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Comments of Franklin Versteeg on force reduction/vertical deformation

Von: "Franklin Versteeg" <Franklin.Versteeg@isa-sport.com>
An: <ROSWITHA.COHRS@DIN.DE>
Datum: 3.12.04 14.36 Uhr
Betreff: Testmethods.

Dear Roswitha.
I tried to sent this Email to Hartmuth too but is did not work.
So therefor I sent it now to you again.
Kind regards
Franklin Versteeg.

P.S. Could you inform me if you have received it please.

Dear Hartmuth.
There are a lot of comments on the documents concerning force reduction and vertical deformation which were sent out for enquiry.
These testmethods were also dicussed between the FIFA and the UEFA.
To make a long story short ISA Sport was given the opportunity to see if it would be possible to develop a testmethod based on the testmethods as the Berlin Athlete, the Sports Floor Tester and the Poitiers.
We developed a testmethod, mainly based on the Berlin, where we attached the spring of the Berlin firm to the falling mass of the Berlin. Furthermore we attached an accelerometer to the mass to register the deceleration of the mass during impact. The execution of the test is in accordance with the Berlin. We have tested several types of artifical turf for football and determined the force reduction ,the vertical deformation and the energyrestitution and the results were very promising. The test was evaluated by several international institutes and they found the testmethod very promising as well. The same opinion do have the FIFA and the UEFA.
In the meantime we did some research on other sport surfaces and now also the results are oké.
Important things are that requirements do not have to be changed is the impression, existing machines can easily be adjusted and the principle is allready accepted in an other TC for sports mats.
The testsresults are very good to reproduce. The method is accurate.
We have produced a draft for this testmethod in CEN format and sent is allready to working group 2 for discussion.
The testmethod will also be discussed in the other working groups so therefor we sent it now to working group 5 as well.
We would like to discuss it.
I hope to have informed you well.
See you in Valencia
Kind regards
Franklin Versteeg.

STANDARD **DRAFT**

Test Method for the determination of

- Force Reduction
- Energy Restitution
- Vertical Deformation

December 2004

Foreword

This standard was prepared by xxxxxxxx

1. Scope

This Standard specifies a method for the determination of force reduction, vertical deformation and energy restitution characteristics of indoor and outdoor sport surfaces.

2. Normative references

This Standard incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications will apply to this Standard only when incorporated into it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 12229, Surfaces for sports areas-Procedure for the preparation of artificial turf and textile test pieces.

ISO 6487 Road Vehicles – Measurement techniques in impact tests – Instrumentation.

NEN-EN 12503-4 Sportsmats-part4: Determination of shock absorption (peak deceleration, deflection, resilience)

3. Terms and Definitions

For the purposes of this standard, the following term and definitions apply.

3.1
area elastic sports surface
sports surface in which a relatively rigid upper layer is supported by an elastic layer.

3.2
point elastic sports surface
sports surface which comprises only elastic or viscoelastic materials.

3.3
start position
the start position is the position of the falling weight including the spring before release where the registered acceleration (g) is zero.
The registered acceleration after the release is the actual acceleration for the calculation of force reduction, vertical deformation and energy restitution.

3.4
force reduction

the ability of a sports surface to reduce the impact force of a body falling onto the surface and which is a physical quantity consisting of damping and resilience due to a certain impact. This parameter is also known as shock absorption.

3.5
vertical deformation
deformation of the surface to an applied load.

3.6
energy restitution
the energy returned by the surface after an applied load.

4. Principle

A weight attached to a spring is allowed to fall on the test specimen and from the recorded deceleration of the weight during the course of impact and after impact the maximum force applied, the vertical deformation and the energy restitution are calculated. The difference between this maximum force and the maximum force on concrete is reported as the force reduction.

5. Test piece

For an area elastic system, a sample of the complete surfacing system measuring 3.5 m by 3.5 m, assembled and installed in accordance with the manufacturer's method statement, on a substrate complying with the manufacturer's requirements.

For a point elastic system, a piece of surface of minimum size 500 mm by 500 mm, in combination with the supporting layers to be used in service and using the recommended method of attachment in accordance with the manufacturer's instructions.

Laboratory test pieces of artificial turf shall be prepared in accordance with EN 12229.

Systems which include elements of both area- and point-elastic types of surfacing shall be treated as area-elastic.

6. Conditioning and Test Temperature

For tests in the laboratory, condition the test piece for a minimum of 40 h at the test temperature. If the material is known to be very sensitive to humidity, condition for a minimum of 88 h at a relative humidity of 50 +/- 10% at the test temperature. Unless otherwise specified the test temperature shall be 23 +/- 2 ºC.

Tests on site shall be made at the prevailing ambient temperature and humidity, which shall be recorded and reported.

7. Test method – Artificial Athlete with attached spring

7.1. Apparatus

7.1.1 The principle of the apparatus is shown in Figure 1 and consists of the following essential components specified in 7.1.2 to 7.1.9.

7.1.2 Falling weight, provided with a spiral metal spring and steel base plate, having a mass of 20 kg +/- 0,1 kg, guided so it is allowed to fall smoothly and vertically with minimum friction.

7.1.3 Spiral metal spring, whose characteristic is linear with a spring rate of 2000 +/- 60 N/mm over the range 0,1 to 7,5 kN with a hardened upper plate rounded. The spring should have three or more coaxial coils which shall be rigidly fixed together at their ends. This may be achieved, for instance, by milling the spring from single piece of steel.

7.1.4 Steel base plate having a lower side rounded to a radius of 500 mm; an edge radius of 1 mm, a diameter 70,0 +/- 0,1 mm and a thickness 10 mm minimum.

7.1.5 Adjustable supporting feet , no less than 250 mm, for a point elastic sports surface and no less than 600 mm for an area elastic sports surface from the point of application of the load depending of the type of sports surface.

7.1.6 Deceleration-sensing device with a capacity of a minimum of 50 g with an accuracy of 1% across the operating range.

7.1.7 A means of supporting the weight, allowing it to be set to the falling height with an accuracy of +/- 0,25 mm.

71.8 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, in accordance with ISO 6487 shall be 1 kHz or greater.

The system should be able to record the peak value of single deceleration force-pulse signals of 10 ms duration with an accuracy of no greater than +/- 0,2%.

If digital recording techniques are used the word length shall be no less than 12 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.

7.1.9 A rigid non vibrating smooth and even concrete floor which achieves a F_{max} in accordance with 7.2.4. and a E in accordance with 7.2.5.

7.1.10 Round, smooth positioning plate, weight 150 grams +/- 25 grams and a radius of 75 mm +/- 0,5.

7.2 Measurement of Reference Force ($F_{max\ (concrete)}$) and Reference Energy Restitution ($E_{(concrete)}$)

7.2.1 Set up the apparatus so that it is vertically positioned on the concrete floor.

7.2.2 Set the height of the lower face of the steel base plate of the impact weight so it is 55 +/- 0,25 mm above the concrete floor. Allow the weight to fall onto the concrete floor. Record the peak deceleration applied to the surface in the course of the impact. The peak deceleration shall be 33 ± 1.5g.
Determine the peak force by multiplying the peak deceleration value, expressed in g (= 9.81 m/s^2) by the value of the mass of the weight, expressed in kilograms (kg).

$F_{max\ (concrete)} = 20 \times 33 \times 9.81$

7.2.3 Repeat the procedure of 7.2.2 two times, giving a total of three impacts.

7.2.4 The value of $F_{max\ (concrete)}$ is 6,50 kN.

7.2.5 The minimum speed of impact shall be 1.02 m/s. The value of $E_{(concrete)}$ must be at least 98%. If the values are less the results will be considered invalid.

7.2.6 Carry out this procedure at intervals no greater than three months.

7.3 Test procedure

7.3.1 Set up the apparatus so it is vertically positioned on the test sample.

7.3.2 Place the under side of the falling weight smoothly onto the surface of the positioning plate (7.1.10), which is put on the surface of the test sample. This is the zero position and in accordance with a preload of the test piece of 0,01 N/mm^2. Set the upper side of the falling weight to a distance of 55 mm minus the thickness of the positioning plate to the electric magnet, so that the total drop height is 55 mm +/- 0,25 mm. Allow the weight to fall onto the test piece

7.3.3 Record the peak deceleration of the impact on the surface.
After the impact (within 5 seconds) lift and re-attach the impact mass to its support mechanics so that the surface may recover before the following impact. Note the peak deceleration. Calculate and note the peak force (7.2.2).

7.3.4. Repeat the procedure of 7.3.2 twice at intervals of 60 +/- 10 seconds giving a total of three impacts. Calculate the average peak deceleration from the second and third impact. Calculate the average value of peak force from the second and third impact and denote it $F_{max\ (test\ piece)}$:

$F_{max\ (test\ piece)}$ = weight (kg) x deceleration (g) x 9.81

7.3.5. If further tests are to be carried out on the same sample, each must be carried out at a new location, no test position being less than 100 mm from any other or edge of the sample.

7.4 Expression of the results

7.4.1 Calculate the force reduction (FR) from the expressions:

$$FR = \left(1 - \frac{F_{max\,(test\,piece)}}{F_{max\,(concrete).}}\right) x\,100\,(\%)$$

$$F_{max} = G_{max} \cdot M \cdot g$$

Where

FR is the force reduction, expressed as a percentage (%);

$F_{max,\,(test\,piece)}$ is the calculated peak force for the test piece, expressed in Newtons(N);

$F_{max\,(concrete)}$ is the calculated peak force for the concrete, expressed in Newtons(N);

G_{max} is the peak deceleration during the impact, expressed in g;

M is the falling weight including spring, expressed in kg.

7.4.2 Calculate the force reduction (FR), of a single test location as the average of the force reduction results of the second and third impact and report the result to the nearest whole percentage number, e.g. 57%.

7.4.3 Calculate, by integration of the deceleration signal, the maximum velocity that occurs during the downwards (initial impact velocity) and upwards (take-off velocity) movement of the mass.

Calculate the energy restitution ER (%) defined by:

$$ER = \frac{E_2}{E_1}.100\%$$

E_2 = energy after impact
E_1 = energy before impact

$E_2 = ½\,M\,V_2^2$
$E_1 = ½\,M\,V_1^2$

V_2 = take-off velocity [m/s]
V_1 = initial impact velocity [m/s]
M = mass [kg]

$$ER = \frac{(V_2)^2}{(V_1)^2}.100\%$$

7.4.4 Calculate the energy restitution (ER), of a single testing spot as the average of the energy restitution results of the second and third impact and report the result to the nearest whole percentage number, e.g. 37%.

7.4.5 Calculate by double integration of the deceleration signal, the total displacement of the falling mass ($D_{total(t)}$) during the first impact. Calculate the spring deformation along the time ($D_{spring(t)}$). Calculate the vertical deformation (VD) from the following expressions:

$$VD = \max\left(D_{total(t)} - D_{spring(t)} - D_{drop}\right)$$

$$D_{spring(t)} = F_{(t)} \;/\; C_{spring,\ dynamic}$$

Where

VD	is the vertical deformation, expressed in millimetres (mm);
$D_{total(t)}$	is the total displacement of the mass, expressed in millimetres (mm);
$D_{spring(t)}$	is the maximum deformation of the spring, expressed in millimetres (mm);
D_{drop}	is the drop height (55 mm);
$F_{(t)}$	is the force during the impact, expressed in Newtons (N);
$C_{spring,\ dynamic}$	is the dynamic spring rate of the spring (2220 N/mm).

7.4.6 Calculate the vertical deformation (VD), of a single testing spot as the average of the vertical deformation results of the second and third impact and report the result to the nearest tenth of a mm, e.g. 9.8 mm.

8. Test report

The test report shall include the following information:

a. reference to this test method;

b. complete identification of the surface tested; a statement of the manufacturer's reference; type of supporting layers and method of attachment; the dimensions of the test piece;

c. the ambient temperature and relative humidity;

d. the value of $F_{max\ (concrete)}$ and the date on which it was determined;

e. the Force Reduction;

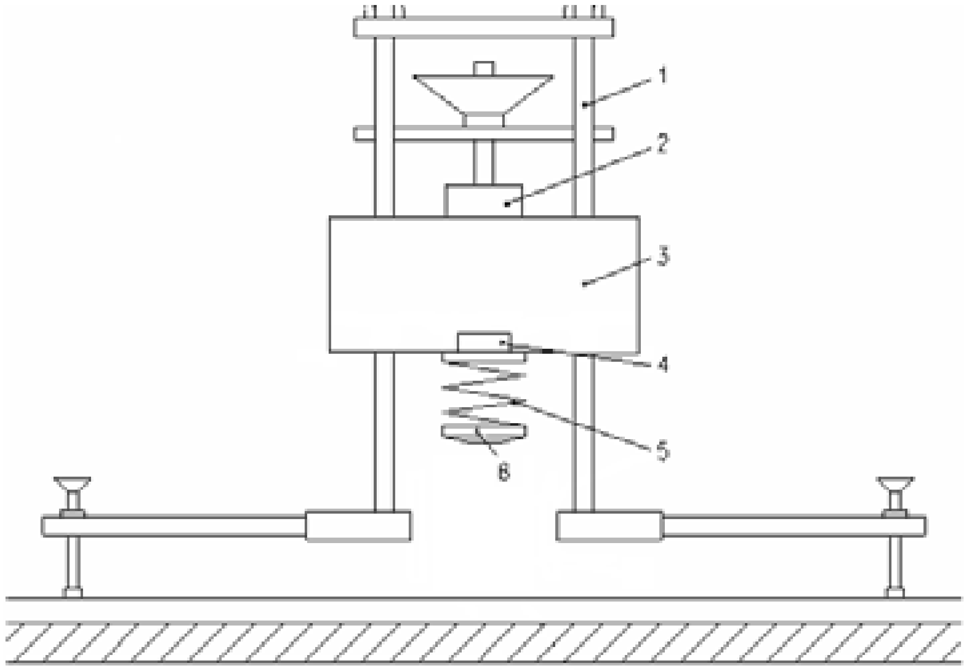
f. the Vertical Deformation;

g. the Energy Restitution;

h. the condition of the surface at the time of test, i.e. wet or dry;

i. a statement of the uncertainty on the result reported.

Figure 1 Artificial Athlete with the spring attached to the falling weight



1 guide of the falling weight;
2 electric magnet;
3 falling weight;
4 deceleration sensing device;
5 spring;
6 base plate.