SLOVENSKI STANDARD
oSIST prEN 17950:2023

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Varovalne čelade - Preskusne metode - Absorpcija udarcev, vključno z merjenjem rotacijske kinematike

Protective helmets - Test methods - Shock absorption including measuring rotational kinematics

Schutzhelme - Prüfverfahren - Stoßdämpfung einschließlich Messung der Rotationskinematik

Casques de protection - Méthodes d'essai - Absorption des chocs avec mesure de la cinématique de rotation

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ICS:

13.340.20	Varovalna oprema za glavo	Head protective equipment

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English Version

Protective helmets - Test methods - Shock absorption including measuring rotational kinematics

Casques de protection - Méthodes d'essai - Absorption des chocs avec mesure de la cinématique de rotation

Schutzhelme - Prüfverfahren - Stoßdämpfung einschließlich Messung der Rotationskinematik

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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 17950:2023) has been prepared by Technical Committee CEN/TC 158 “Head protection”, the secretariat of which is held by SIS.

This document is currently submitted to the CEN Enquiry.

Introduction

0.1 Purpose and background

The test method described in this document is designed to measure translational and rotational kinematics from any helmeted dynamic event such as an impact to an object. Statistics from bike, ski, equestrian, and other accidents show that oblique impacts, resulting in a combination of translational and rotational kinematics of the head, are more frequent than pure translational impacts. EN 13087-2, *Protective helmets — Test methods — Part 2: Shock absorption* measures only the translational motion in impacts against flat, hemispherical or curb stone anvils. A test method that measures the translational and rotational kinematics is therefore important and much needed.

As this document specifies the measuring the translational and rotational kinematics, it is possible to use this document as a complementary test method to EN 13087 2 when performing tests to measure shock absorption of helmets.

This document does not replace EN 13087 2.

0.2 Background to the design of the test method

Preliminary discussions to start work on the test method specified in this document started in 2006. In 2013, the responsible working group within CEN/TC 158 Head protection, *Head forms and test methods*, accelerated the work on the design of the test method.

Extensive efforts to ensure the soundest state-of-art test method have been made by:

— gathering data and scientific evidence from the widest range of scientific sources possible;

— performing multiple round robin tests;

— organizing numerous physical and online working group meetings in which a multitude of alternatives were analysed and discussed exhaustively before finally opting for the final design specified in this document;

— ensuring that experts within the field of biomechanics and brain understanding are members of the working group.

As part of the CEN standardization process, the content of this document has been further scrutinized and refined by other stakeholders and experts in the member countries of CEN.

0.3 Head form

A new head form without a neck for rotational impact tests has been developed for the test method specified in this document. The main reasons for developing a new type of head form are described below:

a) analysis of the inertial properties (Mass, Moment of Inertia and Centre of Gravity) of the existing EN 960 and Hybrid III head forms showed values that were very different from the values found in literature from measurements of the human head. This is not surprising as the EN 960 head form includes parts of a rigid neck, and the Hybrid III head form was developed for frontal car collisions and not for helmet testing;

b) the new test method requires that the outer surface of the head form that comes in contact with the helmet has more humanlike properties. Specifically, the coefficient of friction between the head form and the inner surface in a helmet needs to be specified. Neither the EN 960 head form nor the Hybrid III head form has the coefficient of friction chosen for the head form specification in this document.

0.4 Performance requirements and prerequisites

Performance requirements for pass/fail criteria when using the test method in this document will be specified in the relevant helmet product standards. The writers of those documents will also specify test prerequisites, see Clause 4 for details.

1 Scope

This document specifies a test method for helmets that measures the translational and rotational kinematics in impacts of a helmeted head form against an anvil.

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 12195-2, *Load restraint assemblies on road vehicles - Safety - Part 2: Web lashing made from man-made fibres*

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

ISO 6344-2, *Coated abrasives — Determination and designation of grain size distribution — Part 2: Macrogrit sizes P12 to P220*

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 https://www.electropedia.org/

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

3.1
Tragion point
cephalometric point in the notch just above the tragus of the ear

Note 1 to entry: The Tragion point is part of defining the *Frankfurt plane* (3.2) and close to the external auditory meatus.

Note 2 to entry: The Tragion point is illustrated in Figure 1 in 4.2.7 and is defined in the CAD files described in 4.2.2.

3.2
Frankfurt plane
longitudinal plane defined on the head form through the *Tragion point* (3.1) and the lower orbit of the eye

Note 1 to entry: The Frankfurt Plane is similar to the Basic Plane defined in EN 960.

Note 2 to entry: The Frankfurt plane is illustrated in Figure 1 in 4.2.7.

3.3
Pilz plane
plane on the head form angled 10° from the reference plane at the rear of the head at the intersection of the reference plane with the midsagittal plane

Note 1 to entry: The Pilz plane is illustrated in Figure 1 in 4.2.7.

3.4
reference plane
for a given head form, when erect, the horizontal plane located at a vertical distance 'y' measured down the central vertical axis from the centre of the crown

Note 1 to entry: All horizontal datum levels are quoted relative to this plane.

Note 2 to entry: The reference plane is illustrated in Figure 1 in 4.2.7.

[SOURCE: EN 960:2006, 2.5, modified – Note 2 to entry has been added.]

4 Prerequisites

4.1 Parameters needed

To perform the test method specified in this document, the following parameters shall be specified:

a) performance requirements;

b) preparation of samples;

c) sequence of conditioning;

d) sequence of tests;

e) sizes of head forms;

f) number and locations of impact points on the helmet;

g) for each impact, the impact energy, including tolerance or the impact speed, including tolerance.

NOTE Requirements for the parameters needed can be found in the relevant helmet product standard.

4.2 Head form

4.2.1 General

The head form shall not exhibit any resonant frequencies < 2 000 Hz.

4.2.2 External geometry

The external geometry of the head form shall conform to the specifications in the CAD files which are provided in the attached file CAD.zip.

NOTE There is one CAD file for each size of the head form.

4.2.3 Head form specifications

The head form shall conform to the specifications in Table 1.

Table 1 — Head form specification

Circumference at the Pilz Plane plane	Mass including instrumentation[a]	Centre of gravity (CG)			Moment of inertia (MOI)[e]		
		CG_x[b,d]	CG_y[b]	CG_z[b,d]	I_{xx}[c]	I_{yy}[c]	I_{zz}[c]
mm	**kg**	**mm**	**mm**	**mm**	**kg × cm²**	**kg × cm²**	**kg × cm²**
470	2,29	2,68	0,0	29,3	68,20	76,70	59,50
490	2,64	4,00	0,0	28,8	89,40	99,20	74,70
510	3,01	5,20	0,0	28,3	113,60	124,80	91,90
530	3,39	6,50	0,0	27,9	139,10	151,70	109,80
550	3,79	7,80	0,0	27,4	167,40	181,40	129,40
570	4,23	9,00	0,0	26,9	199,47	214,92	151,37
590	4,67	10,30	0,0	26,4	233,87	248,20	171,65
610	5,11	11,60	0,0	26,0	268,26	281,48	191,94
630	5,55	12,80	0,0	25,5	302,66	314,75	212,22

[a] Tolerance ± 2 %. See 4.2.5 for instrumentation.

[b] Tolerance ± 2 mm.

[c] Tolerance ± 5 %.

[d] See Figure 1 for location of CG_x and CG_z in relation to the Tragion point.

[e] Calculated about the Centre of gravity.

4.2.4 Outer surface specification

The coefficient of friction (μ) shall be 0,3 ± 0,03 between the outer surface of the head form and a polyester strap according to Annex A.

4.2.5 Instrumentation

For measuring translational acceleration, the instrumentation shall be able to measure within a range from 15 g to 300 g with a duration up to 30 ms.

For measuring angular acceleration, the instrumentation shall be able to measure within a range from 1 000 rad/s² to 25 000 rad/s² with a duration up to 30 ms.

For measuring angular velocity, the instrumentation shall be able to measure within a range from 5 rad/s to 70 rad/s with a duration up to 30 ms.

The assembly shall enable the measurement at the centre of gravity of the three components of the linear acceleration (ax, ay, az) and the angular rate (ωx, ωy, ωz) over time.

The linear accelerometers shall be oriented in the three natural directions of the head form. The accelerometers shall be capable of withstanding a maximum acceleration of 2 000 g without damage. The acceleration data shall be sampled at a frequency of > 10 000 Hz with a CFC 1 000 filter according to ISO 6487.

The angular rate sensors shall have a measurement capacity of at least 140 rad/s. The angular velocity data shall be sampled at a frequency of > 10 000 Hz with a CFC 180 filter according to ISO 6487.

4.2.6 Instrumentation for measuring the head initial position

The initial head form position shall be measured around the X and y-axis of the head form with a margin of error of ± 1°.