SLOVENSKI STANDARD

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Podloge za športne dejavnosti - Preskusna metoda za ugotavljanje kriterija poškodbe glave (HIC) in kritične višine padca (CFH)

Surfaces for sports areas - Test method for the determination of Head Injury Criterion (HIC) and Critical Fall Height (CFH)

Sportböden - Prüfverfahren für die Bestimmung des Kopf-Verletzungs-Faktors (HIC) und der kritischen Fallhöhe (CFH)

Sols sportifs - Méthode d'essai pour la détermination du Critère de blessure à la tête (HIC) et de la Hauteur de Chute Critique (HCC)

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Surfaces for sports areas - Test method for the determination of Head Injury Criterion (HIC) and Critical Fall Height (CFH)

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Sportböden - Prüfverfahren für die Bestimmung des Kopf-Verletzungs-Faktors (HIC) und der kritischen Fallhöhe (CFH)

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 217.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 17435:2019) has been prepared by Technical Committee CEN/TC 217 “Surfaces for sports areas”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

Introduction

Sports injuries occur for a variety of reasons; in many contact sports they are as a result of athlete on athlete collisions. Injuries also occur when athletes fall onto the surface on which they are playing. Of these the most severe are likely to be injuries to the head, which can be life changing or even life threatening. Consequently, a test method has been developed to measure the ability of sports surfacing materials to reduce the likelihood of severe head injuries occurring. It is intended that this test method will be specified in standards for sports surfaces used for activities where head impacts with the surface are likely.

The test method is based on work undertaken by CEN committee CEN/TC 136 "Sports, playground and other recreational facilities and equipment". The Head Injury Criterion (HIC) at a tolerance level of 1 000 has been adopted as it is considered to be the upper limit for the brain injury severity unlikely to have disabling or fatal consequences.

By choosing the measurement of HIC as one criterion of sports surfacing athlete protection, the method considers only the kinetic energy of the head when it impacts the surface. This is considered to be the best model available to predict the likelihood of head injury from falls.

The HIC value of 1 000 is merely one data point on a risk severity curve where an HIC of 1 000 is equivalent to a 3 % chance of a critical injury (MAIS[1)] 5), a 18 % probability of a severe (MAIS 4) head injury, a 55 % probability of a serious (MAIS 3) head injury, a 89 % probability of a moderate injury (MAIS 2), and a 99,5 % chance of a minor head injury (MAIS 1), to an average male adult.

This method of test and HIC and Critical Fall Height (CFH) performance requirements are specified in product and facility specifications published by CEN and a number of sports governing bodies.

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

1 Scope

This document specifies test methods for measuring the Head Injury Criterion (HIC) of sports surfaces. Two different methods are specified. In Procedure A, a series of tests are undertaken from differing drop heights and the HIC values are plotted, and the Critical Fall Height determined. In Procedure B, a series of tests are made at a fixed drop height and the mean value of HIC is calculated.

This test method is primarily intended for use on synthetic turf sport surfaces. It may be carried out in a laboratory on test specimens or in situ on installed sports surfaces.

NOTE Annex A contains an indicative test method where a single test is made at each drop height and an indicative value of HIC is calculated. This test method can also be used on other forms of sports surfacing that may be intended to provide impact protection against head impacts.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12229, *Surfaces for sports areas - Procedure for the preparation of synthetic turf and needle-punch test pieces*

EN 12504-2, *Testing concrete in structures - Part 2: Non-destructive testing - Determination of rebound number*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
impact attenuation
property of a surface, which dissipates the kinetic energy of an impact by localized deformation or displacement such that the acceleration is reduced

3.2
critical fall height
calculated drop height producing a HIC value of 1 000

3.3
Head Injury Criterion (HIC) value
measure of the severity of a head injury likely to arise from an impact, determined as described in Clause 7 of this standard

3.4
test position
position on the surfacing to be tested, located vertically below the centre of the headform

3.5
drop height
distance between the test position on the surfacing and the lowest point of the free falling headform prior to release

Note 1 to entry: In the case of a guided headform, this value is calculated from measurement of velocity at impact.

3.6
drop test
single impact measurement from the selected drop height

4 Test apparatus

4.1 Suitability

The same apparatus and recording procedures are used for the three methods of test described in this document.

4.2 Components of the apparatus

4.2.1 General

The equipment comprises: a headform (4.2.2) fitted with one or more accelerometer(s) (4.2.3), optionally a signal processor (4.2.4), a release system for the headform (4.2.7), means for measuring the effective free fall height (4.2.6), a signal transmission system (4.2.8) and impact measuring equipment (4.2.9). If the equipment is using a uniaxial accelerometer, it shall also have a guidance system for the headform (4.2.5).

4.2.2 Headform

4.2.2.1 The headform shall consist of either

a) an aluminium alloy ball; or

b) a hemispherical ended aluminium alloy missile.

4.2.2.2 The impacting face of the headform shall have a diameter of 160 mm ± 5 mm. The maximum deviation from the hemispheric surface shall be 0,5 mm (1). The total mass of the headform shall be 4,6 kg ± 0,05 kg. In the case of a wired headform, the weight of any connector which is directly attached to or mounted on the headform and the mass of 1,5 m of the wire or cable shall be included in the determination of the mass of the headform.

NOTE The inclusion of the mass of the wiring is to avoid errors in measurement caused by vibrations of the lower boundary.

If the alloy from which the headform is made is too soft, deformation of the surface of the aluminium may occur when testing hard or rigid sports surfaces. This will result in unquantifiable errors in the measurement of HIC. When testing surfaces of this type, the impacting surface of the headform should be inspected frequently. If deformation of the headform surface is observed, the test shall be considered invalid.

4.2.3 Accelerometer

The measuring accelerometer(s) shall be comprised and be incorporated into the headform as follows:

a) accelerometer(s) aligned to measure 3 axes for free falling headform, mounted at the centre of gravity (+ or – 5 mm in the vertical or horizontal axis) of the headform; or

b) a uniaxial accelerometer for guided headforms, aligned to measure in the vertical axis ± 5° and located directly above the centre of mass.

4.2.4 Signal processor (optional)

Depending on the accelerometer technology, different signal processors may be used. This could be, for example, a charge amplifier (internal or external), a wheatstone bridge and an amplifier or an integrated electronic conditioner.

4.2.5 Guidance system

When using a uniaxial accelerometer, a vertical guidance for the headform shall be provided, including a means to measure the velocity of the headform immediately prior to impact (see 4.2.6.2).

4.2.6 Fall height measuring equipment

4.2.6.1 General

In all cases, the effective free fall height of the headform shall be recorded using one of the following methods:

4.2.6.2 Free-fall impact tests

By physical measuring of the drop height or by calculating the drop height from the measured time between release and contact of the headform with the surface.

When calculating the drop height from the measured time between release and contact of the missile with the surface special attention should be paid to possible time differences between the start of time measurement and the effective release of the headform (e.g. caused by permanent magnetism in a magnetic release system). A comparison of the measured height of fall and the calculated height of fall may be needed.

4.2.6.3 For guided impact tests

By measuring the velocity of the headform immediately prior to the impact and calculating the theoretical free fall drop height. To allow for frictional losses, the velocity of the headform immediately prior to impact shall be recorded and the equivalent drop height calculated, as if the headform had been in free fall.

4.2.7 Release system

The release system for free-fall impact test shall not create a significant rotation moment or any other forces on the headform, when released.

NOTE A rotation moment or other forces on the headform would cause additional accelerations at impact in the accelerometer, leading to an uncontrollable error of the resultant for the vertical measurement.

4.2.8 Signal transmission system

When using a signal cable for transmission of the acceloromter signal it shall not cause any significant restraining, or pushing forces or cause unsteadiness of the headform.

4.2.9 Impact measuring equipment

4.2.9.1 The impact measuring equipment shall consist of an accelerometer measurement system (see 4.2.9.2), a recording device (see 4.2.9.3) and an HIC calculation program (see 4.2.9.4).

4.2.9.2 Accelerometer measurement system, capable of measuring all signal frequencies in the range 20 Hz to 1 000 Hz and having a sufficient response at all frequencies to keep amplitude errors below 5 %. It shall be capable of measuring, recording and displaying the acceleration and time duration of each complete impact.

For piezoelectric accelerometers, to have a sufficient response at low frequencies, the - 3 dB lower limiting frequency should be less than or equal to 0,3 Hz to reduce the error by overshooting the baseline after the impact and underestimating the g-max (and resulting HIC score), particularly for appropriate signal conditioning will generally meet this requirement. Other accelerometers are not concerned.

For piezoelectric accelerometers, to have sufficient response at low frequencies, the −3 dB lower limiting frequency shall be ≤ 0,3 Hz.

NOTE 1 This requirement is to reduce the errors resulting from signal droop, which is most obviously visible in the form of baseline overshoot after the impact. Signal droop also results in under estimation of *gmax* and as a result HIC, particularly for longer pulse durations.

NOTE 2 Piezoelectric accelerometers with a time constant of 2 s or greater and appropriate signal conditioning will generally meet this requirement. Other accelerometers are not affected.

4.2.9.3 Recording device, capable of capturing and recording the acceleration/time signals produced throughout an impact with a sampling rate of at least 20 kHz, including the maximum acceleration (gmax) experienced during each impact. Signal conditioning and filtering shall be compatible with the accelerometer and the data channel specified. When the −3 dB upper frequency response of the accelerometer and its signal conditioning system is at a frequency greater than one-quarter of the sampling frequency, an anti-aliasing filter with an attenuation of at least 30 dB at half the sampling rate shall be employed.

4.2.9.4 Program for calculating the HIC value for the recorded acceleration time history of each impact in accordance with 7.3.4.

4.3 Accuracy of apparatus

4.3.1 Calibration

4.3.1.1 The apparatus should be calibrated periodically in accordance with EN ISO/IEC 17025.

4.3.1.2 The acceleration measurement system (including accelerometers and electronic part (analogue and numerical) shall be calibrated for the whole frequency range from 20 Hz to 1 000 Hz. Recalibration shall be carried out at time intervals recommended by the manufacturer of the accelerometer or at least every two years. Calibrations shall be documented.

Accelerometers shall have an uncertainty not greater than 1 %.

4.3.1.3 Velocity measurement systems and any algorithms used for calculating the fall height shall be calibrated for the whole velocity range (up to 1m higher than the expected Critical Fall Height).

For free falling head forms the calculated fall height shall be compared with the physically measured effective fall height.

It shall be possible to calculate the drop height by at least two of the following three methods:

- Physical measurement
- Extrapolation using both the instance at which release, or initial velocity is zero and the acceleration due to gravity
- Extrapolation using both the impact velocity and the acceleration due to gravity

The variation between the two determined drop heights can be no more than 5 %.

4.3.1.4 The computer algorithm used for the calculation of HIC shall be checked, e.g. by imposing a half-sine curve and the result, when compared with an independent mathematical calculation of this curve, shall not deviate by more than ± 1 %.

NOTE An example for verification is given in Annex C.

4.3.2 Checks by operators

4.3.2.1 Operators shall verify at regular intervals the correct function of apparatus they use. The results of any checks shall be recorded during the life time of the apparatus (e.g. by using a monitoring log).

NOTE The tests given in 4.3.2.2 and 4.3.2.3 are for checking any deviations or anomalies in the components and neither replaces calibration nor the validation for compliance of the apparatus with this document.

4.3.2.2 Comparative testing on defined surfaces:

Conduct the testing procedure for determination of the Critical Fall Height on a defined prefabricated reference surface with constant properties under conditions as described for laboratory tests to give an HIC value of 1 000.

Carry out a series of at least three consecutive drop tests on the same test position, using the same fall heights (±2 cm) for all. Record the results for HIC of each drop test and determine the CFH.

The corresponding values for the CFH obtained shall not differ more than ± 5 %.

In case of higher deviations, maintenance or re-calibration is required.

4.3.2.3 Uncertainty test on defined surfaces:

Carry out a series of ten consecutive drops from the same drop height and on the same test position continually (within 15 min) on a reference surface with constant properties.

Discard any obvious incorrect results and calculate the standard deviation of the calculated HIC.

A standard deviation below 5 % of the average of the ten calculated HIC values is considered satisfactory. If this is not the case, maintenance or calibration operations shall be conducted.