TECHNICAL REPORT

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Road vehicles — Determination of head contact and duration in impact tests

Véhicules routiers — Détermination du moment et de la durée du contact tête dans les essais de choc

Reference number
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Foreword

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In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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

ISO/TR 12351 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Restraint systems*.

Introduction

This Technical Report gives several methods of determination presented in:

— clause 4, calculation method. This method is based on SAE J2052, *Test device head contact duration analysis*;

— clause 5, visual method;

— clause 6, electrical contact method.

The calculation method is recommended subject to the availability of the appropriate transducer, as it is the most reliable of the three methods described. When the transducer cannot be used, the other two methods can be applied with their limitations.

Road vehicles — Determination of head contact and duration in impact tests

1 Scope

This Technical Report gives methods to determine the instant of head contact and the duration of this contact during impact tests.

The determination of head engagement and disengagement times are used in the calculation of the contact head injury criteria (HIC).

2 Reference

ISO 6487:—[1]), *Road vehicles — Measurement techniques in impact tests — Instrumentation.*

3 Terms and definitions

For the purposes of this Technical Report, the following term and definition apply.

3.1
HIC
Head Injury Criterion
maximum value calculable from the head centre-of-gravity resultant acceleration-time profile, in accordance with the following equation:

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

where

a is the resultant acceleration expressed as multiples of g (the standard acceleration of gravity);

t_1 and t_2 are any two points in time during the crash.

NOTE Other measures of head injury may be calculated from a similar formula, where t_1 and t_2 are separately-defined instants during the period when the head is in contact.

1) To be published. (Revision of ISO 6487:1987)

4 Calculation method

4.1 Principle, device

4.1.1 Principle

This clause gives a method to determine head engagement and disengagement times for use in the calculation of the HIC without reliance on contact switches or photography.

This method can be used for all calculations of HIC, with all test devices having an upper neck load cell with a minimum of three force channels (F_x, F_y, F_z) mounted rigidly to the head and head triaxial accelerometers.

4.1.2 Head contact

Head contact is defined as the application of a force over 500 N to the head other than a force through the neck as defined in 4.3.

4.1.3 Contact HIC

HIC values are calculated only during the periods of each head contact.

4.1.4 Head engagement (t_e) and disengagement (t_d) times

The head engagement and disengagement times, are determined by the method given in 4.3. These are the starting and ending times, i.e. the windows for the iterative HIC calculations for each head contact.

NOTE The maximum contact HIC for each t_e, t_d interval will have associated with it times t_1, t_2 which may be equal to, or less than the t_e, t_d interval.

4.1.5 Accelerometers (a_x, a_y, a_z)

The triaxial accelerometer(s) in the head of the test device will be referred to as an accelerometer: $+a_x$ is forward, $+a_y$ is to the right, and $+a_z$ is downward. These orientations are shown in Figure 1.

4.1.6 Test device

Any full, partial or simulated anthropomorphic dummy equipped with head accelerometers and load cell per 4.1.5 and 4.1.7 is defined as the test device.

4.1.7 Load cell

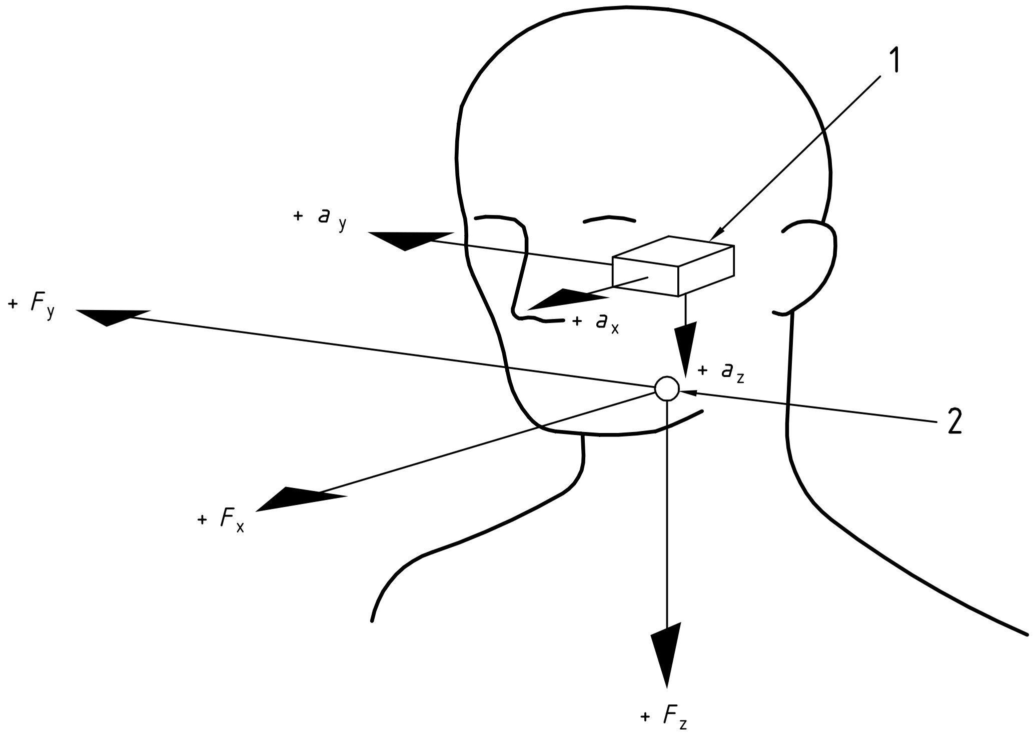
The load cell (attached rigidly to the base of the skull portion of the test device to which the neck is attached) will be referred to as a load cell, omitting the triaxial and upper neck classification. Load cells with additional outputs can also be used.

4.1.8 Head mass (M)

The mass of the head including the masses of the head accelerometers and mounting brackets and the mass of the load cell which is rigidly attached to the head.

4.1.9 Inertial head forces (Ma_x, Ma_y, Ma_z)

The inertial head forces are calculated from the triaxial accelerometers which are inside the head of the test device. The accelerations are multiplied by the head mass of the test device to determine the inertial head forces. The directions of these inertial forces are the same as the directions of their corresponding acceleration vectors.



Key

1 Triaxial accelerometer at centre of gravity of head

2 Upper neck transducer at base of skull

Figure 1 — Head contact duration analysis — Acceleration and force

4.1.10 Neck forces (F_x, F_y, F_z)

The neck forces are determined directly from the load cell, per 4.1.7, which reads the forces acting on the neck at the location of the load cell (the base of the skull). F_x is longitudinal shear, F_y is lateral shear, and F_z is axial force. Forces (F_x, F_y, F_z) are applied to the neck according to Figure 1. A positive F_x output from the load cell means head rearward motion relative to neck; positive F_y output is head left motion relative to neck; and positive F_z output is tensile force or head upward motion relative to the neck. Any other sign convention may be used subject to modification in the formulae in 4.3 and 4.4.2.

4.2 Data acquisition and processing system

The data acquisition and processing system shall be capable of supplying transducer data per ISO 6487.

4.3 Procedure for determining head contact duration (t_e, t_d)

Acceleration and forces are filtered using a CFC 1000. According to ISO 6487, filtering shall be carried out before calculating the resultant.

The subject method uses the following equation:

$$F = \sqrt{\left(Ma_x - F_x\right)^2 + \left(Ma_y - F_y\right)^2 + \left(Ma_z - F_z\right)^2}$$

The acceleration components (a_x, a_y, a_z) of the head are multiplied by the head mass (M) to produce the components of inertial head force. Each neck force component (F_x, F_y, F_z) is subtracted from the corresponding calculated intertial head force component. The aforementioned subtractions produce three force-differences. The

