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Impact attenuating playground surfacing – Determination of critical fall height

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SS-EN 1177, utgåva 1 och 2 gäller parallellt t.o.m. 2009-05-31.

The European Standard EN 1177:2008 has the status of a Swedish Standard. This document contains the official English version of EN 1177:2008.

SS-EN 1177, edition 1 and 2 are valid for and run parallel to 2009-05-31.

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EUROPEAN STANDARD
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EN 1177

May 2008

ICS 97.200.40

Supersedes EN 1177:1997

English Version

Impact attenuating playground surfacing - Determination of critical fall height

Sols d'aires de jeux absorbant l'impact - Détermination de la hauteur de chute critique

Stoßdämpfende Spielplatzböden - Bestimmung der kritischen Fallhöhe

This European Standard was approved by CEN on 25 April 2008.

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Foreword

This document (EN 1177:2008) 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of an identical text or by endorsement, at the latest by November 2008, and conflicting national standards shall be withdrawn at the latest by May 2009.

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

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This document supersedes EN 1177:1997.

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

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

EN 1176-2, *Playground equipment and surfacing — Part 2: Additional specific safety requirements and test methods for swings*

EN 1176-3, *Playground equipment and surfacing — Part 3: Additional specific safety requirements and test methods for slides*

EN 1176-4, *Playground equipment and surfacing — Part 4: Additional specific safety requirements and test methods for cableways*

EN 1176-5, *Playground equipment and surfacing — Part 5: Additional specific safety requirements and test methods for carousels*

EN 1176-6, *Playground equipment and surfacing — Part 6: Additional specific safety requirements and test methods for rocking equipment*

EN 1176-7, *Playground equipment and surfacing — Part 7: Guidance on installation, inspection, maintenance and operation*

EN 1176-10, *Playground equipment and surfacing — Part 10: Additional specific safety requirements and test methods for fully enclosed play equipment*

EN 1176-11, *Playground equipment and surfacing — Part 11: Additional specific safety requirements and test methods for spatial network*

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 that all safety requirements have been removed and are now included in EN 1176-1 so that this standard is now only a method for assessing impact attenuation. As a result of round robin testing, additional criteria for carrying out the test procedure and additional requirements for the test equipment have been introduced.

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.

Injuries caused by falls from playground equipment occur for a variety of reasons but the most severe injuries are likely to be injuries to the head. The committee responsible for this European Standard recognizes that there are many factors that influence injury mechanisms independent of the surfacing, e.g. body orientation, awkwardness of fall, bone density, etc. Recent research has indicated that permanent disabilities and long bone injuries could be influenced by the duration of the acceleration pulse. The committee responsible for this European Standard intends to consider recent research in this area in a future revision of this standard.

Consequently, priority has been given to developing a criterion for surfacing materials intended to assess their ability to reduce the likelihood of head injuries.

On the basis of statistical analysis of available data the Head Injury Criterion (HIC) at a tolerance level of 1 000 has been used as the upper limit for the brain injury severity unlikely to have disabling or fatal consequences. By choosing measurement of HIC as the criterion of safety, the method considers only the kinetic energy of the head when it impacts the surface of the impact area. This is considered to be the best model available to predict the likelihood of head injury from falls. Surfaces fulfilling the test requirements of this standard are considered to be in compliance with the requirements for impact attenuation in EN 1176-1.

NOTE The HIC value of 1 000 is merely one data point on a risk severity curve where a 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.

There are a variety of materials available providing impact attenuation, including rubber tiles, mats, slabs, continuous synthetic surfacing, either prefabricated or formed 'in-situ', loose particulate material, such as gravel, sand, wood chips, bark, etc. The method in this European Standard can be used to assess any of these surfaces.

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 European Standard specifies a method for determining the impact attenuation of playground surfacing. It defines a “Critical Fall Height" (see 3.2) for surfacing, which represents the upper limit of its effectiveness in reducing head injury when using playground equipment conforming to EN 1176. The test methods described in the European Standard are applicable for tests carried out in a laboratory and for tests on site.

2 Normative references

The following referenced documents are indispensable for the application 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 933-1, *Tests for geometrical properties of aggregates – Part 1: Determination of particle size distribution – Sieving method*

EN 1176-1:2008, *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 17025:2005)*

ISO 6487:2002*, Road vehicles – Measurement techniques in impact tests – Instrumentation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1176-1:2008 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 such that the acceleration is reduced

3.2
critical fall height
maximum free height of fall, for which a surface will provide an acceptable level of impact attenuation, determined as described in 4.4

3.3
head injury criterion (HIC) value
criterion for head injuries caused from falls as calculated in accordance with 4.6.1

3.4
test position
position on the material 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 In the case of a guided headform this value is calculated from measurement of velocity at impact (see 4.2.6).

3.6
impact measurement
HIC value from the recorded acceleration of the headform falling from one fall height onto one test position

3.7
drop test
series of impact measurements determined from at least four increasing drop heights

3.8
loose particulate material
material which absorbs the energy of an impact usually through its displacement

4 Test method

4.1 Principle

Test specimens or installed areas of the impact attenuating material under test are struck by an instrumented headform in a defined series of impacts from different drop heights. The signal emitted by an accelerometer (see Figure B.1) in the headform during each impact is processed to yield a severity from the measured impact energy, defined as head injury criterion (HIC).

The HIC of each impact is plotted and the critical fall height is determined as the lowest drop height producing a HIC value of 1 000 (see Figure B.2).

4.2 Apparatus

4.2.1 Test rig, comprising a headform with accelerometer (4.2.2), optionally with a charge amplifier (4.2.3) and, if using a uniaxial accelerometer, a guidance system (4.2.4) and impact measuring equipment (4.2.8), as shown in Figure A.1.

4.2.2 Headform, consisting of either

a) an aluminium alloy ball; or

b) a hemispherical ended aluminium alloy missile.

It 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, incorporating an accelerometer as follows:

c) triaxial accelerometer for free falling headforms, mounted in the centre of gravity of the headform; or

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

The impacting part of the headform between the lower boundary and accelerometer shall be homogeneous and free from voids.

4.2.3 Charge amplifier (optional)

4.2.4 Guidance system, to guide the headform when using a uniaxial accelerometer, including a means to measure the velocity of the headform immediately prior to impact.

4.2.5 Length measuring equipment, such that for the free-fall impact test, the drop height can be measured directly prior to release of the headform.

NOTE Calculating the drop height from the measured time between release and contact of the missile with the surface may be not sufficient because of 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).

In all cases, the drop height shall be measured with an uncertainty of not greater than 1 %.