

Using a support, holding the cut end in a vertical position perpendicular to the microscope verify that the cut is clean, and if necessary, depending on the colour of the fibre, use an insert of a different coloured background to maximize the definition of the image.

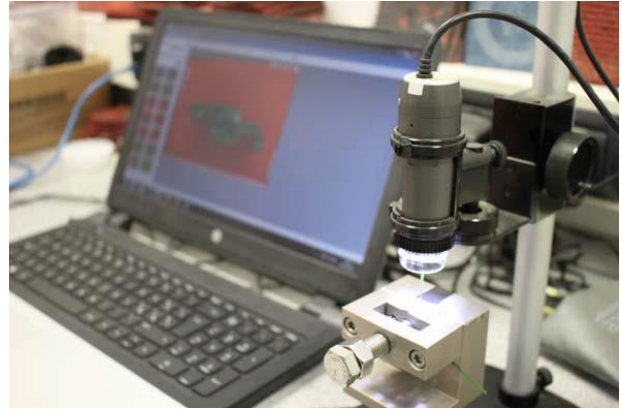
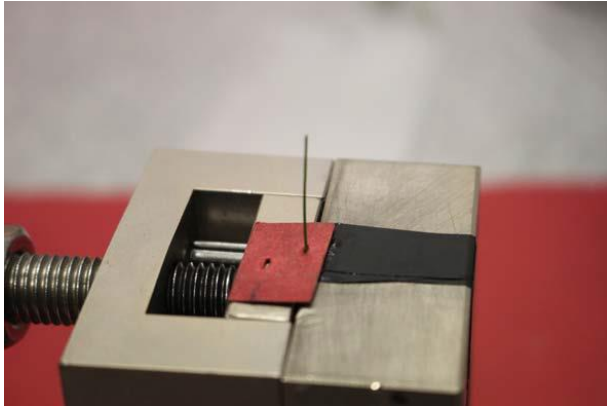


Figure 60: placement under the microscope

Adjust the magnification of the microscope in the range of 200x to 250x, and focus on the cross-sectional cut plane of the fibre; after making sure they're in focus take the picture.

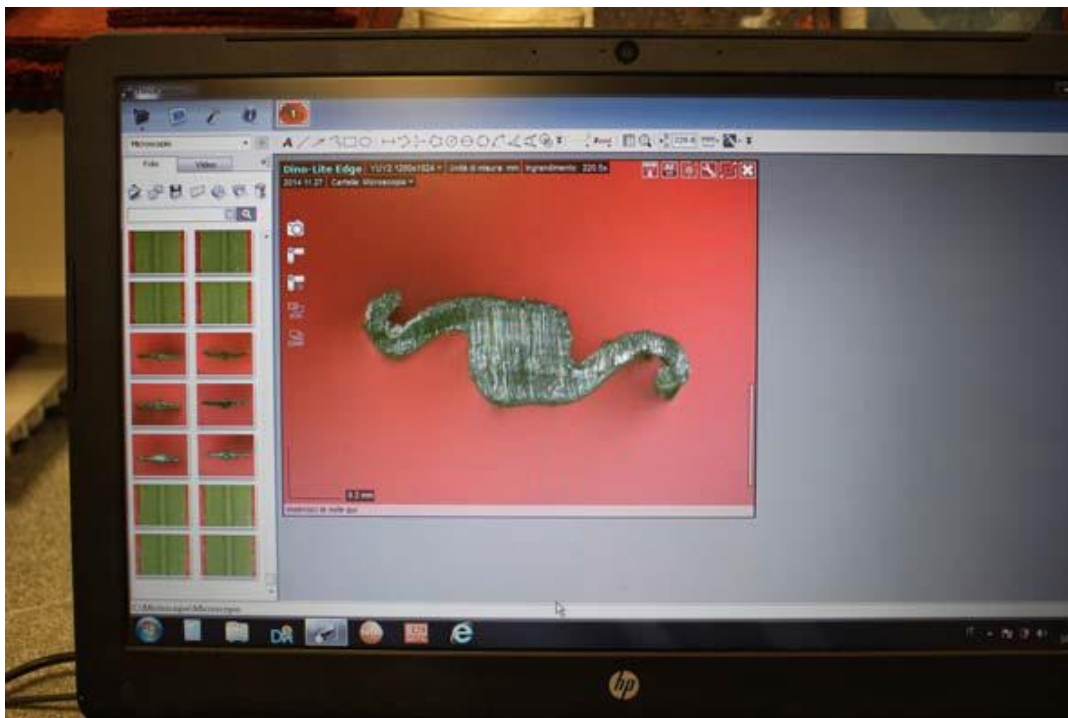


Figure 61: screen view of the sample under the microscope

Proceed now to the measurement of the following points.

Using the measurement function of the microscope (line)

- 1) maximum width of the fibre;
- 2) maximum thickness of the fibre, referred to as the perpendicular to its width;
- 3) at least one reading intermediate between the centre and the extremity, on each side;

Using the "circle" function of the microscope, inscribe where possible, in the areas of maximum thickness, the largest circle possible.

The picture obtained will be included in the FIFA Laboratory Report with the following details:

- Length 15cm
- Width 10cm
- The diameter of the largest circle

- Resolution 100 dpi

32.5. Results

Record the dimensions of the yarn from a cross-sectional perspective including all measurements.

The thickness of the fibre is defined as the diameter of the largest circle possible inserted in the core of the fiber.

Typical examples of the most commonly used fibres are shown below:

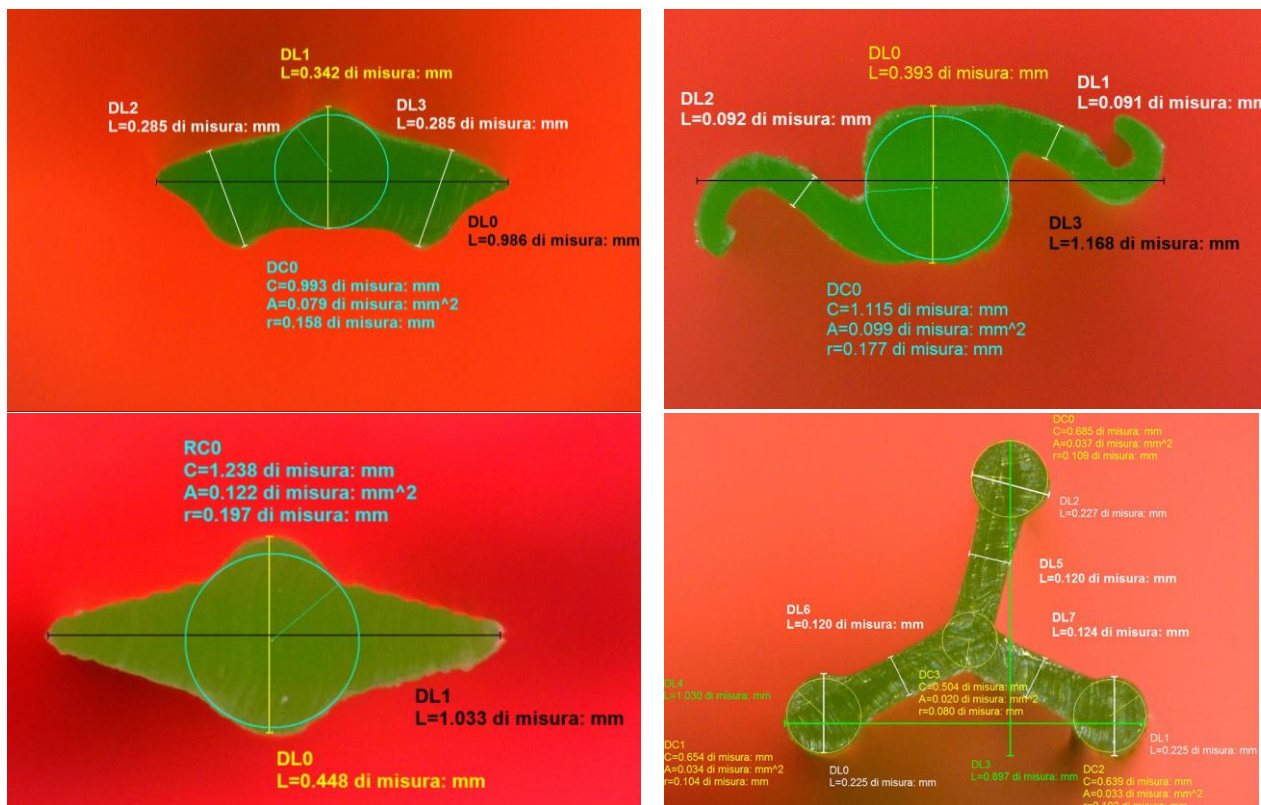


Figure 62: Some typical common fibre shapes

Where there are complex shapes, note the dimensions at several points as per the example below or consult the FIFA Quality Programme for clarification.

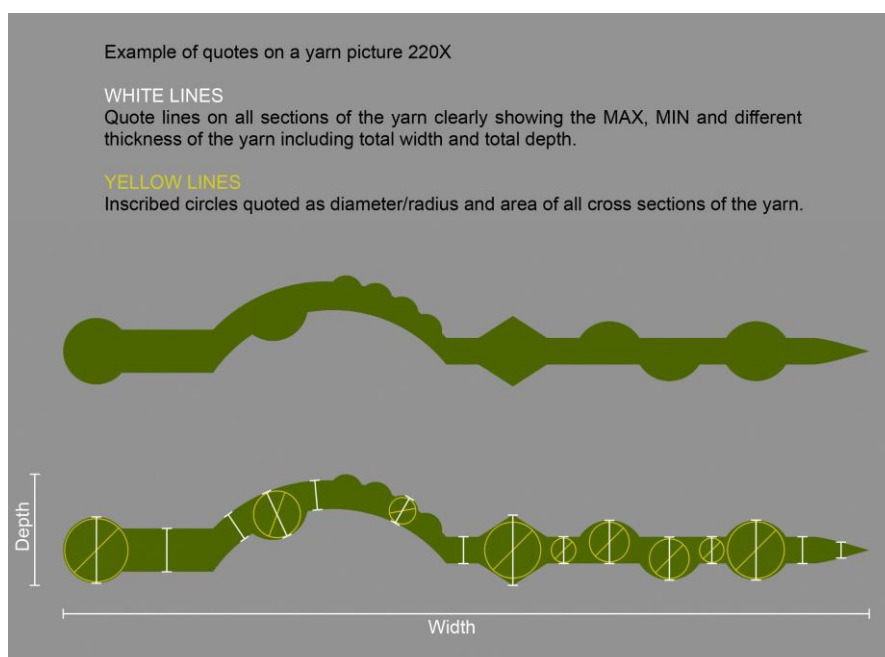


Figure 63: Sample of thickness measurements

33. Procedure for Determination of tuft withdrawal force (FIFA Method 26)

33.1. Scope

This method is based upon ISO 4919 (2012) and has been adapted to minimize the difference when testing Football Turf.

33.2. Apparatus

- A Tensile testing apparatus with a load cell that is accurate $\pm 5\%$ over the range of testing 10N to 250N.
- Surgical forceps
- A base plate with a minimum dimension of 60x60mm with a circular hole, of a minimum radius of 12mm, has been cut-out. The cut-out may have a throat to allow easier positioning of the tufts to be withdrawn.

33.3. Conditioning of samples

Take a sample of minimum 200x200 mm from the carpet to be tested.

If samples are from a (wet) field, they should be first dried in an oven at 70°C for 24h. Afterwards they should be conditioned for a further minimum of 24h at 23 \pm 2°C.

Tests should be performed at 23 \pm 2°C.

33.4. Procedure

Install the base plate so that this is flat, on a plane perpendicular to the direction of the tuft withdrawal.

Select one end of one whole tuft and attach it into the surgical forceps.

Clamp the carpet on the baseplate and take care the tuft is located in the cut-out of the base plate.

Set the tensile testing machine in motion with a constant speed of 100mm/min and completely withdraw the tuft along a path that is essentially perpendicular to that of the carpet specimen.

Verify that only one tuft was withdrawn and register the maximum force recorded by the tensile machine.

If additional fibres from another tuft were inadvertently gripped or if only a part of the tuft was withdrawn, ignore the result.

Repeat the procedure for a minimum of 20 tufts, spread over the sample. The minimum distance between each withdrawn tuft is at least 25mm.

33.5. Calculation of results

Calculate the mean tuft withdrawal force in Newtons and note the value to one decimal place. Also note the standard deviation for the 20 tufts.

34. Minimising infill migration into the environment – field design (FIFA Method 27)

The polymeric infills used within many synthetic turf sports surfaces have been identified as a source of potential environmental contamination if they are allowed to migrate from the field into the surrounding land. It is therefore important that the design of any football turf field that has these infills includes features that will minimize the risk of this occurring.

Based on the recommendations of the draft CEN Technical Report Surfaces For Sports Areas — Synthetic Turf Sports Surfaces: Controlling Infill Migration to help Minimize Environmental Contamination. All Football Turf fields incorporating polymeric infills should consider the following design features.

34.1. Drainage filters

To minimize this risk of infill being transported by stormwater into the aquatic environment, all drains around or near the synthetic turf field shall include silt traps to capture any infill being washed into the drainage system. These should typically comprise a filter bucket offering primary filtration (removing the heavier silts) and a secondary fine micro-filter that captures any remaining small particles. Both the filter bucket and secondary fine micro filter should be easily removable for cleaning/replacement.

34.2. Perimeter fencing/edge margin containment barriers

Figure 64: Fencing panels, used when the synthetic turf surface is laid up to fence. and Figure 65: Raised edging options and paved zone to separate synthetic turf surface from perimeter boundary for typical examples of the fencing and details described below.

If a field is enclosed by a non-solid (e.g. mesh) fence it shall incorporate some form of physical barrier to prevent infill leaving the field.

A number of different edge barriers have proven successful including:

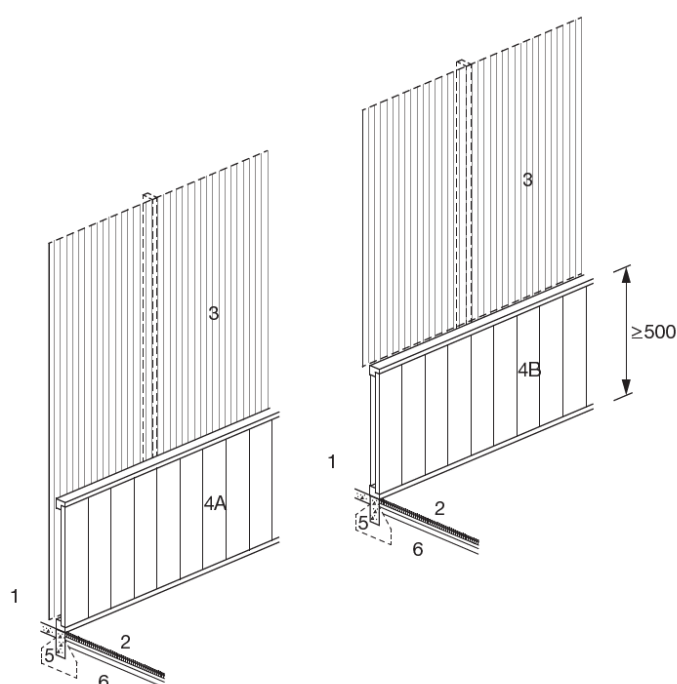
- 0.5 m or higher panels. These may be formed from brickwork, timber, rigid plastic extrusions, metal work or other materials;
- a combination of a paved area and 200 mm of timber or plastic boards, mounted to the fencing system so they sit flush with the ground and do not allow infill to migrate under them.

If tanalised timber boards are used it is recommended they be vacuum pressure impregnated softwood timber in accordance with Class 4 of EN 335;

- raised precast concrete edgings or kerbs (minimum 200 mm high) located inside and adjacent to the fence line;
- cast concrete plinth/kerb (minimum 200 mm high) on which the perimeter fencing is flush mounted.

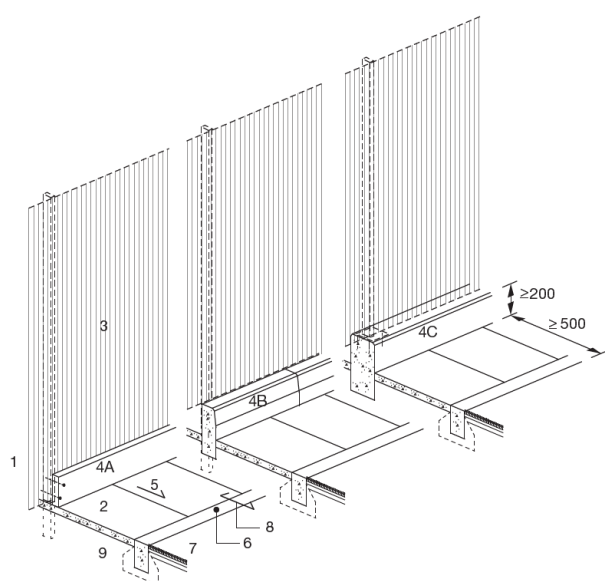
If the perimeter edge detail is less than 500 mm high there is a possibility of infill being lifted over the edge detail during routine play and maintenance. To minimize the risk of this occurring a paved (asphalt, concrete, paving slabs, etc) margin (minimum 500 mm wide) should be positioned between the synthetic turf surfacing and the fence line. This should be designed to allow ground-staff to collect any dispersed infill that has worked its way to the sides of the field and put it back onto the playing area, before it leaves the facility. It shall be designed to avoid construction joints and other features where the infill can accumulate.

If a slot or gully drain are required to capture water falling on the paved margin, they should be fitted with a silt trap to capture infill being washed into the drainage system.



1	Area outside field
2	Synthetic turf surfacing
3	Perimeter fencing
4a	Fencing boards mounted in front of fence. May be used on new build fields or be fitted to existing fields
4b	Fencing mounted above boards - most suited to new fields and fencing
5	Field edge detail/kerb
6	Synthetic turf field base
<i>All dimensions in millimeters</i>	

Figure 64: Fencing panels, used when the synthetic turf surface is laid up to fence.



1	Area outside field
2	Field side of fence
3	Perimeter fencing
4a	Timber or plastic board
4b	Pre-cast concrete kerb with fence mounted behind
4c	Cast concrete edging with fence mounted above
5	Hard paved zone between synthetic turf and fence
6	Field edging/kerb
7	Synthetic turf surfacing
8	Flush edge detail to avoid trip hazard
9	Synthetic turf field base
<i>All dimensions in millimeters</i>	

Figure 65: Raised edging options and paved zone to separate synthetic turf surface from perimeter boundary

34.3. Access points

At all (single and double) entrances to the field, boot cleaning grates/scrapper mats should be installed. They may comprise:

- Smooth bar industrial decontamination grates
- Heavy duty rubber scraper mats
- Heavy duty honey-comb profile mats

The cleaning grates/scrapper mats shall be the full width of the entrance gate and at least 1.5 m in length so people cannot step over them. They should be positioned immediately adjacent to entrance gates, either internally, when located in a paved surround/spectator area, or externally, when the synthetic turf surfacing is laid to the perimeter fence.

The mats should be set in recessed concrete bases that will contain any infill or other detritus being taken off the field by players' footwear or maintenance equipment, etc. To prevent the bases filling with water they should contain a suitably designed drain fitted with a silt trap to capture infill.

All metalwork shall be hot dip galvanized in accordance with EN ISO 1461 and care should be taken to ensure that no sharp edges are left after galvanizing.

Typical examples of decontamination/boot cleaning grate:

Figure 66: Decontamination / boot cleaning grate (located outside all entrances) & Figure 67: Decontamination grate / boot cleaning – alternative configuration show for typical examples of cleaning grates/scrapper mats.

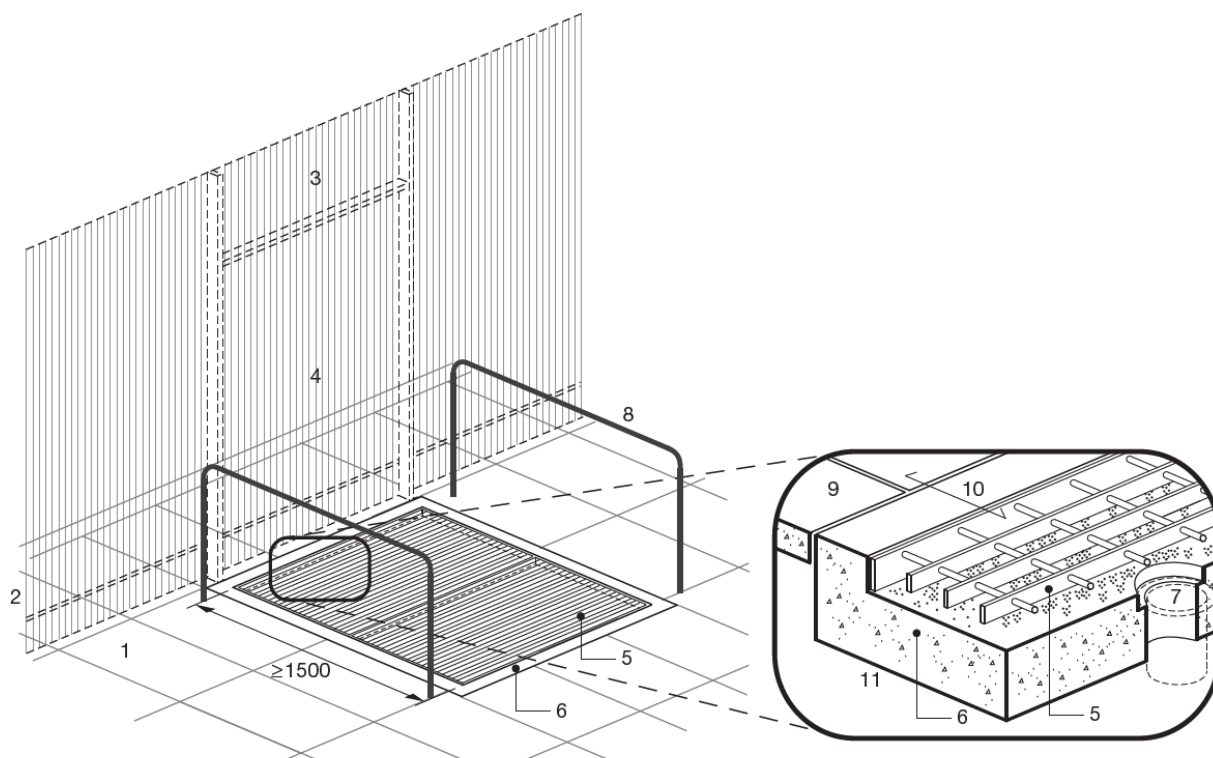


Figure 66: Decontamination / boot cleaning grate (located outside all entrances)

1	Area outside field
2	Synthetic turf surfacing
3	Perimeter fencing
4	Gate
5	Removable recessed grating panels with space below for rainwater discharge
6	Concrete base and edging surrounds
7	Drain with filter bucket and secondary fine micro-filter
8	Access barrier / fence
9	Hard paving
10	Flush edge detail to avoid trip hazard
11	Suitable base
<i>All dimensions in millimeters</i>	

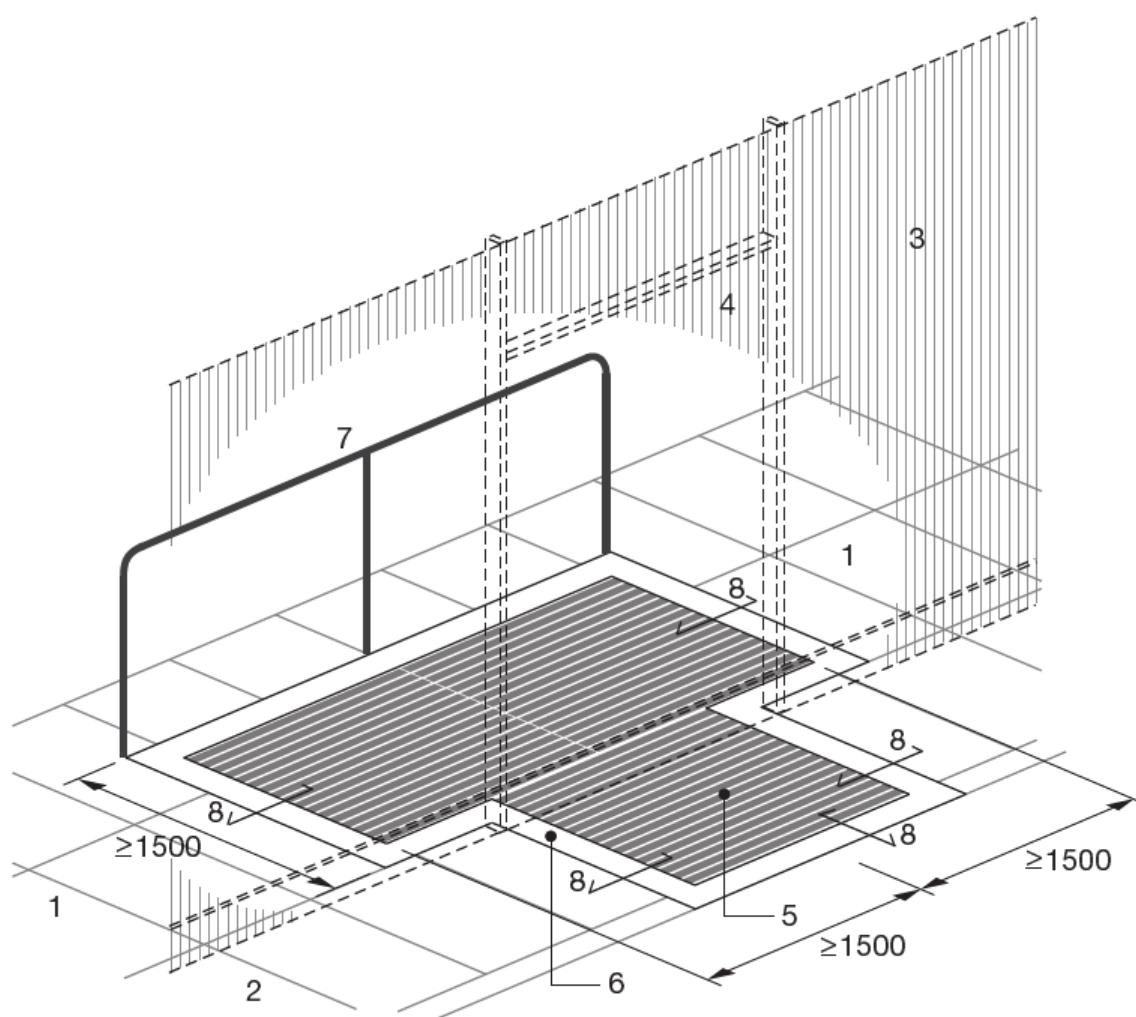


Figure 67: Decontamination gate / boot cleaning – alternative configuration

1	Area outside field
2	Synthetic turf field
3	Perimeter fencing
4	Gate
5	Heavy duty rubber scraper mats Heavy duty honey-comb profile mats Smooth bar industrial decontamination grates
6	Concrete base with drain and silt trap
7	Control barrier / fence
8	Paved footpath, flush to grate to avoid trip hazards
<i>All dimensions in millimetres</i>	

34.4. Boot cleaning stations

Multi-person boot cleaning stations, with suitable signage encouraging athletes to use them, should be located at the main points of egress from the field.

Figure 68: Boot cleaning station. If mounted outside the synthetic turf field, it should be positioned over a hard paved area that has a suitable design to contain dislodged infill and drains in accordance with 34.2 Perimeter fencing/edge margin containment barriers.

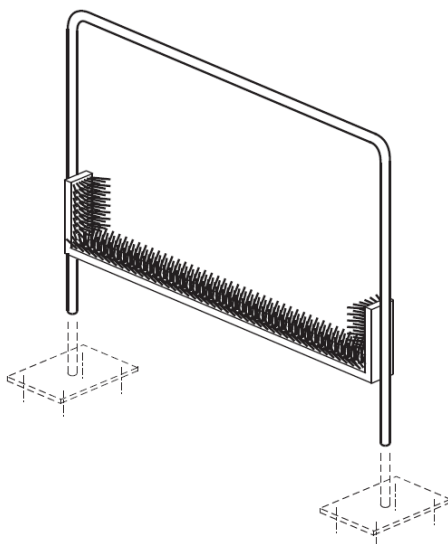


Figure 68: Boot cleaning station

34.5. Snow clearance

In climates where heavy snow fall can be anticipated the field should contain a hard paved or extended synthetic turf area that is designed to ensure snow–melt drains back onto the main field, or to suitably designed drains that have suitable silt traps to capture any infill being washed away.

Figure 69: Snow storage area

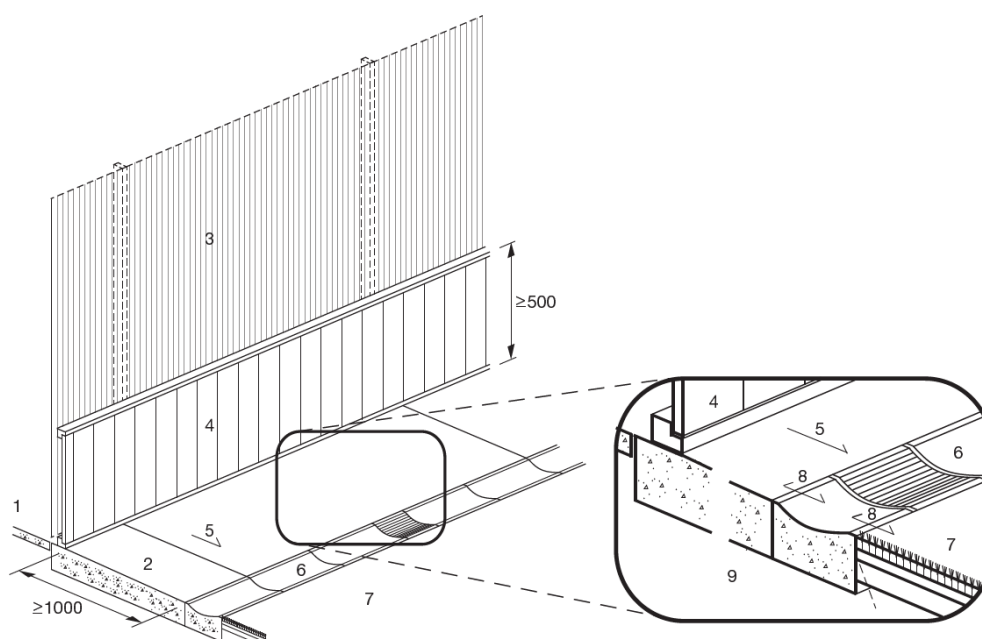


Figure 69: Snow storage area

1	Area outside field
2	Field side of fence
3	Perimeter fencing
4	Timber of plastic board
5	Hard paving with slope towards field
6	Drainage channel/drain containing filter bucket and secondary fine micro-filter
7	Synthetic turf surfacing
8	Flush edge detail to avoid trip hazard
9	Foundation / base
<i>All dimensions in millimetres</i>	

35. List of International and European Standard test methods adopted by FIFA

In addition to the test methods described in this manual FIFA has adopted the following International and European Standards for measuring the material properties of football turf.

Bulk density of infill materials	EN 1097 – 3	Tests for mechanical and physical properties of aggregates - Part 3: Determination of loose bulk density and voids
Thickness of shockpads and depth of infill layers	EN 1969	Surfaces for sports areas: Determination of thickness of synthetic sports surfaces
Joint strength of artificial turf	EN 12228	Surfaces for sports areas - Determination of joint strength of synthetic surfaces
Tensile strength of shockpads	EN 12230	Surfaces for sports areas: Determination of tensile properties of synthetic sports surfaces
Immersion in hot water	EN 13744	Surfaces for sports areas: Procedure for accelerated ageing by immersion in hot water
Mass per unit area of artificial turf	ISO 8543	Textile floor coverings: Methods for determination of mass
Tufts per unit area of artificial turfs Knots per unit area (woven carpets)	ISO 1763	Carpets: Determination of number of tufts and or loops per unit length and per unit area
Pile length above backing of artificial turf	ISO 2549	Hand knotted carpets: Determination of tuft leg length above woven ground
Mass per unit area of artificial turf and total pile weight	ISO 8543	Textile floor coverings: Methods for determination of mass
Particle shape of infill materials and unbound base materials	EN 14955	Surfaces for sports areas: Determination of composition and particle shape of unbound mineral surfaces for outdoor sports areas

36. Appendix I Lisport XL | Sample preparation procedure

The following procedure describes how a football turf sample needs to be prepared when it is exposed to the Lisport XL:

1. Rake sample against direction of tufting to lift the fibres. Use a hard rake (picture)
2. Disperse the sand evenly with a spreader
 - a. Fine tune the sand distribution with a rigid rake
 - b. Ensure an even distribution by measuring the infill depth using a depth probe (forceful penetration)
3. Add the performance infill (with the spreader)
 - a. Fine tune the infill distribution with either a rigid or soft rake
 - b. Ensure even distribution (within 10% of the product declaration) by measuring the infill depth using a depth probe (soft penetration) and a Prism (3 readings per m²)
4. Ball rebound
 - a. Take 5 measurements diagonally across the sample
5. Run 5 conditioning cycles in the Lisport XL
6. Ball rebound
 - a. Take 5 measurements diagonally across the sample
7. Lisport XL | 3000 or 6000 cycles
 - a. Maintenance after each 500 cycles
 - i. Deconsolidate the performance infill by using a hard rake (do not deconsolidate the sand infill)
 - ii. Add displaced performance infill and redistribute evenly on the sample by using a spreader.
 - iii. Use a hard rake to distribute the infill evenly and finish off with the brush
 - iv. Ensure an even distribution (within 10% of the product declaration) by measuring the infill depth using a depth probe (soft penetration) and a Prism (3 readings per m²)
 - b. Maintenance after 3000/6000 cycles
 - i. Deconsolidate the performance infill by using a hard rake (do not deconsolidate the sand infill)
 - ii. Add displaced performance infill and redistribute evenly on the sample by using a spreader.
 - iii. Use a hard rake to distribute the infill evenly and finish off with the brush
 - iv. Ensure an even distribution (within 10% of the product declaration) by measuring the infill depth using a depth probe (soft penetration) and a Prism (3 readings per m²)
8. 5 conditioning cycles in the Lisport XL
9. Perform required testing after Lisport XL (Reduced Ball Roll (dry/wet), Ball Rebound, AAA, Rotational Resistance, Surface Friction and Abrasion and any other required test)

37. Appendix II Determination of excess Spin Oil on synthetic grass fibres (Not mandatory)

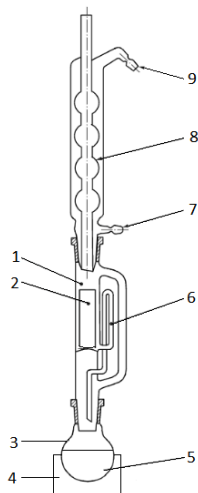
37.1. Scope

This method describes how to determine the presence of excess spin oil, also referred to as spin finish on synthetic grass fibres.

37.2. Apparatus

37.2.1. General

Soxhlet extraction apparatus consisting of:



1. soxhlet extractor with a volume of 150ml
2. cellulose Soxhlet extraction thimbles
3. round-bottomed flask with a capacity of min 200ml
4. heating device
5. iso-propanol p.a.
6. syphon
7. cold water intake of the condenser
8. condenser
9. outlet of condenser
10. ventilated oven
11. analytical balance capable of weighing to the nearest 1 mg
12. rotavapor with heating bath
13. desiccator with silica gel
14. weighing flasks

Figure 1 Soxhlet Extractor

Note: An automated system for soxhlet extraction can be used as an alternative

37.3. Procedure

Dry the round-bottom flasks for a minimum of 4h in an oven at $105 \pm 3^\circ\text{C}$. Let them cool down in a desiccator for 2h.

Weigh them on the analytical balance, this is m_2 .

Transfer approximately 5g of fibre into the extraction thimble and place this in the soxhlet extractor as shown in Figure 1.

Fill the round bottomed flask with isopropanol and connect it to the soxhlet extractor. Attach the condenser to the soxhlet extractor and turn on the water flowing into the intake (position 7).

Regulate the temperature of the extraction apparatus to achieve 2 extraction cycles of 10 minutes.

Note: It is recommended to do a pretest to determine the heating temperature of the heating device to achieve this number of extraction cycles.

Reflux the solvent through the sample for 20 minutes, this is 2 extraction cycles.

Remove the extraction thimble with the yarn from the apparatus.

Allow most of the solvent to evaporate and evaporate the remainder of the solvent in a rotavapor.

Dry the round-bottomed flask in an oven at $105 \pm 3^\circ\text{C}$ during 1h. Let it cool down for at least 1h in a desiccator.

Weigh the dried and cool round-bottomed flask on an analytical balance (m_3).

Remove the yarn out of the extraction thimble and put it in a weighing flask. Let it dry in an oven for at least 4h and max 16h at 105±3°C. Let it cool down in a desiccator for a minimum of 2h.

Weigh them on the analytical balance, this is m_d.

37.4. Calculation of results

The percentage of spin oil on the yarn is given by:

$$\frac{m_3 - m_2}{m_d} \times 100 \%$$

Where:

m₂ mass of the empty round-bottomed flask in g

m₃ mass of the round-bottomed flask with residue in g

m_d dry mass of the yarn after solvent extraction in g.