



SLOVENSKI STANDARD
SIST EN 17435:2022

01-februar-2022

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)

Ta slovenski standard je istoveten z: EN 17435:2021

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ICS:

97.220.10 Športni objekti Sports facilities

SIST EN 17435:2022

en,fr,de

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EUROPEAN STANDARD

EN 17435

NORME EUROPÉENNE

EUROPÄISCHE NORM

December 2021

ICS 97.220.10

English Version

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

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This European Standard was approved by CEN on 1 November 2021.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 17435:2021) has been prepared by Technical Committee CEN/TC 217 “Surfaces for sports areas”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2022, and conflicting national standards shall be withdrawn at the latest by June 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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EN 17435:2021 (E)**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 (MAIS¹ 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.

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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 impact attenuation of sports surfaces. Three 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 single test is undertaken from differing drop heights and the HIC values are plotted, and the Critical Fall Height determined. In Procedure C a series of tests are made at a fixed drop height and the maximum value of HIC is calculated.

This test method is primarily intended for use on both natural and synthetic turf sport surfaces. It may be carried out in a laboratory on test specimens or *in situ* on installed sports surfaces. This test method may not be suitable for sports surfaces covered by EN 14904.

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 corresponding to the limits set by the pass/fail criteria for the surface. If no limit is set it should be assumed to be 1 000 HIC

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 7.3.4

3.4

test position

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

3.5

free fall impact test

test undertaken where the impactor is free to find its own path from the point of release to the surface

EN 17435:2021 (E)**3.6****guided impact test**

test undertaken where a method of maintaining the impactor in the correct orientation is used and which may inhibit the progress of the impactor by preventing it from rotating

3.7**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.

3.8**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 \pm 5 mm. The maximum deviation from the hemispheric surface shall be 0,5 mm (See Note). The total mass of the headform shall be 4,6 kg \pm 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 (± 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 $\pm 5^\circ$ 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).

4.2.6 Fall height measuring equipment

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

- For free falling 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;

- 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 accelerometer 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).

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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 < 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 shall be $\leq 0,3$ 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.

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 g_{\max} 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 (g_{\max}) 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 shall be no more than 5 %.