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First edition

Sports and recreational facilities — Impact surfacing testing device

Installations sportives et récréatives — Dispositif d'essai de revêtement d'impact

PROOF/ÉPREUVE

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 83, *Sports and other recreational facilities and equipment.*

This first edition cancels and replaces ISO/TS 24667:2020, which has been technically revised.

The main changes are as follows:

— Addition of a new Formula (1) and renumbering of the subsequent formulae.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

 PROOF/ÉPREUVE

Introduction

Impact attenuating surfacing has been shown to be fundamental to the prevention of 60 % to 75 % of the injuries in playgrounds from impacts with the surface after a fall. The surface materials can be sourced and installed locally, such as sand, wood chips or rounded gravel, while others can be sourced from materials around the world and assembled on site such as poured in place rubber, tiles, mats or synthetic turfs and installed at local playgrounds. The performance of installed surfacing materials should be comparable from playground to playground no matter where the playground is situated. The equipment used to measure the performance of playground surfacing is internationally consistent, repeatable and reproducible.

The field of impact attenuation measurement as it applies to playground safety surfaces is very small, resulting in a limited market for potential manufacturers of such equipment. While a small number of reputable manufacturers exist, organizations needing playground impact test equipment, such as test laboratories and university researchers, often rely on their own technical abilities or those of related engineering departments to create the needed equipment from scratch.

Sports and recreational facilities — Impact surfacing testing device

1 Scope

This document gives the specifications for impact attenuation testing equipment used to evaluate the impact performance characteristics of playground surfacing. The specifications are aimed at ensuring that developers and manufacturers of such instruments meet minimum performance characteristics to allow repeatable, reproducible and accurate results.

This document does not specify a test method.

NOTE Such test methods are covered in other standards, e.g. EN 1177, ASTM F1292, ASTM F3313, AS 4422, CSA Z614.

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.

ISO 6487, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

3 Terms and definitions

No terms and definitions are listed in this document.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Apparatus

4.1 Missile (headform)

The missile shall have the following specifications:

a) machined from solid billet of 6061-T6 or equivalent aluminium;

b) impacting surface of the missile shall be spherical or hemispherical in shape with diameter of (160 ± 1) mm;

c) final mass of missile assembly (including any moving part of a possible guiding system) shall be (4,6 ± 0,02) kg;

d) accelerometer (see 4.2) mounted at centre of mass (±5 mm in the vertical or horizontal axis);

e) no gaps or voids between the mounting face of the accelerometer and the impacting face of the missile;

f) for non-guided systems, a tri-axial accelerometer shall be used;

g) for guided systems:

   1) The velocity of the missile immediately prior to impact shall be recorded in order to calculate the theoretical free fall drop height;

   2) Velocity measurement systems as well as algorithms for calculating the fall height shall be calibrated for the whole velocity range (up to 3,5 m drop height);

      For free falling missiles, the calculated fall height shall be compared with the physically measured effective fall height;

      In all cases, the effective free height of fall shall be measured with an uncertainty of not more than ±1 %;

   3) A uniaxial accelerometer may be used, which is aligned to measure in the vertical axis ±1° and located directly above the centre of mass.

4.2 Accelerometer

The accelerometer can be any type of sensor technology (piezoelectric, piezoresistive, variable capacitance, etc.) but shall have the following performance specifications:

a) minimum design frequency response shall be ≥1 Hz to ≤1 000 Hz;

b) capable of periodic calibration at 20 Hz, 50 Hz, 100 Hz, 300 Hz, 500 Hz, and 1 000 Hz;

c) sensitivity (mV/g) shall not deviate from 100 Hz reference frequency by more than ±5 % at all calibration points;

d) transverse sensitivity shall be <5 %;

e) discharge time constant >1,0 s

NOTE Time constant not applicable to MEMS type accelerometers.

f) minimum range of all axes is 500 g where g shall be equal to one gravitation force.

4.3 Data acquisition system

4.3.1 General

The data acquisition system shall have the following specifications for all channels:

a) 12 bits including sign minimum;

b) 20 000 Hz minimum sample rate per channel;

c) anti-aliasing filter with - 30 dB at half of the sample rate;

d) class 1 000 data channel dynamic accuracy in accordance with ISO 6487;

e) record data for minimum 10 ms before and 50 ms after the point on start of impact where acceleration on any axis rises above 5 g (total 60 ms record);

f) output all recorded data points in a suitable file format to facilitate post-processing.

4.3.2 Channels

The data acquisition system should be configured with enough channels to accommodate the number of accelerometers to be monitored.

Single channel missiles as described in 4.1 g) shall be connected to a data acquisition system with at least one channel.

Three-channel missiles as described in 4.1 f) shall be connected to a data acquisition system with at least three channels.

5 Calculation and processing

The system will display peak g, Head Injury Criterion (HIC) and HIC interval ($t_2 - t_1$).

HIC is calculated with Formula (1). A time interval (dt) of ≤50 µs will be used.

NOTE This ensures that the data collected at a 20 000 sample rate is used (20 000 samples per second equals 0,05 ms per sample). A faster sample rate would give a smaller dt which results in a more accurate HIC calculation.

$$HIC = \left(\left(\frac{\int_{t_1}^{t_2} a \cdot \mathrm{d}t}{t_2 - t_1} \right)^{2,5} \cdot (t_2 - t_1) \right) \max \tag{1}$$

where

t_1, t_2 are the time in seconds;

$\mathrm{d}t$ is the time interval;

a is the acceleration experienced by the missile in metres per second squared;

with the conditions:

t_1 ≥ time immediately preceding onset of impact where acceleration > 5 g

$t_2 > t_1$

t_2 < time following cessation of impact where acceleration < 5 g

The algorithm is executed for all combinations of t_1, t_2 with the HIC determined as the maximum value of the algorithm. HIC interval is the value of $t_2 - t_1$ at which the HIC was determined.

An alternate format of Formula (1) is Formula (2):

$$HIC = \left[(t_2 - t_1) \left(\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a \mathrm{d}t \right)^{2,5} \right] \max \tag{2}$$

6 Periodic calibration

6.1 General

Each test instrument is a system consisting of the missile, accelerometer, data acquisition and the reference pad Calibration of the individual components periodic calibration shall also consist of testing the components together as a system and reporting the results for future verification.

6.2 Accelerometer

The maximum interval between calibrations of the accelerometer is 2 years.

The periodic calibration is conducted at 20 Hz, 50 Hz, 100 Hz, 300 Hz, 500 Hz, and 1 000 Hz. The sensitivity (mV/*g*) shall not deviate from 100 Hz reference frequency by more than ±5 % at all calibration points.

Verify that the discharge time constant is >1,0 s.

6.3 Data acquisition system

The maximum interval between calibrations of the data acquisition system is 2 years.

The data acquisition system calibration and HIC calculation verification is conducted on each axis individually by the injection of a single cycle of a known haversine waveform. A haversine waveform more closely represents real impact waveforms than that of a simple half sine waveform.

The pulse to be generated is a single positive cycle of a haversine wave of the form, according to Formula (3):

$$V = \frac{AS}{2}\left(1 - cos\left(2\pi \frac{t}{T}\right)\right) \quad (3)$$

where

V is the output voltage, in V;

A is the reference pulse amplitude, in g;

S is the data acquisition system channel sensitivity in V/g;

t is the time, in s;

T is the reference pulse width in s.

The waveform shall be generated with a minimum sample frequency of 20 000 Hz.

The HIC and HIC interval values calculated by the data acquisition system are to be within the ranges of ±2 % around the reference scores given in Table 1.

Table 1 — Calibration waveform reference

Waveform		Target scores		
Pulse width ms	Reference g_{max}	g_{max}	HIC	HIC interval ms
10,0	100	100	302,9	5,08
10,0	150	150	834,8	5,08
10,0	200	200	1 713,7	5,08
20,0	100	100	605,9	10,15
20,0	150	150	1 669,6	10,15
20,0	200	200	3 427,4	10,15

6.4 Reference pad

For verification of the instrument between calibrations, the manufacturer of the impact tester shall supply a reference pad.

