SLOVENSKI STANDARD
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Podloge otroških igrišč, ki ublažijo udarce - Ugotavljanje kritične višine padca

Impact attenuating playground surfacing - Methods of test for determination of impact attenuation

Stoßdämpfende Spielplatzböden - Prüfverfahren zur Bestimmung der Stoßdämpfung

Sols d'aires de jeux absorbant l'impact - Méthodes d'essai pour la détermination de l'atténuation de l'impact

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Impact attenuating playground surfacing - Methods of test for determination of impact attenuation

Sols d'aires de jeux absorbant l'impact - Méthodes d'essai pour la détermination de l'atténuation de l'impact

Stoßdämpfende Spielplatzböden - Prüfverfahren zur Bestimmung der Stoßdämpfung

This European Standard was approved by CEN on 29 October 2017.

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European foreword

This document (EN 1177:2018) has been prepared by Technical Committee CEN/TC 136 “Sports, playground and other recreational facilities and equipment”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by July 2018, and conflicting national standards shall be withdrawn at the latest by July 2018.

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.

This document supersedes EN 1177:2008.

European standards for playground equipment and surfacing comprise this European Standard and the EN 1176 series, which consists of a number of parts as follows:

— *Part 1: General safety requirements and test methods*

— *Part 2: Additional specific safety requirements and test methods for swings*

— *Part 3: Additional specific safety requirements and test methods for slides*

— *Part 4: Additional specific safety requirements and test methods for cableways*

— *Part 5: Additional specific safety requirements and test methods for carousels*

— *Part 6: Additional specific safety requirements and test methods for rocking equipment*

— *Part 7: Guidance on installation, inspection, maintenance and operation*

— *Part 10: Additional specific safety requirements and test methods for fully enclosed play equipment*

— *Part 11: Additional specific safety requirements and test methods for spatial network*

This standard should also be read in conjunction with:

— EN 1176:2017 series

— CEN/TR 16467:2013, *Playground equipment accessible for all children*

— CEN/TR 16598:2014, *Collection of rationales for EN 1176 - Requirements*

— CEN/TR 16396:2012, *Playground equipment for children, replies to requests for interpretation of EN 1176:2008 and its parts*

For inflatable play equipment, see EN 14960, *Inflatable play equipment — Safety requirements and test methods*.

The principal changes from the previous edition of this European Standard are as follows:

a) European foreword: References to CEN/TRs added.

b) Introduction: Rationale for retaining HIC 1 000 and introducing g_{max} 200 as upper limits for surfacing when assessed in accordance with this standard has been added.

c) Scope: Two methods of impact testing are now provided. Method 1 (as in the previous edition) – Test for determination of Critical Fall Height AND new Method 2 – Test for measurement of impact attenuation on site to enable, upon installation or at periods later in its life, confirmation as required of suitability of the product for that specific site location at the time of the test.

d) Body of standard:

   1) change of the order and adding new clauses by implementation of Method 2;

   2) adaption of recent technology for requirements on test apparatus and measurements in order to improve accuracy of results (including checks by operators);

   3) adapting Annex B and adding new Annexes C, D, E and F.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard is based on the safety principles given in EN 1176-1 for playground equipment and provides a method for the assessment of impact attenuation of surfaces intended for use in the impact area as defined in EN 1176-1. This standard (EN 1177) aims to reduce consequences of experiencing risks that are desirable for child development according to the principles set in EN 1176-1.

Injuries arise during the use of playground equipment for a variety of reasons and the great majority are minor. Even the presence of protection features like impact attenuating surfacing is known to affect the behaviour of children, as well as carers and play providers, which in turn can affect the risk. The majority of more serious injuries are attributable to falls and there are many factors that influence injury mechanisms during a fall that are independent of the surfacing, e.g. body orientation, awkwardness of fall, bone density, etc.

The most severe injuries are likely to be injuries to the head. Recent research has indicated that arm and leg injuries are more frequent and could be influenced by the duration of the acceleration pulse. The committee responsible for this European Standard maintains a constant review of research in this area for possible use in a future revision of this standard. The committee recognizes that there is a relationship between the risk of arm and leg injuries and surface type but takes the view that such injuries are not usually in the most severe category. At present the available injury data can be taken into account by limitation of the maximum (peak) acceleration.

Consequently, the committee has chosen to make its priority the reduction of the likelihood of serious head injuries caused by a fall from playground equipment, because even though such injuries are relatively uncommon, they can have the most severe consequences. The severity of injury resulting from an impact to the head can be quantified in terms of Head Injury Criterion (HIC) and the level of HIC = 1 000 together with the upper limit of the peak acceleration of g_{max} = 200g (g for gravity) have been chosen as the upper limits for surfacing when assessed in accordance with this standard.

Limiting the HIC value at a maximum of 1 000 is equivalent to a 3 % chance of a critical head injury (MAIS[1] 5), an 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 head injury (MAIS 2), and a 99,5 % chance of a minor head injury (MAIS 1), to an average male adult.

Limiting g_{max} to a maximum of 200g as well as limiting HIC to a maximum of 1 000 takes account of impacts of very short duration and follows the current research on arm injuries as a means of improvement to the Standard.

Two methods of impact tests are provided. The first method is for determination of the Critical Fall Height to enable full and detailed confirmation of a product's range of suitability. The second method describes an on-site drop test, without determination of critical fall height to enable, upon installation or at periods later in its life, confirmation as required of the performance of the surfacing in that specific site location at the time of the test.

The EN committee is aware of discussions within ASTM International since 2014 about a reduction in the HIC threshold to 700 in its corresponding standard. The current limiting value of HIC ≤ 1 000 has been used in Europe since 1998 and the EN committee considers that at present, there is insufficient evidence of net overall value to playground users to support a change. It has therefore chosen to retain the value HIC ≤ 1 000 and to provide a second threshold of 200g as the criteria of acceptability in this standard, whilst continuing to monitor research publications on this subject. The same has been decided by ASTM for the time being.

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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.

A variety of materials, both natural and synthetic, may be used as impact attenuating surfacing with different attributes and performance. These include grass growing in soil, sand, wood chips, bark, gravel, and various rubber-based products which may be in the form of tiles or continuous coatings or combinations of these materials. Whilst the methods described in this Standard can be used to assess the impact attenuation performance of any of these surfaces, attention of users is drawn that the behaviour of some materials can be highly variable and dependent on prevailing test conditions and that test results will likely vary over time or with climatic conditions.

1 Scope

This European Standard specifies the test apparatus and the impact test methods for determining the impact attenuation of surfacing by measuring the acceleration experienced during impact. Test apparatus in compliance with this standard are applicable to tests carried out in a laboratory or on site by either methods described.

NOTE The test methods described in this standard are also applicable for impact areas required in other standards than for playground equipment, e.g. for outdoor fitness equipment and parkour equipment.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 933-1, *Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method*

EN 1176-1:2017, *Playground equipment and surfacing — Part 1: General safety requirements and test methods*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1176-1 and the following apply.

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

3.2
impact attenuating surfacing
IAS
surfacing intended to reduce the risk of injury when falling onto it

Note 1 to entry: product or material having the inherent ability to attenuate the impact of a user falling onto it

3.3
critical fall height
CFH
maximum Free Height of Fall (FHF), for which a surface will provide an adequate level of impact attenuation, determined by test Method 1 as described in Clause 6 of this standard

3.4
head injury criterion
HIC
measure of the severity of a head injury likely to arise from an impact, determined as described in Clause 5 of this standard

3.5
peak acceleration
g_{max}
maximum acceleration a experienced by the headform during an impact, expressed in units of g (gravity)

3.6
impact measurement
HIC value and g_{max} calculated from the recorded acceleration a (in g) of the headform falling from one drop height onto one test position of the surface (see 5.1)

3.7
test position
position on the surface to be tested, located vertically below the centre of the headform

3.8
drop height
Free Height of Fall, measured between the test position on the surface and the lowest point of the free falling headform prior to release; or, in the case of a guided headform, calculated from measurement of headform velocity immediately prior to impact

3.9
drop test
procedure for conducting impact measurements on one test position of the impact area

Note 1 to entry: The number of drops and the drop heights of drop tests are specified separately in Method 1 for specific types of products (see 6.2.4) and in Method 2 for all types of surfacing material (see 6.3.5).

3.10
loose particulate material
material consisting of separate, un-bound pieces of a substance

Note 1 to entry: Sand, gravel, bark and wood chips are examples of loose particulate materials.

3.11
impact area
area that can be hit by a user after falling through the falling space

3.12
test zone
subdivision of the impact area for the purpose of verification of impact attenuation. All test zones to be verified constitute the impact area of the equipment (see 5.2).

4 Test apparatus

4.1 Suitability

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

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) (4.2.2.3 a or b), optionally a signal conditioner (4.2.3), a release system for the headform (4.2.6), means for measuring the effective free fall height (4.2.5), a signal transmission system (4.2.7) and an impact measuring equipment (4.2.8).

If using a uniaxial accelerometer, a guidance system for the headform shall be provided (4.2.4).

Principle of apparatus see Figure A.1.

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 headform shall have a diameter of 160 mm ± 5 mm, a mass of 4,6 kg ± 0,05 kg, with a maximum deviation from the hemispheric surface of 0,5 mm.

If the alloy from which the headform is made is too soft, deformation of the surface of the aluminium may occur when testing loose particulate materials like gravel or any other hard and rigid elements in the impact attenuating surface. This will result in unquantifiable errors in the measurement of gmax and HIC. When testing materials of this type, the impacting surface of the headform should be inspected frequently. If deformation of the headform surface is observed, the test is invalid.

In the case of a wired headform, the weight of any connector which is directly attached to or mounted on the headform and the weight of 1,5 m of the wire or cable shall be included in the determination of the mass of the headform.

4.2.2.3 Accelerometer(s) shall be incorporated as follows:

a) accelerometer(s) aligned to measure 3 axes for free falling headform, mounted at the centre of gravity (±5mm 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.

4.2.2.4 The impacting part of the headform below the mounting plane of the accelerometer shall be homogeneous and free from voids.

NOTE This is to avoid errors in measurement caused by vibrations.

4.2.3 Signal conditioner (optional)

Depending on the accelerometer technology employed, different methods of signal conditioning may be needed. Examples include: a charge amplifier, a Wheatstone bridge and amplifier, or an integrated electronic conditioner.

4.2.4 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 4.2.5.2).