FIFA

Quality Concept

for Football Turf

Handbook of Test Methods

January 2012 Edition

FIFA

For the Game. For the World.

Contents

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Changes in the 2012 FQC Test Method Manual (compared to 2009 edition):

- New methodology for the measurement of Force Reduction (Advanced Artificial Athlete)

- New methodology for the measurement of Vertical Deformation (Advanced Artificial Athlete)

- New methodology for the measurement of Energy Restitution (Advanced Artificial Athlete)

- Update of Stud Slide and Stud Deceleration methodology

- Addition of methodology for assessment of synthetic performance infill

- Addition of methodology for planarity

- Update of methodology for ball roll

1   Introduction

This Handbook describes the procedures for assessing artificial turf football surfaces under the FIFA Quality Concept. 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 31 January 2012.

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

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

3.3   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.

3.4   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.

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

3.6   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
Ball roll	11.0m	1.0m
Shock absorption	1.0m	1.0m
Vertical deformation	1.0m	1.0m
Rotational resistance	1.0m	1.0m
Stud Slide Value & Stud Deceleration Value	0.5m	0.5m
Surface Friction / Abrasion	1.0m	1.0m
Sub-ambient & Elevated tests	0.4m	0.4m
Simulated wear	0.8m	0.4m
Artificial weathering: carpet pile yarn(s)	5m length	

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

3.8   Preparation of test specimens

Test specimens shall be prepared strictly in accordance with the manufacturer's instructions. If required this may include consolidation of the infill by means of a conditioning roller (see below) or other means. The same conditioning procedure shall be used on all test specimens being prepared for sports performance and simulated use tests.

All test specimens (other than those being prepared for simulated use, tests at sub-ambient and elevated temperatures and artificial weathering) shall then be conditioned prior to test by passing a hand-pulled roller or the lisport machine over the test specimen for a minimum of 50 cycles and a maximum of 250 cycles (one cycle comprises one outward and one return path by a single roller, where double rollers (without chain between rollers), etc are used the number of cycles shall be adjusted pro-rota). The barrels of the roller shall weigh 28.5 $\pm$2 kg, be 118 $\pm$5 mm in diameter and have plastic studs (see Section 7) mounted as shown in Figure 1.
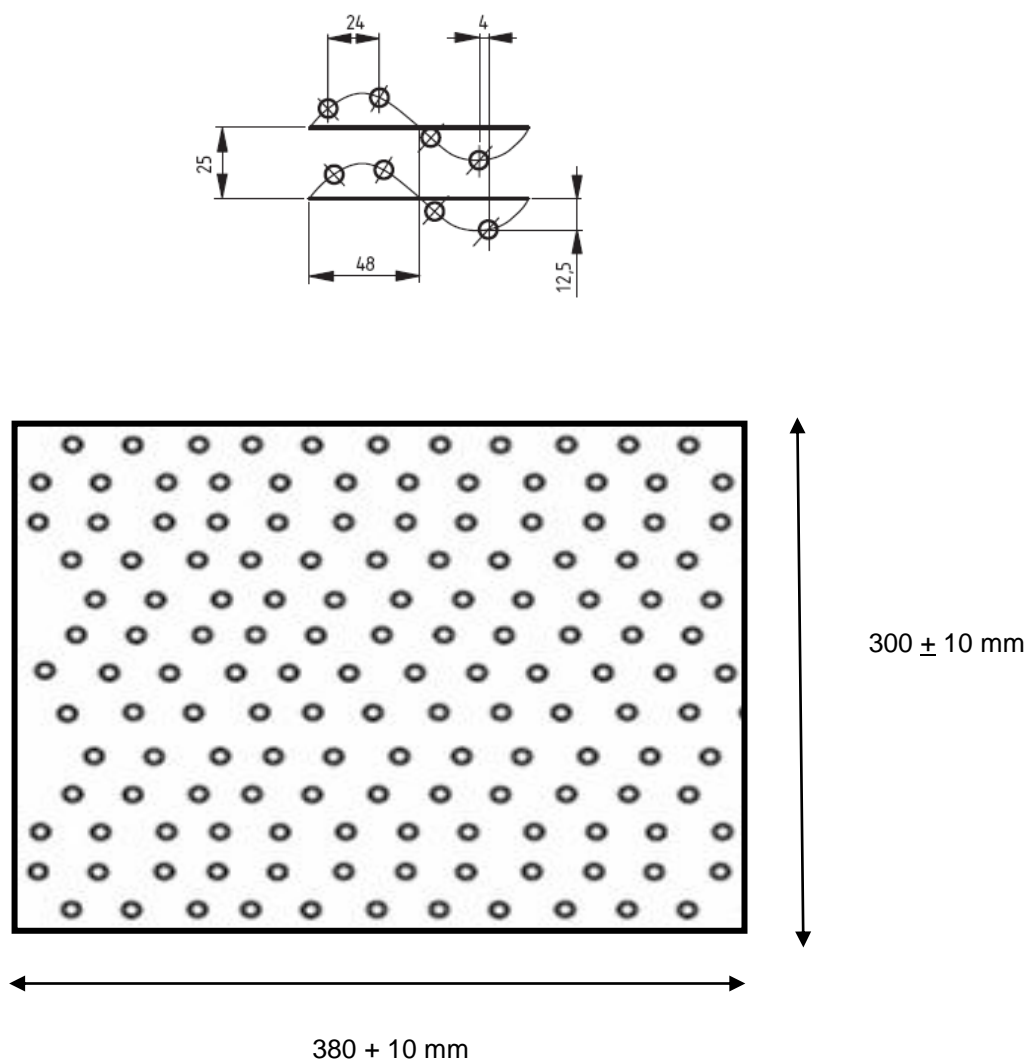

300 $\pm$ 10 mm

380 $\pm$ 10 mm

Figure 1 – stud pattern on conditioning roller and Lisport Wear Machine

4 Field test positions

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

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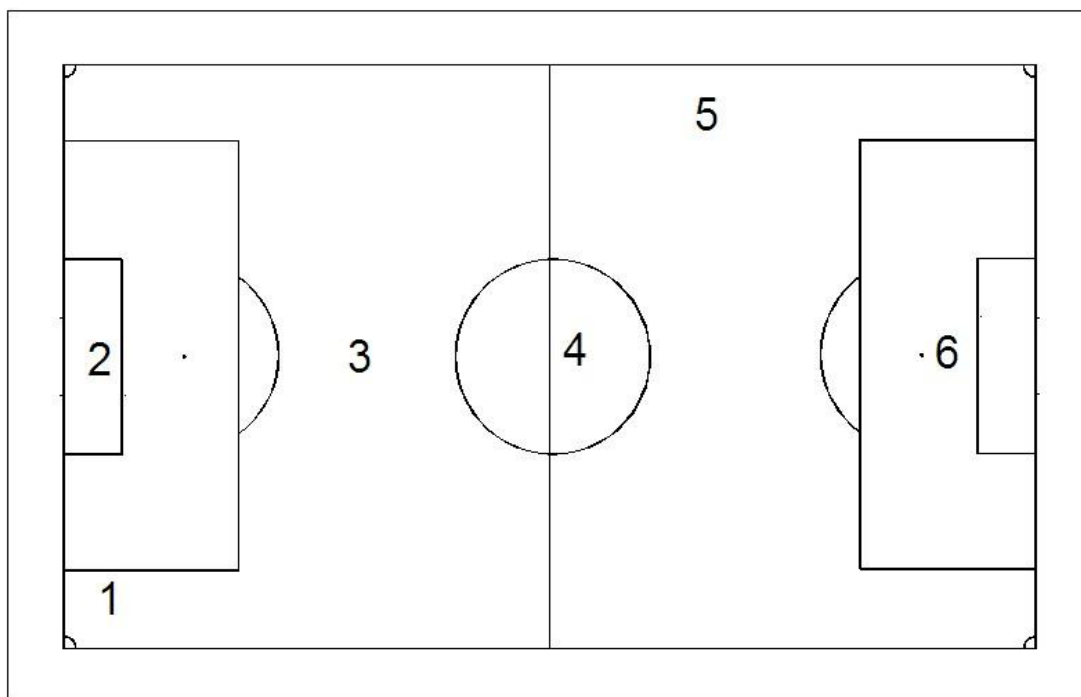

Figure 2 - field test positions

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

5 Test conditions

5.1 Laboratory tests

Laboratory tests shall be made at an ambient laboratory temperature of 23 ± 2° C.

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

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.

5.3 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 to +40°C. If weather conditions make it impossible to undertake tests within the specified temperature range the deviation from the specified test conditions shall be 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 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 ($\pm$ 3mm 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 three directions (0°, 90°and 180°) on at least one area of the pitch. If the free pile height is found to be inconsistent (> $\pm$ 3mm 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° (nine readings at each of the six test positions).

6 Balls used for test

Tests shall be made with a FIFA approved football. Immediately prior to any test, the pressure of the ball shall be adjusted within the range 0.6 – 0.9 bar so the ball gives a rebound on concrete to the bottom of the ball, at the temperature the test will be made, of 1.35 $\pm$ 0.03m, from a drop height of 2.0 $\pm$ 0.01m.

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.

7 Football studs used for test

The studs used on the Rotational Resistance, Linear Friction Stud Slide Value and Friction Linear Stud Deceleration Value, Lisport Wear Machine and sample conditioning roller shall be in accordance with Figure 3. They shall be manufactured from plastic and have a Shore A Hardness of 96 $\pm$2.
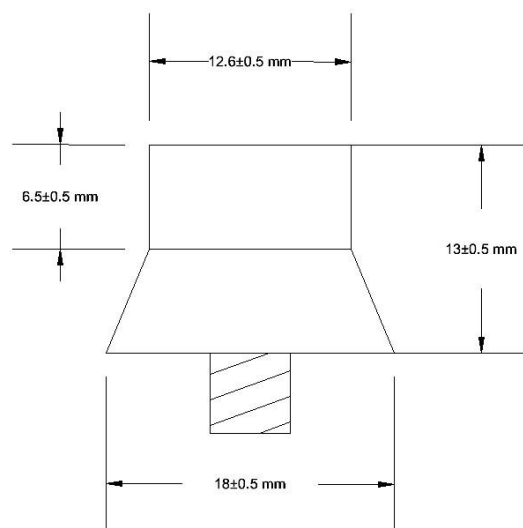
Figure 3 - profile of football stud (new)

Stud replacement – simulated wear

After every twenty tests (5200 cycles), the length of 15 studs removed at random from the rollers shall be determined and the mean length and the standard deviation of the fifteen studs.

If the mean length is less than 11.0mm, the standard deviation is more than 0.5 or any one stud has a length of less than 10mm all the studs on both rollers shall be replaced.

Stud replacement – Rotational Resistance

After a maximum of fifty tests (5200 cycles), the length of the studs shall be determined.   If any stud is found to be less than 11.0mm all shall be replaced.

8 Determination of ball rebound (FIFA Test Method 01)

8.1 Principle

A ball is released from 2m and the height of its rebound from the surface calculated.

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

8.2 Test apparatus

8.2.1 <u>Measuring device</u>

The test apparatus comprises:

- An electro magnetic or vacuum release mechanism that allows the ball to fall vertically from 2.00 $\pm$0.01m (measured from the bottom of ball) without imparting any impulse or spin.

- Vertical scale to allow the drop height of the ball to be established.

- Timing device, activated acoustically, capable of measuring to an accuracy of 1ms.

- Football.

- Means of measuring wind speed to an accuracy of 0.1 m/s (field tests only).

8.3. Test procedure

Validate the vertical rebound of the ball on concrete immediately before testing.

Release the ball from 2.00 $\pm$0.01m, bottom of ball to top above the top of the infill (in filled systems) or on the top of the pile on unfilled systems of playing 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 when the ball is attached.

8.4 Calculation and expression of results

For each test calculate the rebound height using the formula:

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

Where:

H = rebound height in cm

T = the time between the first and second impact in seconds

$\Delta t = 0.025s$

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 $\pm$ 0.03m.

8.5   Laboratory tests at 23 $\pm$2°C

8.5.1   Procedure

Determine the ball rebound of the test specimen in five positions, each at least 100mm apart and at least 100mm from the sides of the test specimen. Remove any displaced infill from adjacent tests positions prior to making a test.

Undertake tests under dry and wet conditions, as appropriate.

8.5.2   Calculation of results

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

8.6   Laboratory tests after simulated mechanical abrasion during use

8.6.1   Procedure

Condition the test specimen in accordance with Section 16.

Carefully remove the test specimen from the Lisport Wear Machine and place on the test floor.

Determine the ball rebound of the test specimen in three positions each at least 100mm from the sides of the test specimen. Remove any displaced infill from adjacent tests positions prior to making a test

Undertake tests under dry conditions only.

8.6.2   Calculation of results

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

8.7   Field tests

8.7.1   Test Conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 5.3. The conditions shall be reported.

8.7.2   Procedure

Record the maximum wind speed during the test.

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

8.7.3   Calculation of results

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

9 Determination of Angle Ball Rebound (FIFA Test Method 02)

9.1 Principle

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

9.2 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 to an accuracy of ±0.1 km/h.

- Football.

The ball must be launched without spin (relative to the axis of shooting). Spin tolerance: less than one half turn between the canon and the surface

9.3 Test procedure

Validate the vertical rebound of the ball on concrete immediately before the testing.

Adjust the pneumatic cannon so that the vertical height of the inner diameter of the cannon mouth is 0.90 ± 0.02m above the top of the infill (in filled systems) or on the top of the pile on unfilled systems and so the ball departs the cannon at an angle of 15 ±2° to the horizontal and has a velocity of 50 ±5 km/h just prior to impacting the surface.

Position the radar 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 of between 450mm and 500mm 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 the same position twice.

9.4 Calculation and expression of results

Calculate the angle ball rebound using the formula:

Angle ball rebound (%) = (S2 / S1). 100

Where:

S2 = velocity after rebound in km/h
S1 = velocity before rebound in km/h

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

Quote the uncertainty of measurement as ± 5% absolute.

9.5 Laboratory tests

9.5.1 Procedure

Determine the angle ball rebound of the test specimen, ensuring each test position is each at least 300mm 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.

9.5.2 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.

10　Determination of Ball Roll (FIFA Test Method 03)

10.1　Principle

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

10.2　Test apparatus

The test apparatus comprises:

- A ball roll ramp as shown in Figure 4 consisting of two smooth parallel rounded bars, 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 ±0.01m (e.g. steel tape, laser).

- Football

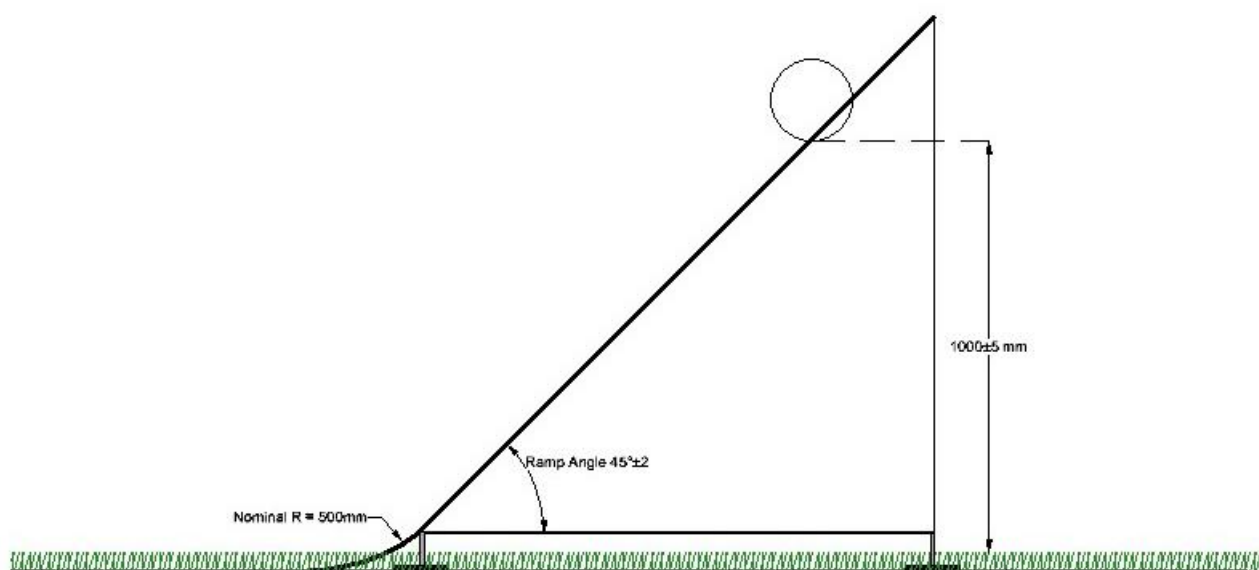- Means of measuring wind speed to an accuracy of 0.1 m/s (field tests only).

1000±5 mm

Ramp Angle 45°±2

Nominal R = 500mm

Figure 4 Ball Roll ramp

10.3　Test procedure

Validate the vertical rebound of the test ball on concrete immediately before the testing.

Adjust the ramp so that it is perpendicular to the surface and so the end of the guide rails are sitting on the top of the infill (in filled systems) or on the top of the pile on unfilled systems 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 below the centre of the ball sitting on the ramp is 1000 ±5 mm above the test specimen.

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.

10.4 Expression of results

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

Quote the uncertainty of measurement as ± 0.05m.

10.5 Laboratory tests

10.5.1 Procedure

From one end of the test specimen determine the Ball Roll in five positions, each at least 100mm from the sides of the test specimen.

Repeat the test from the opposite end of the test specimen to assess the influence of factors such as turf pile pattern, etc.

Undertake tests under dry and wet conditions, as appropriate.

10.5.2 Calculation of results

Calculate the mean value of Ball Roll from the 3 tests in each direction.

Calculate the mean of the two test directions.

10.6 Field tests

10.6.1 Test conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 5.3. The conditions shall be reported.

10.6.2 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 (0º, 90º, 180º and 270º) with three individual measurements in each direction to determine if the result is influenced by factors such as slope or turf direction.

10.6.3 Calculation of results

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

Calculate the mean value of ball roll from all tests at each test position.
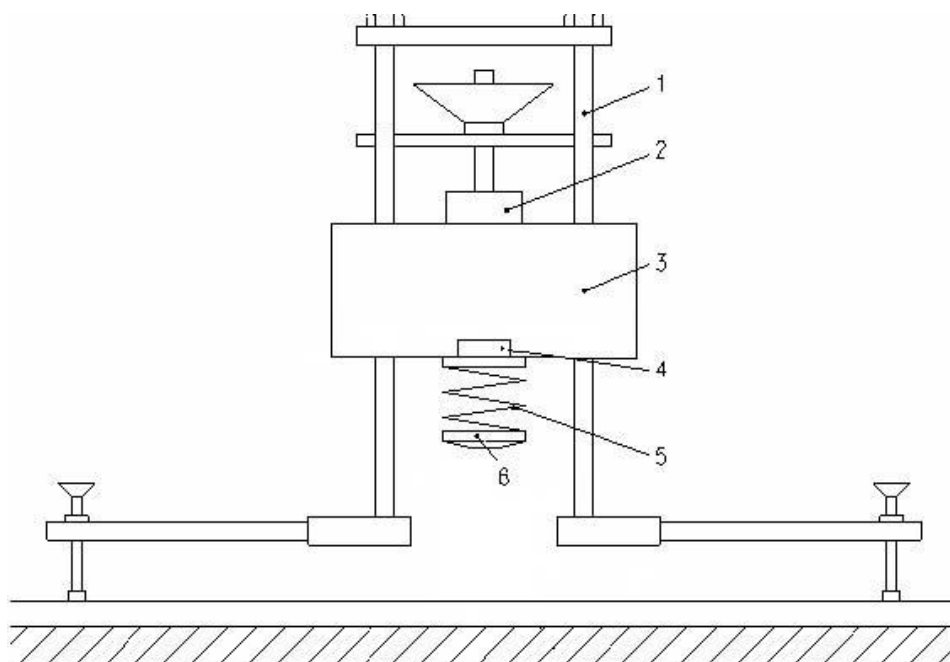
11 Determination of Shock Absorption (FIFA Test Method 04a)

11.1 Principle

A mass with a spring attached to it is allowed to fall onto the test piece and from the recorded acceleration of the mass from the moment of release till after its impact with the test piece the Force Reduction is calculated by comparing the percentage reduction in this force relative to a reference force (theoretical force on concrete).

11.2 Test Apparatus

11.2.1 The principle of the apparatus is shown in Figure 1 and consists of the following essential components specified in 11.2.2 to 11.2.7.

- Figure 1 – test apparatus

1	guide for the falling mass;
2	electric magnet;
3	falling mass;
4	accelerometer;
5	spring;
6	test foot.

11.2.2 Falling mass (3), incorporating a spiral metal spring and steel test foot, having a total mass of 20,0 kg ±0.1 kg.

11.2.3 Spiral steel spring (5), whose characteristic is linear (measured with maximum increments of 1000N) with a spring rate of 2000 ± 100 N/mm over the range 0.1 to 7.5 kN. The spring shall be positioned centrally below the point of gravity of the falling mass. The spring shall have three coaxial coils that shall be rigidly fixed together at their ends. The mass of the spring shall be 0.80 ± 0.05 kg.

11.2.4 Test foot (6) having a lower side rounded to a radius of 500 mm ±50 mm; an edge radius of 1 mm; a diameter 70 ± 1 mm and a minimum thickness of 10 mm. The mass of the test foot shall be 400g ± 50g.

11.2.5 Test frame with three adjustable supporting feet, no less than 250 mm from the point of application of the load designed to ensure the weigh of the apparatus must be equally distributed on its feet. The pressure (with the mass) on each foot must be less than 0.020 N/mm² and the pressure (without the mass) on each foot must be greater than than 0.003 N/mm².

11.2.6 A piezo-resistive accelerometer - (4) having a 50g full scale capacity) with the following characteristics: -frequency range: bandwidth until 1000 Hz (-3dB) -linearity : 2% operating range. The g-sensor should be positioned on the vertical line of gravity of the falling weight (see figure 1), as much as possible on the lower side of the weight. The g-sensor should be firmly attached, to avoid natural filtering.

11.2.7 A means of supporting the mass (2) that allows the falling height to be set to an accuracy of ± 0.25 mm.

11.2.8 A means of conditioning and recording the signal from the acceleration sensing device and a means of displaying the recorded signal. (see the figure 2, below)

- Sampling rate minimum: 9600 Hz.

- Electronic A/D converter must have a minimum resolution of 16 bits.

- Signal from the acceleration-sensing device must be filtered with a 2nd order low-pass

  Butterworth filter with a cut-off frequency of 600 Hz.

11.2.9 Means of calculating the speed and displacement of the falling weight during the course of impact by integration and double integration of the acceleration signal. To be verified in accordance with 11.3.3 and 11.3.4.
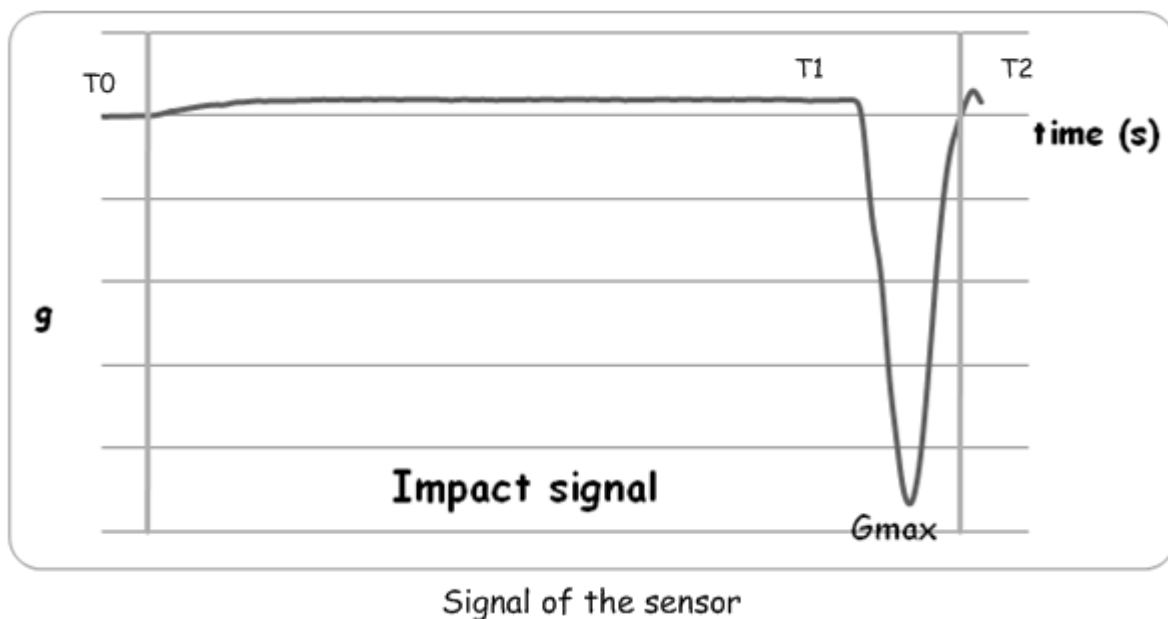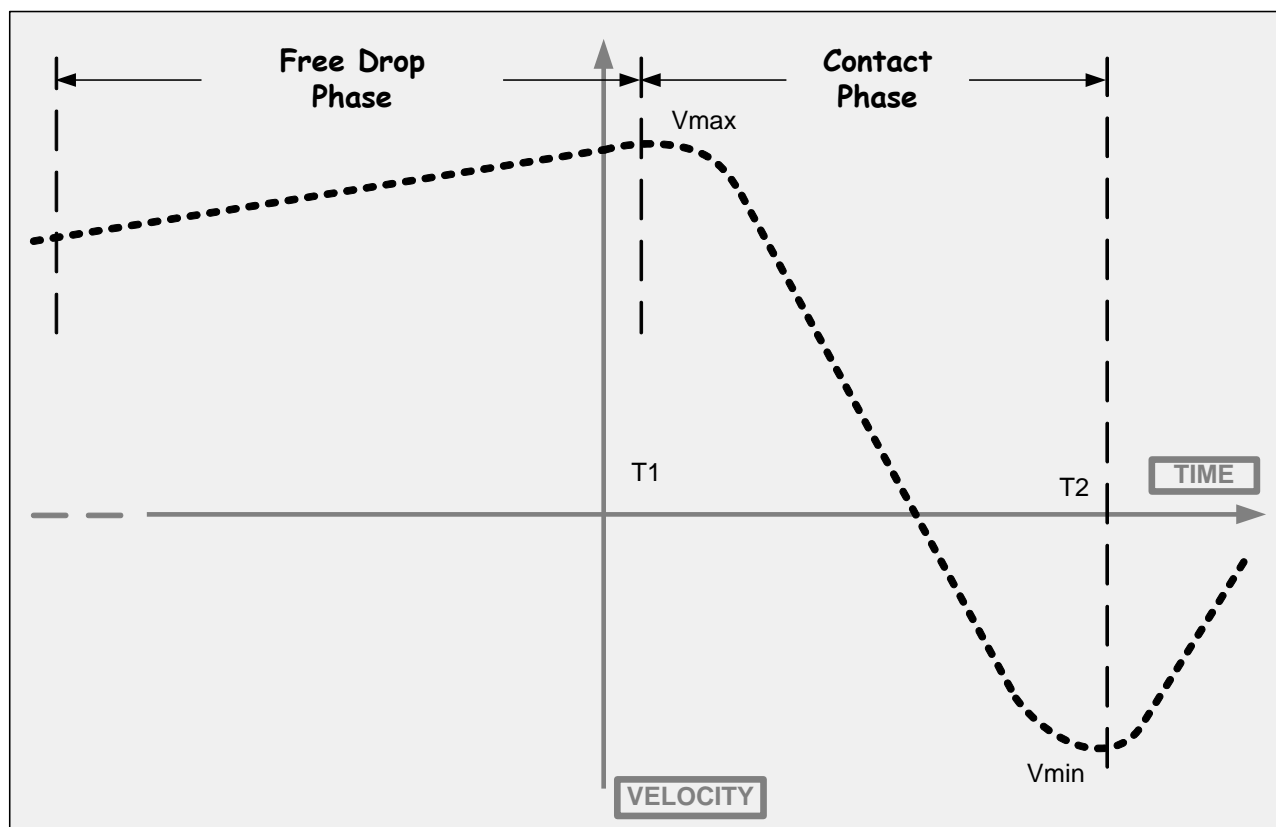

Figure 2 – example of falling mass acceleration/time curve

T0 time when the mass starts to fall

T1time when the test foot makes initial contact with the surface (determined on the Velocity / time curve – Vmax*)

T2 time (determined on the Velocity / time curve) – Vmin*) corresponding to the maximum velocity when the mass is rebounds after the impact.

* *it could be a minimum or maximum depends on the sensor direction*

- Figure 3 – example of velocity / time curve

11.2.11   Apparatus for tests at -5°C

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

Sample tray with internal dimensions of at least 450 mm by 450 mm. The depth of the tray shall be at least 10 mm greater than the test specimen and the base of the tray shall be of rigid mesh, to allow the free draining of water from the test specimens.

Temperature probe.

11.2.12   Apparatus for tests at 40°C

Air circulating oven conforming to ISO 188

Temperature probe.

11.2.13   Stop watch graduated in seconds

11.3.   Checking of impact speed

Note: The verification should be carried out to ensure the correct impact speed (or energy, because the mass is fixed) and the correct functioning of the apparatus.

The checking procedure consists of three steps and must be carried out on a stable and rigid floor (no significant deflexion under a 5 kg/cm² pressure).

This checking must be done:

- In lab: At the labs discretion and adapted to the apparatus life (travelling, environment …)

- On site: on every field, before the measurements

11.3.1 Set up the apparatus to assure a perfect vertical free drop. Verticality tolerance: max 1°. Adjust Set the height of the lower face of the steel test foot so it is 55.00 ± 0.25 mm above the rigid floor. Dropped the weight on the concrete floor and record the acceleration of the falling weight till the end of impact.

11.3.2 Repeat 11.3.1 two more times, giving a total of three impacts.

11.3.3 For each impact calculate, by integration from T0 to T1 of the acceleration signal, the initial impact velocity . Calculate the mean impact velocity of the. The mean impact velocity shall be in the range of 1.02 m/s toi 1.04 m/s. If the initial impact velocity s outside this range any subsequent results obtained shall be considered invalid.

11.3.4 After verifying the initial impact velocity place the falling weight on the rigid floor. Measure the height between a static reference point on the apparatus (for examplethe magnet) and the falling weight. The measured height shall be used for all measurements and is ll designated the "lift height".

Note: The "lift height" will be slightly greater than 55.0 mm. due to the deflection of the apparatus.

11.4   Test procedure

11.4.1 Set up the apparatus so it is positioned vertically (90 degrees to the surface ± 1 degree) on the test sample

11.4.2 Lower the test foot smoothly onto the surface of the test piece

11.4.3 Immediately after (within 10 seconds set the "lift height" described 11.3.4 and re-attach the mass on the magnet.

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

11.4.4 Re-validate the lift height after the impact so that within 30 ± 5 seconds the mass is lifted from the surface of the test piece and re-attached to the magnet. Repeat the procedure described in clause 11.4.3.

11.4.5 Force reduction calculation:

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

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

Where

- F_{max}, correspond to the peak force, expressed in Newtons [N];

- G_{max}, is the peak acceleration during the impact, expressed in g [1 g = 9.81 m/s²];

- m, is the falling weight including spring, base plate, acceleration sensing device expressed in [kg], 20 kg $\pm 0.1\ kg$ (given by the mass calibration)

- g, is the acceleration by gravity (9.81 m/s²).

Calculate the Force reduction (F_{red}) with the following formula,

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

Where :

F_{Red} , is the force reduction, in %,

F_{max} , is the Force max measured on the sport surface, in [N],

F_{ref} , is the reference force fixed to 6760 N corresponding to the theoretical value calculated for a concrete surface

Expression of the results

Report the Force Reduction value to the nearest 0.1% e.g. 56.9%.

11.5   Laboratory tests

The laboratory test floor must be a concrete floor with a minimum of 10 cm thickness. The surface hardness when measured in can be verified according to EN 12504-2 "Testing concrete in structures – Part 2: Non-destructive testing – Determination of rebound number". Minimum concrete hardness: 40 MPa.

11.5.1 Laboratory tests at 23 $\pm$ 2°C

11.5.1.1 Procedure

Determine the Force Reduction of the test specimen, making three repeat measurements on the same spot. 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 sides of the test specimen.

Undertake tests under dry and wet conditions, as appropriate.

11.5.2 Laboratory tests at -5°C

11.5.2.1   Procedure

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 $\pm$ 2 minutes before placing the test specimen and sample tray in a conditioning cabinet at a temperature of -8°C to -12°C.

After 240 $\pm$ 5 min, remove the tests specimen and metal tray from the conditioning cabinet. Unless the test specimen includes an unbound mineral base, carefully remove it from the metal tray ensuring any fill 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 test specimen to the top of the performance infill on filled systems or the top of the primary backing on non-filled systems s. When the temperature gauge reads -5°C, make a measure of Force Reduction (initial impact). Move the apparatus and repeat to obtain three results ensuring the temperature of the test specimen does not rise above -3°C. Do not brush or adjust the surface in any way before 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.

Undertake tests under dry conditions only.

11.5.5.2   Calculation of results

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

11.5.3 Laboratory tests at 40°C

11.5.3.1   Procedure

Preheat the oven to a temperature of 40 °C $\pm$ 2°C. Place the tests specimen in the oven ensuring it is stationary, free from strain and freely exposed to air on all sides. After 240 $\pm$ 5 min, remove the tests specimen from the oven. Place the tests specimen on the test floor and determine the Force Reduction of the test specimen making three repeat measurements at intervals of 60 $\pm$ 5s on the same spot, ensuring the temperature of the test piece does not fall below 38°C. Do not brush or adjust the surface in any way between impacts. Check the drop height before each measurement.

If the result falls outside the specified range for the surface type repeat the procedure three times ensuring the positions are at least 100mm apart and at least 100mm from the sides of the test specimen.

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.

Undertake tests under dry conditions only.

11.5.3.2   Calculation and expression of results

Calculate the mean value of Force Reduction (40°C) of the second and third impacts for each test position.

If required calculate the mean value of the second and third impacts of Force Reduction (40°C) of the three test positions.

11.5.4 Laboratory tests after simulated mechanical abrasion during use

11.5.4.1   Procedure

Condition the test specimen in accordance with Section 17.

Carefully remove the test specimen from the Lisport Wear machine and place on the test floor.

Determine the Force Reduction of the test specimen in three positions.

Undertake tests under dry conditions only.

11.5.4.2   Calculation and expression of results

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

Calculate the mean value of Force Reduction (simulated use) from the three tests.

11.6   Field tests

11.6.1 Test conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 5.3. The conditions shall be reported.

11.9.2 Procedure

Tests shall be made in the 19 test positions shown in Figure 4; 15 test Positions are 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 test institute. Bonded carpet joints should be avoided unless they are the cause of compliant or concern.
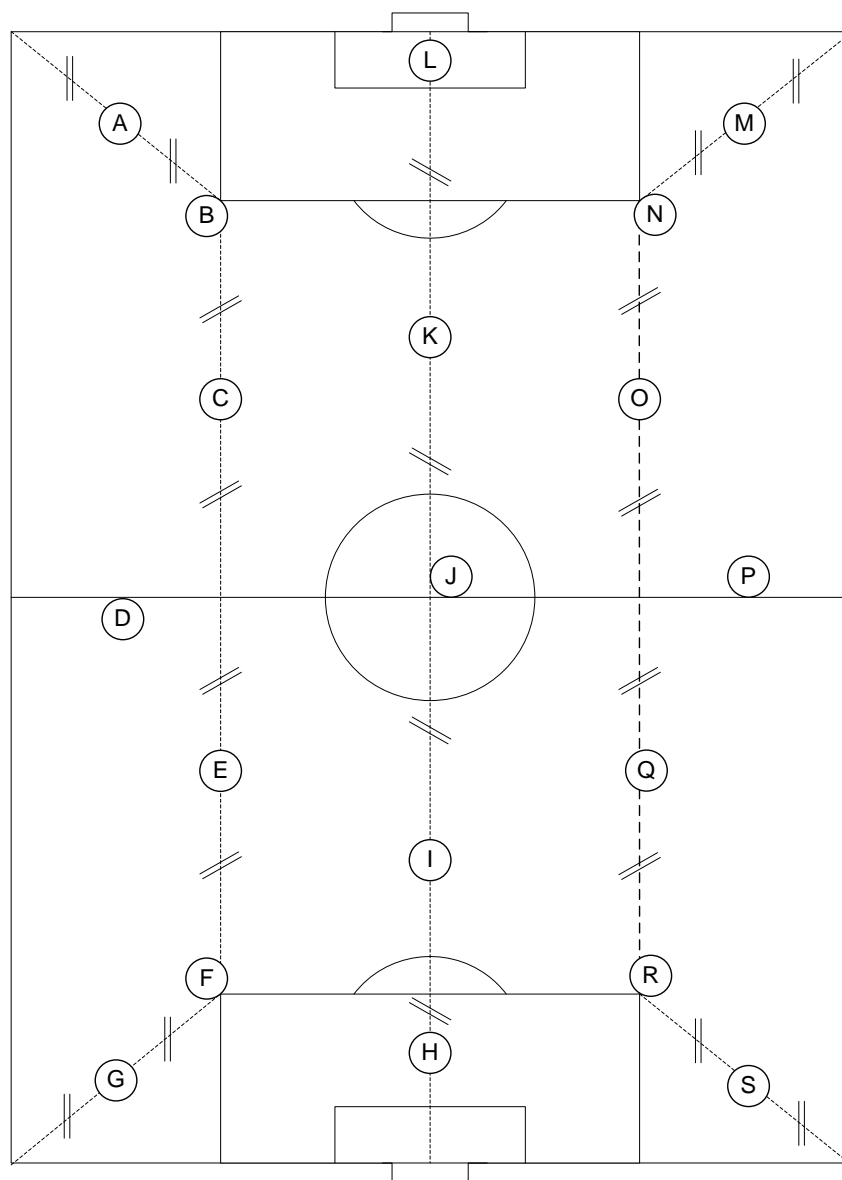
Figure 4 – field test positions

11.9.3 <u>Calculation of results</u>

Calculate the mean values (second and third impacts) of Force Reduction for each test location (three drops per location).

12 Determination of Standard Vertical Deformation (FIFA Test Method 05a)

12.1 Principle
A mass with a spring attached to it is allowed to fall onto the test piece and from the recorded acceleration of the mass from the moment of release till after its impact with the test piece. The deformation is given by the double integration of the signal acceleration.

12.2 Test Apparatus

See description in test procedure 4 clause 11.2

12.3. Checking of the impact velocity

See description in test procedure - clause 11.3

12.4 Test procedure

See description in test procedure – clause 11.4

12.5 Calculation and expression of test results

Calculate by integration of $V_{(t)}$ on the interval $[T_1, T_2]$ the displacement of the weight D_{weight} (t), starting at the moment where it has reached its highest velocity (at T_1).

The vertical deformation is defined (on the time interval $[T_1,T_2]$)as:

$$VD = D_{weight} - D_{spring}$$
Where:

$$D_{weight} = \iint_{T_2}^{T_1} g \, dt \text{, with } D_{weight} = 0 \, mm \text{ at } T1$$

$$D_{spring} = \frac{(m \times g \times G_{max})}{C_{spring}}$$

Where

- F_{max}. correspond to the peak force, expressed in Newtons [N];

- G_{max}. is the peak acceleration during the impact, expressed in g [1 g = 9.81 m/s²];

- $m,$ is the falling weight including spring, base plate, acceleration sensing device expressed in [kg], 20 kg $\pm 0.1\,kg$ (given by the mass calibration)

- $g,$ is the acceleration by gravity (9.81 m/s²).

- C_{spring} is spring constant (given the certificate of calibration, in the adapted range)

Expression of the results:

Record the resultant Vertical Deformation to the nearest 0.5mm

12.5   Laboratory tests

12.5.1 Laboratory tests at 23 $\pm$2°C

12.5.1 <u>Procedure</u>

Determine the Standard Vertical Deformation in three positions, each at least 100mm apart and at least 100mm from the sides of the test specimen.

Undertake tests under dry and wet conditions, as appropriate.

12.5.2 <u>Calculation of results</u>

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

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

12.5.2 Laboratory tests after simulated mechanical abrasion during use

12.5.2.1   <u>Procedure</u>

Condition the test specimen in accordance with Section 16.

Carefully remove the test specimen from the Lisport Wear machine and place on the test floor.

Determine the Standard Vertical Deformation of the test specimen in three positions, each at least 100mm apart and at least 100mm from the sides of the test specimen.

Undertake tests under dry conditions only.

12.5.2.2   <u>Calculation of results</u>

Calculate the mean value of Standard Vertical Deformation (simulated use) from the three tests. Calculate the mean value of Standard Vertical Deformation of the second and third impacts for each test position.

12.6   Field tests

12.6.1 Test conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 5.3. The conditions shall be reported.

12.6.2 Procedure

Tests locations shall be as shown in Figure 4

12.6.3 Calculation of results

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

13 Determination of Energy of Restitution (FIFA Test Method 11)

13.1 Principle

A weight, with a spring attached to it, is allowed to fall on the test piece and from the recorded acceleration of the weight from the moment of release till after the impact. The energy of restitution is given by speeds calculations (the signal acceleration integration).

Laboratory tests are also undertaken to assess the affects on this property of compaction through simulated use of the surface

13.2 Test Apparatus

See description in 11.2

13.3. Calibration of the impact energy

See description in 11.3

13.4 Test procedure

See description 11.4

13.4 Calculation and expression of test results

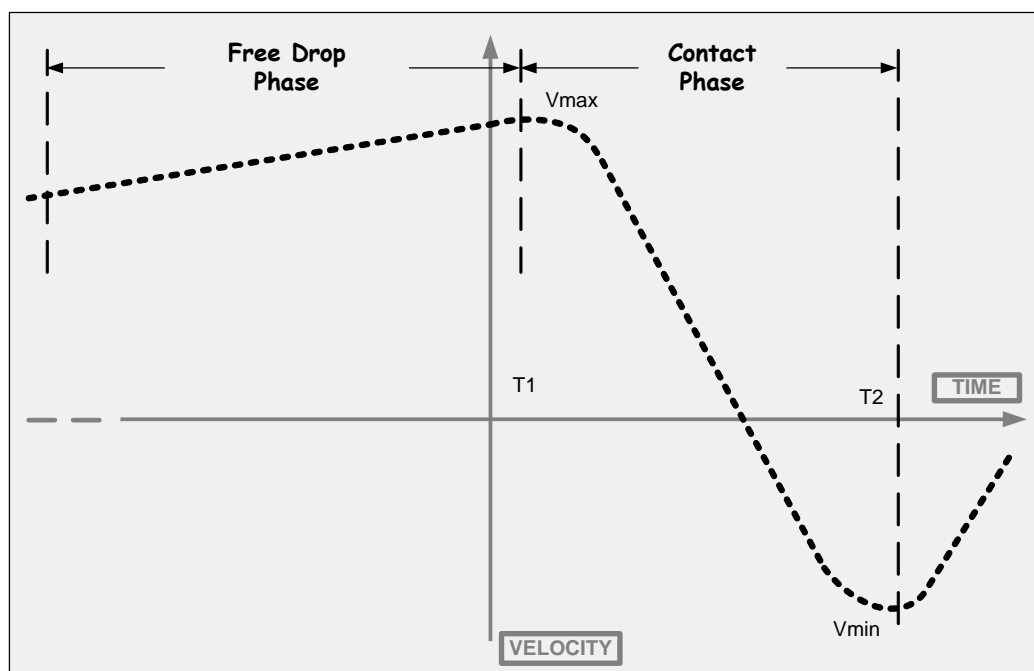Based on the figure 3, Calculate the energy restitution ER (%) defined by the formula:

$$ER = [E_2/E_1] \times 100$$

Where

E_1 is the energy before impact., $E_1 = 0.5 \times mV^2_{max}$
V_{max} is the initial impact velocity [m/s] (T1)

E_2 is the energy after impact; $E_2 = 0.5 \times mV^2_{min}$
V_{min} is the take-off velocity [m/s] (T2)

- $m,$ is the falling weight including spring, base plate, acceleration sensing device expressed in [kg], 20 kg ±0.1kg (given by the mass calibration)

13.5   Laboratory tests

13.5.1 Laboratory tests at 23 ±2°C

13.5.1.1   Procedure

Determine the **Energy of Restitution** in three positions, each at least 100mm apart and at least 100mm from the sides of the test specimen.

Undertake tests under dry and wet conditions, as appropriate.

13.5.1.2   Calculation of results

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

Calculate the mean value of the second and third impacts of **Energy of Restitution** of the three test positions.

13.5.2 Laboratory tests after simulated mechanical abrasion during use

13.5.2.1   Procedure

Condition the test specimen in accordance with Section 16.

Carefully remove the test specimen from the Lisport Wear machine and place on the test floor.

Determine the **Energy of Restitution** of the test specimen in three positions, each at least 100mm apart and at least 100mm from the sides of the test specimen.

Undertake tests under dry conditions only.

13.5.5.2   Calculation and expression of results

Calculate the mean value of Energy of Restitution (simulated use) from the three tests. Calculate the mean value of Energy of Restitution of the second and third impacts for each test position

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 5.3. The conditions shall be reported.

13.6.2 Procedure

Test locations: see § 11.8.2

At each test location determine the Energy of Restitution.

13.6.3 Calculation of results

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

14 Determination of Rotational Resistance (FIFA Test Method 06)

14.1 Principle

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

Laboratory tests are undertaken to assess the affects on this property of mechanical abrasion of the surface during use.

14.2 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 $\pm$ 2 mm in diameter with six football studs equally spaced on the bottom surface each 46 $\pm$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-handled mechanical torque wrench with a scale of 0 to 80Nm in maximum 2 Nm increments, which attaches to the top of the shaft.
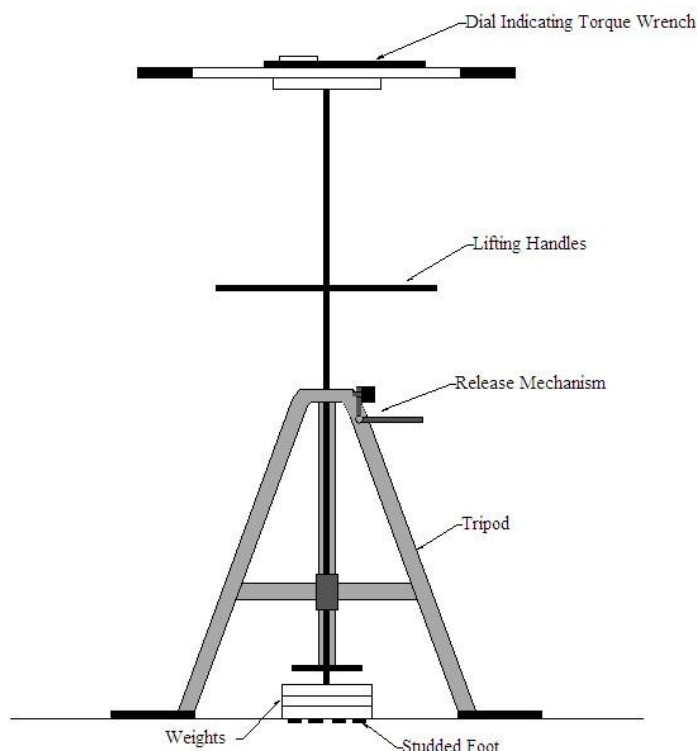

Figure 7 - Rotational Resistance apparatus

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 studded disc, weights, shaft and torque wrench, shall be 46 $\pm$ 2 Kg.

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 holding and dropping the weighted test foot onto the test specimen from a height of 60 $\pm$ 5mm.

14.3 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 $\pm$ 5mm onto the surface. Reattach the torque wrench.

Zero the torque wrench indicator needle.

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 snatching, at a nominal speed of rotation of 12 rev/min until movement of the test foot occurs and it has rotated through at least 45º.

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

14.4 Calculation & expression of results

Calculate the mean value of Rotational Resistance.

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

Quote the uncertainty of measurement as $\pm$ 2Nm.

14.5 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 sides of the test specimen.

Undertake tests under dry and wet conditions, as appropriate.

14.6 Laboratory test after simulated use

Condition the test specimen in accordance with Section 16. 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 three positions, each at least 50mm apart (outside edge of test foot to outside edge of test foot) and at least 50mm from the sides of the test specimen. Undertake dry tests only.

14.7 Field tests

14.7.1 Test Conditions

Tests shall be made under the meteorological conditions found at the time of test subject to the limits of Section 5.3. The conditions shall be reported.

14.7.2 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.

15 Determination of Linear Friction Stud Slide Value & Stud Deceleration Value (FIFA Test Method 07)
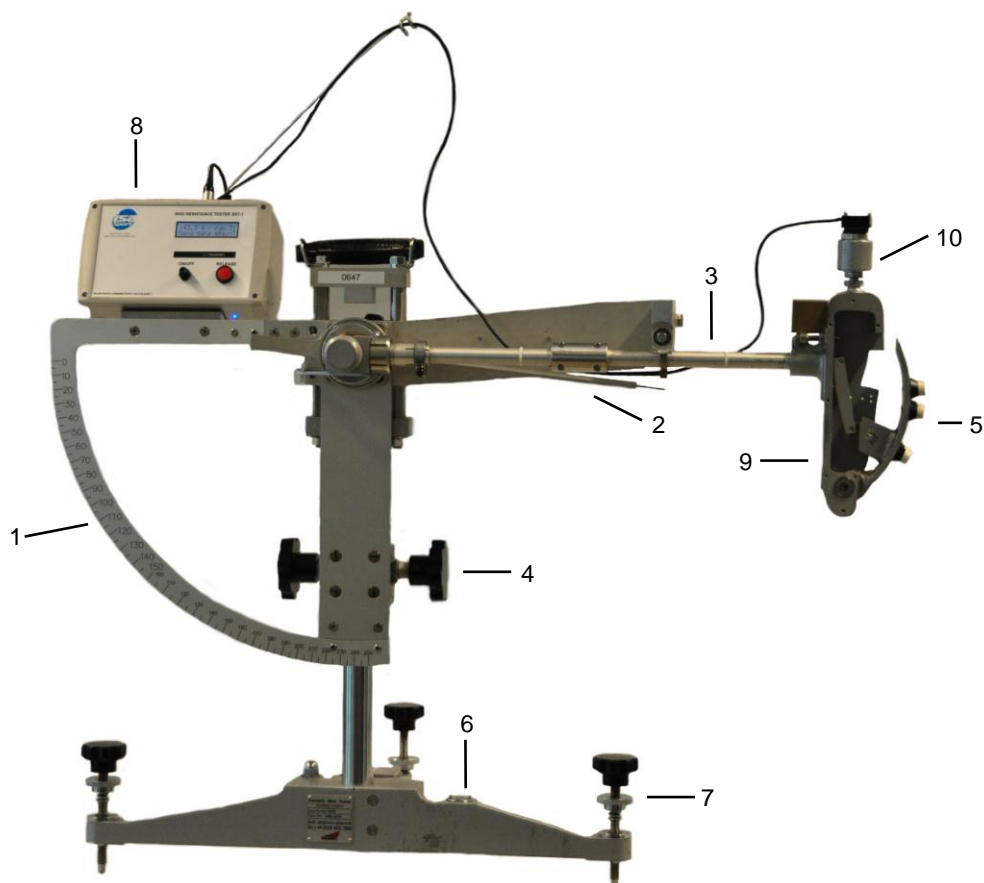
15.1 Principle

A test foot with a studded shoe profile attached to a pendulum arm is allowed to strike the surface in a semi-circular motion and the slide of the foot across the surface and the peak deceleration due to the interaction between the studs and the test surface is recorded.

Apparatus

TRRL Skid Resistance Tester (see figure 8) as specified in EN 13036-4 but modified as follows:

- The test foot shall be as detailed in Figure 9. The pressure exerted by the test foot over the first 10mm of compression shall be 32 N ± 2 N.

- A pendulum arm 525 mm ± 2 mm in length (axis to holder for studded shoe profile) fitted with a test foot of length 114 ± 2 mm (see Figure 10).

- The K-value of the spring in the pendulum arm shall be 2.0 N/mm ± 0.2 N/mm.

- The mass of the studded shoe profile without the studs shall be 210 g ± 10 g.

- The mass of the pendulum arm and test foot shall be 2000 g ± 50 g.

- The distance of the center of gravity of the pendulum arm (including test foot) from centre of oscillation shall be 410 mm ±10 mm. The center of gravity must be in the axis of the pendulum arm.

- Modified scale comprising a mirror of the TRRL scale. 150 on the TRRL scale corresponds with 250 on the modified scale as shown in Figure 11.

- Acceleration sensor having a range of 0 - 50 g and a recording devise capable of measuring the deceleration of the pendulum arm (also in static condition) to an accuracy of ± 1%. The sensor shall be mounted centrally on the balance weight at the rear of the test foot.

Means of conditioning and recording the signal from the deceleration sensing device and a means of displaying the recorded signal. The channel frequency class of the conditioning amplifier, as described in ISO 6487, shall be 1 kHz or greater. The system shall be able to record the peak value of single deceleration force-pulse signals of 10ms duration with an accuracy of no greater than +/- 0.2%. If digital recording techniques are used the word length shall be no less than 16 bits, the amplitude of the signal shall be no less than 25% of the equipment full scale and the sampling frequency shall be no less than 2 kHz or twice the upper frequency response limit of the amplifier system preceding the digital system, whichever is the greater. Butterworth filters shall be 600Hz, 2nd order.

1	Modified scale	2	Pointer needle
3	Pendulum arm	4	Vertical adjustment screw
5	Studded shoe profile	6	Bubble level
7	Levelling screws	8	Electronics for recording deceleration
9	Test foot	10	Accelerometer

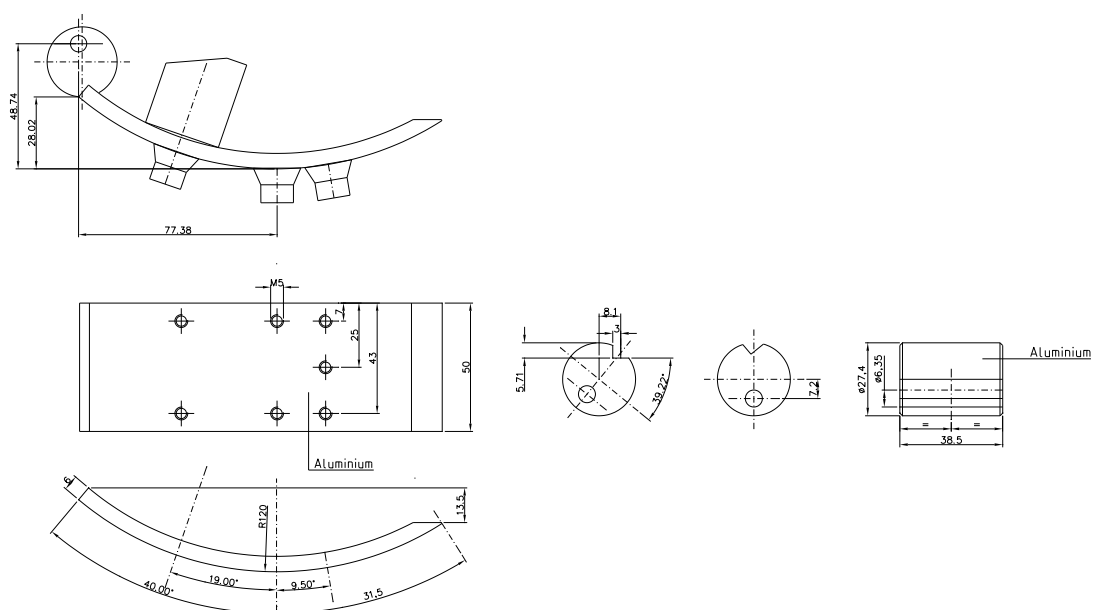**Figure 8 - Modified TRRL Skid Resistance Tester**
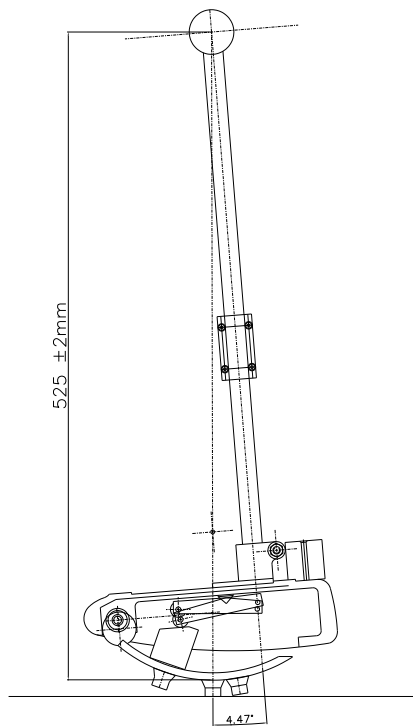

Figure 9 - dimensions studded shoe profile

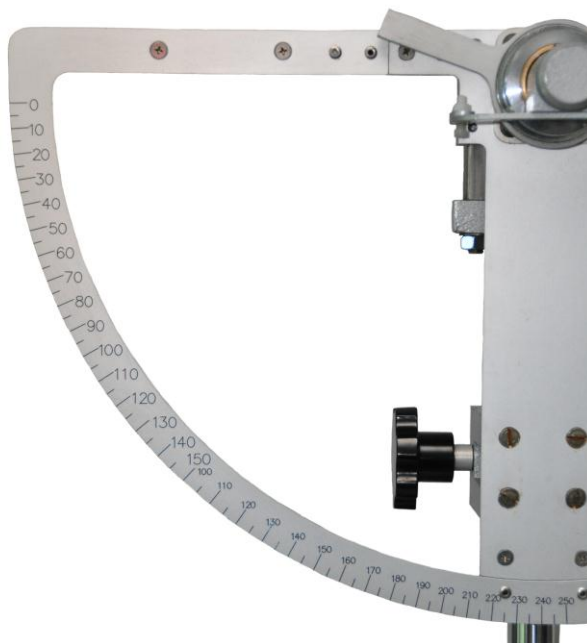**Figure 10 - pendulum and zero-position test foot**

Figure 11 - scale of Stud Slide value

15.3 Test Procedure

15.3.1 Calibration of the apparatus

Place the apparatus on a rigid surface and adjust the levelling screws so the apparatus is horizontal.

Adjust the vertical adjustment screw to raise the axis of the pendulum arm so that the pendulum can swing freely.

Set the zero position by adjusting the test foot so the studs in the middle are placed horizontally onto the rigid surface (figure 10). Mark this setting as position A (see Figure 12). Adjust the accelerometer sensor so it reads zero when the pendulum hangs horizontally. The test foot shall be parallel with the apparatus.
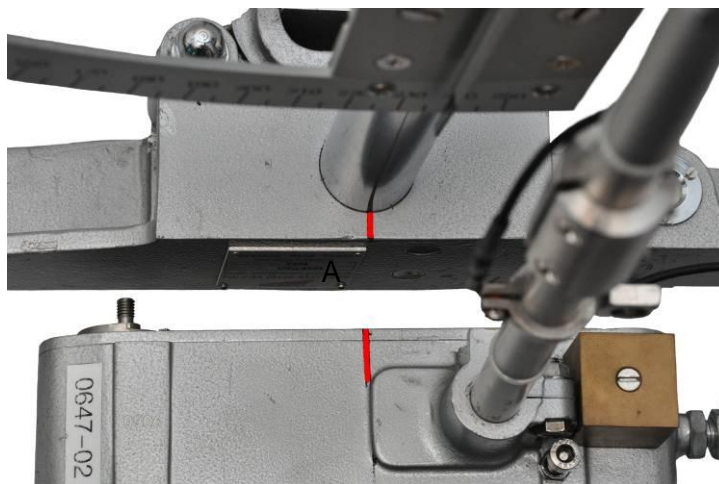

Figure 12 - Position A markers

Align the pendulum arm on position A. Adjust the pointer needle on the 250 position of the modified scale.

Adjust the friction plate in the pointer mechanism so that when the pendulum arm is released from its horizontal position it comes to a stop at the zero position on the TRRL scale.

Place the pendulum arm at position A on the rigid surface, so that it exactly touches the surface without vertical force. Lower the pendulum arm 10 mm, measured at position A in Figure 12. To enable measurements with the same setting each time, either use a 10 mm spacer for each measurement or mark the position of the holder in relationship to the test foot.

15.3.2 <u>Calibration of the pendulum arm at 23 +/- 2°C</u>

The calibration shall be carried out with a tensile test apparatus, capable of measuring to an accuracy of 0.5 N.

The calibration of the pendulum arm shall be carried out with a test speed of 30 mm/min and a preload of 2.5 N.

Place the pendulum arm with a flexible adaptor in a tensile test apparatus. By using a flexible adaptor the pendulum arm can freely move. Place the studded shoe profile on the centring point. The centring point should be positioned between the two middle studs perpendicular to the sensor of the tensile test apparatus (see Figure 13).

The pressure exerted by the test foot over the first 10 mm of compression shall be 32 N ± 2 N. If the pressure is not in the range adjust the spring tension and repeat procedure.
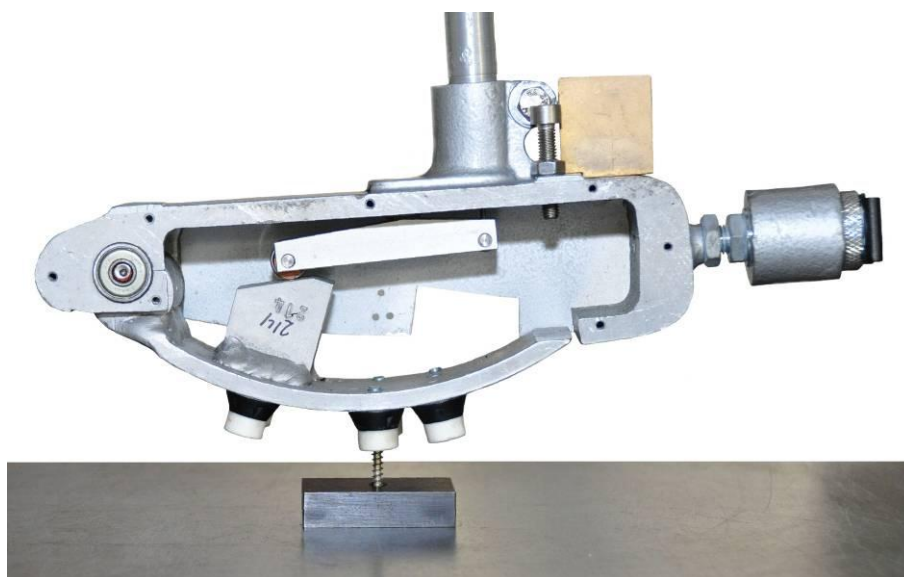
Figure 13 - studded shoe profile on the centring point

15.3.3 Measurement

Place the apparatus with the base plate on the test specimen. Use the levelling screws to set the apparatus horizontal. Hold the arm pendulum so that the marking of position A on the test foot and the marking of position A of frame of the apparatus are opposite each other. Use the vertical adjustment screw to decrease the height of the pendulum 10 mm until the shoe profile is pressed into the surface.

Lift the test foot from the surface and raise the pendulum arm and the pointer needle until it makes contact with the support mechanism. Release the pendulum arm.

Record the value on the scale corresponding to the maximum movement of pointer needle during the test. This is the Sliding Value (SSV).

Record the maximum deceleration that occurred during the test. The Deceleration Value (SDV) is the difference between the maximum deceleration and the deceleration just before the moment of impact.

Repeat the measurement seven times in multiple directions ensuring the apparatus is moved each time so no area is tested twice and no test is made within 100 mm of the sides of the test specimen.

14.4   Calculation and expression of results

Disregard the highest and lowest recorded values of SSV and SDV and calculate the mean of the remaining five values.

Report the mean value of SSV as a dimensionless value e.g. 100.

Report the mean value of SDV in gravities to one decimal place e.g. 3.5 g.

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

15.5   Laboratory tests at 23 +/- 2°C

Determine the SSV and the SDV under dry and wet conditions, as appropriate.

16   Determination of Skin / Surface Friction (FIFA Test Method 08)

16.1   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 calculated.

16.2   Apparatus

The test apparatus comprises:

- Securisport ® Sports Surface Tester.

- Test foot as detailed in Figure 14

- Silicon Skin L7350 supplied by Maag Technic AG, Sonnentalstrasse 8600 DUEBENDORF, Switzerland (Tel. +41 44 824 9191).

- Water level

- Polished steel test plate (0.2µm < Ra < 0.4µm).

16.3   Procedure

Caution: do not touch the silicon skin during the test.

Determination of sliding distance force – new test skins

Wash in water three silicon skin specimens each measuring 15cm by 8m. Allow to air dry for 24 hours.

Attach a test skin to the test foot (glossy side exposed) using double sided adhesive tape and the clamping screws. Ensure the smooth surface of the silicon skin is the test face; the grooved side being attached to the test foot.

Test foot with clamping screws

Figure 14 - Test Foot

Clean the metal test plate with acetone and allow it to evaporate for at least 5 minutes.

Attach the draw strings to the mounting screws on the test foot and place the test foot (with silicon skin) onto the clean test plate and add additional mass to obtain a total mass of 1,700 ± 50g, ensuring the test foot remains stable on the test plate.

Measure the force required to pull the silicon skin along the metal plate over a sliding distance of 100mm at a speed of 500 ± 10mm/min. Repeat the force measurement at least ten times.

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

Calculate the average force ($F_{new\ skin}$) of the ten measurements. Ensure the standard deviation is less than 0.3 and the average force is 6 ± 1.5N.

Repeat on two further samples of silicon skin.

Undertake the test under laboratory conditions of 23 ± 2 °C.

Determination of sliding distance force
(note additional mass added to test foot)

<u>Determination of skin friction</u>

Undertake the test under laboratory conditions of 23 ± 2 °C.

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

Attach the silicon skin to the test foot of the Securisport Sports Surface Tester using double sided adhesive tape and mount onto the apparatus. Adjust the test foot so it is positioned just above the test specimen.

Position the Securisport Sports Surface Tester over test specimen and adjust to level. Apply a vertical force to the test foot of 100N ± 10 N and start the rotation of the test foot. Allow the test foot to make five complete revolutions at a speed of 40 ± 1 rev/min; sampling at a frequency of 40 Hz.

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

Repeat the test three times, changing the synthetic skin and replacing any infill between tests.

Calculate and report the mean Coefficient of Friction of the three tests

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 compressed air.

Place the test foot (with silicon skin) onto the clean metal plate and add an additional mass to obtain a total mass of 1,700 ± 50g.

Measure the force required to pull the silicon skin along the metal plate over a sliding distance of 100mm at a speed of 500 ± 10mm/min. Repeat the force measurement at least ten times.

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

Calculate the skin abrasion using the following formula:

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

where:

$F_{(new\ skin)}$ = the mean average force of the second to fourth tests prior to the Skin Friction test

$F_{(abraded\ skin)}$ = 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 have are yet to be established.

17 Procedure for simulated mechanical abrasion during use (FIFA Test Method 9)

17.1 Principle

Two studded rollers are traversed over a test specimen of artificial turf for to simulate the mechanical abrasion of the surface that occurs during normal use.

17.2 Test apparatus

Lisport Wear Machine having a stud configuration as shown in Figure 1 (Section 3). The number of studs per cylinder shall be 145 $\pm$ 5. The linear speed of movement (to and fro) of the roller carriage shall be 0.25 $\pm$ 0.05 ms-1 and the transversal cycle of the sample tray shall be 20 mm $\pm$ 1 mm, at a speed of 0.015 $\pm$ 0.005 ms-1. The studded rollers shall be geared so the speed of rotation the rollers is 40 $\pm$ 3% (ratio of 1:1.75). The design of the machine shall ensure the studs do not repeatedly impact the same spots. This may be achieved by free movement of the cylinders at the end of each a cycle.

Note: the test report should detail whether transversal movement was used or not.

17.3 Test specimen

Test specimen of artificial turf measuring 800mm by 400mm of which at least 500mm by 300mm shall be uniformly abraded. All the complete system must be tested (shock pad included). The sample shall be tested transversally to the tufting direction.

17.4 Procedure

Mount the test specimen into the sample tray and fill (if applicable) strictly in accordance with the manufacturer's instructions.

Place the prepared test specimen in the Lisport Wear Machine and adjust the rollers' height to ensure full stud contact with the infill layer or carpet pile as appropriate.

When testing products for 20200 cycles undertake 2500 cycles (one cycle comprises one complete to and fro movement). Stop the test and replace any fill material that has been dislodged from the test specimen and is lying in the sample tray, do not add new material to the test specimen. Lightly brush the pile to lift. Repeat the procedure stopping the machine after 5000, 7500, 10000, 12500, 15000, 17500 and 20000 cycles and replace any fill material that has been dislodged from the test specimen and is lying in the sample tray, do not add new material to the test specimen. Lightly brush the pile to lift. Carry out a further 200 cycles (20200 in total) before removing the sample tray containing the test specimen from the Lisport. Do not reapply any fill material that has been dislodged.

When testing products for 5200 cycles undertake 1000 cycles (one cycle comprises one complete to and fro movement). Stop the test and replace any fill material that has been dislodged from the test specimen and is lying in the sample tray, do not add new material to the test specimen. Lightly brush the pile to lift. Repeat the procedure stopping the machine after 2000, 3000, 4000 and 5000 cycles and replace any fill material that has been dislodged from the test specimen and is lying in the sample tray, do not add new material to the test specimen. Lightly brush the pile to lift. Carry out a further 200 cycles (5200 in total) before removing the sample tray containing the test specimen from the Lisport. Do not reapply any fill material that has been dislodged.

Carefully remove the test specimen from the sample tray ensuring the test specimen and fill is not disturbed. Do not brush or lift the pile of the carpet.

Photograph the test specimen to show the general effects of the simulated wear.

Assess the fully conditioned area (not the ends) of the test specimen as required for the specified properties.

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 control having the following features:

- UV - A 340 nm lamps in accordance to ISO 4892 - Part 3.

- Exposure chamber constructed from inert material to provide uniform radiance with a means for controlling the temperature.

- Provision for the formation of condensation or spraying of water onto the exposed face of the specimen.

In 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. The specimen racks (completely 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 condensation is provided by spraying of the specimens the condensing water shall conform to sub-clause 4.6 of ISO 4892 - Part 2

- Means of mounting specimens so that the exposed face is located in the plane of uniform radiance and is not within 160 mm of the ends of the lamps or within 50 mm of the edge of a flat lamp array.

Note: Lamp replacement, lamp rotation and specimen rearrangement may be required to obtain uniform exposure of all specimens to UV radiation and temperature. The manufacturer's recommendations for lamp replacement and rotation shall be followed.

- A black-standard thermometer conforming to sub-clause 5.1.5 of ISO 4892 Part 1

- 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 $\pm$ 4 min of dry UV exposure at a black-standard temperature of 55°C $\pm$ 3°C, followed by 120 $\pm$ 2 min of condensation exposure, commencing once equilibrium has been attained, without radiation, at a black-standard temperature of 45°C $\pm$ 3°C.

18.4 Procedure

Mount test specimen of pile yarn in the exposure racks with the test surface facing the lamps. Fill any spaces, using blank panels to ensure uniform exposure conditions.

Mount tests specimens of infill materials in sample trays placed in the cabinet with the test surface facing the lamps.

Expose the test piece, measuring the irradiance and radiant exposure at the surface of the test piece. After an exposure of (4896 ± 125) kJ/m^2, carefully remove the test piece from the exposure cabinet.

NOTE An exposure of (4896 ± 125) kJ/m^2 will take approximately -2500 h (for 0.8W/m² exposure intensity).

Carefully remove the test specimen from the sample tray

18.5 Assessment of test specimens

18.5.1 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 tensile strength of exposed specimens of the pile yarn(s) in accordance with EN 13864 (minimum gauge length 100mm) and calculate the percentage change in tensile strength compared to test specimens of unexposed yarn.

18.5.2 Polymeric infill materials (rubbers, thermoplastics, etc)

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.

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

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 at hand.

19.2 Apparatus

19.2.1 Thermo Gravimetric Analyzer (TGA) which has the following features:

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

19.2.2 Analytical balance with accuracy of ±0.01mg
19.2.3 Nitrogen supply.

19.3 Conditioning of samples

19.3.1 Switch on apparatus and allow to equilibrate for at least 30 min
19.3.2 Use the same purge gas flow rate that was used to calibrate the instrument.

19.4 Procedure

19.4.1 Thermo gravimetric 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 entire test

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

- Heating programme:

    o Heating from 50°C to 300°C with a heating rate of 15°C / min

    o Maintain the sample at 300°C for 8 minutes

    o Heating from 300°C to 650°C at a heating rate of 15°C / min

    o Heating from 650°C to 850°C at a heating rate of 25°C / min

19.4.2 TGA on 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: mass loss from 650°C to 850°C

- 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: mass loss from 650°C to 850°C

- 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

Straight edge design:

- Length 3000 ± 10 mm, Width 75mm ± 5 mm, Height 40mm ± 5 mm

- Weight 7.675 ± 1.075kg

- Linearity of the straight edge : ± 2 mm

- Rigidity of the straight edge : 2 mm minimum

- Sliding side on the surface: 75 mm x 3000 mm

- 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. Typically this would be at a distance some 3.0m from the straightedge.

Wedge (slip gauge) :

Length 250 ± 5 mm,

Width 15 ± 2 mm.

Height ranges from 2 to 18mm

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

20.3 Procedure

Starting from one of the corners 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 ≥ 10mm 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   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.

Particle size of unbound sub-bases	EN 933 -1: 1997	Determination of particle size; sieving method
Particle size of infill materials	EN 933 – 1: 1997	Determination of particle size; sieving method -see below
Bulk density of infill materials	EN 1097 – 3: 1998	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: 2000	Surfaces for sports areas: Determination of thickness of synthetic sports surfaces
Joint strength of artificial turf	EN 12228: 2002	Surfaces for sports areas - Determination of joint strength of synthetic surfaces
Tensile strength of shockpads	EN 12230:2003	Surfaces for sports areas: Determination of tensile properties of synthetic sports surfaces
Water permeability of artificial turf surfaces	EN 12616: 2002	Surfaces for sports areas: Determination of water infiltration rate – laboratory test using single ring infiltometer
Surface Regularity	EN 13036 -7: 2003	Irregularity measurement of pavement courses - The straightedge test
Immersion in hot water	EN 13744: 2004	Surfaces for sports areas: Procedure for accelerated ageing by immersion in hot water
Shock absorption of shockpads	EN 14808: 2005	Surfaces for sports areas Determination of Shock Absorption
Mass per unit area of artificial turf	ISO 8543: 1998	Textile floor coverings: Methods for determination of mass
Tufts per unit area of artificial turfs	ISO 1763: 1986	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: 1972	Hand knotted carpets: Determination of tuft leg length above woven ground
Mass per unit area of artificial turf and total pile weight	ISO 8543: 1998	Textile floor coverings: Methods for determination of mass
Tuft withdrawal force	ISO 4919: 1978	Carpets: Determination of tuft withdrawal force
Particle shape of infill materials and unbound base materials	prEN 14955: 2004	Surfaces for sports areas: Determination of composition and particle shape of unbound mineral surfaces for outdoor sports areas
Pile yarn characterisation (DSC)	ISO 11357-3: 1999	Plastics - Differential scanning calorimetry (DSC)

The particle size of infill materials shall be determined in accordance with EN 933-1 ensuing a minimum of four sieves with mesh sizes within the test specimens overall grading range are used. The sieves shall be selected from the following sizes as appropriate:

200µm, 315µm, 500µm, 630µm, 800µm, 1.00mm, 1.25mm, 1.60mm, 2.00mm, 2.50mm, , 3.35mm, 4.00mm