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Road vehicles — Measurement techniques in impact tests — Instrumentation

Véhicules routiers — Techniques de mesurage lors des essais de choc — Instrumentation

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

International Standard ISO 6487 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Restraint systems*.

This third edition cancels and replaces the second edition (ISO 6487:1987), subclauses 3.5, 3.9 and 3.10, Figure 1, and annex B of which have been technically revised. The new subclauses 4.8, 4.9 and 4.10, annex A, Figure 2, and the bibliography have been added.

Annexes A and B of this International Standard are for information only.

Introduction

This International Standard specifies a series of performance requirements covering the entire measurement sequence of impact shocks. While these requirements are unalterable and obligatory for any party conducting tests in conformance with this International Standard, the method chosen to demonstrate conformance can be adapted to suit the particular equipment being used for testing.

Such an approach affects the interpretation of requirements. For example, the requirement to calibrate within the channel's working range of F_L to $F_H/2{,}5$ (see 4.1) cannot be interpreted literally, as low-frequency calibration of accelerometers requires large displacement inputs beyond the capacity of virtually any test laboratory.

Nor is it intended that each requirement be taken as necessitating proof by a single test. A tester can certify that if such a test of conformity were possible and were to be carried out, the equipment would meet the requirements. This certification would be based on reasonable deductions from existing data — the results of partial tests, for example — and its basis would normally be expected to be made available to the impact-test-result users.

For some subjects a single test is enough to directly demonstrate conformity. Other subjects, however, will need to be certified in an indirect manner. Again, using the example of calibration, this might be obtained with direct current at a medium frequency and, from knowledge of the transducer, an inference drawn that calibrations at intermediate frequencies would be the same.

A similar case is the practical need to divide the whole channel into subsystems for calibration and checking purposes. The requirements covering this are valid for the whole channel, the sole route by which subsystem performance can affect output quality. However, because it is often difficult to measure whole-channel performance, the tester could treat the channel as two or more convenient subsystems, and then certify the whole channel on the basis of the subsystem results, presenting them with the rationale for combining them.

In summary, this International Standard allows the user of impact-test results to call up a set of relevant instrumentation requirements merely by specifying ISO 6487, while conferring on the tester the primary responsibility for certifying that these requirements have been met by the instrumentation system used in testing. The evidence on which this certification is based will be made available on request to the user by the tester. In this way, strict requirements guaranteeing the suitability of instrumentation for impact testing are combined with flexible means of demonstrating conformity with them.

Road vehicles — Measurement techniques in impact tests — Instrumentation

1 Scope

This International Standard specifies requirements and presents recommendations for measurement techniques and instrumentation used in impact tests. The requirements are aimed at facilitating comparisons between results obtained by different laboratories, while the recommendations given in annex B are designed to assist the laboratories in meeting the requirements.

NOTE Optical methods are excluded from this International Standard, being the subject of ISO 8721.

The instrumentation to which this International Standard is applicable is specific to impact tests for road vehicles, and includes that used in tests on sub-assemblies.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2041, *Vibrational shock — Vocabulary.*

ISO 3784, *Road vehicles — Measurement of impact velocity in collision tests.*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 2041 and the following apply.

3.1
data channel
instrumentation ranging from single transducers (or multiple transducers whose outputs are combined in some specified way) to any analysis procedure that may alter the frequency content or the amplitude content of data

3.2
transducer
first device in a data channel used to convert a physical quantity for measurement into a second quantity (such as electrical voltage) able to be processed by the remainder of the channel

3.3
channel amplitude class
CAC
data channel designated as meeting certain amplitude characteristics specified by this International Standard

NOTE The CAC number is numerically equal to the upper limit of the measurement range.

3.4
channel frequency class
CFC
frequency class designated by a number indicating that the channel frequency response lies within limits specified by Figure 1 for CFCs 1 000 and 600

NOTE This number and the value of the frequency F_H, in hertz, are numerically equal. For the definition of characteristic frequencies F_H, F_L and F_N, see Figures 1 and 2.

3.5
calibration value
mean value measured and read during calibration of a data channel

3.6
sensitivity coefficient
slope of the straight line representing the best fit to the calibration values determined by the method of least squares within the channel-amplitude class

3.7
calibration factor of a data channel
mean value of the sensitivity coefficients evaluated over frequencies evenly spaced on a logarithmic scale between F_L and $F_H/2,5$

3.8
linearity error

ratio, in percent, of the maximum difference between the calibration value and the corresponding value read on the straight line defined in 3.6 at the upper limit of the channel-amplitude class

3.9
transverse sensitivity (of a rectilinear transducer)

sensitivity of the transducer to excitation in a nominal direction perpendicular to its sensitive axis

NOTE The transverse sensitivity is usually a function of the nominal direction of the chosen axis. The cross sensitivity of force and bending moment transducers is complicated by the complexity of loading cases. This issue has yet to be resolved.

3.10
transverse sensitivity ratio (of a rectilinear transducer)
ratio of the transverse sensitivity of the transducer to its sensitivity along its sensitive axis

NOTE The cross sensitivity of force and bending moment transducers is complicated by the complexity of loading cases. This issue has yet to be resolved.

3.11
phase delay time (of a data channel)
equivalent to the phase delay (in radians) of a sinusoidal signal, divided by the angular frequency of that signal (in radians per second)

3.12
environment
aggregate, at a given moment, of all external conditions and influences to which the data channel is subject

4 Performance requirements

4.1 Linearity error

The absolute value of the linearity error of a data channel at any frequency in the CFC shall be less than or equal to 2,5 % of the value of the CAC over the whole measurement range.

4.2 Amplitude against frequency [1)]

The frequency response of a data channel shall lie within the limiting curves given in Figures 1 and 2. The 0 dB line is defined by the calibration factor.

4.3 Phase delay time

The phase delay time between the input and the output of a data channel shall be determined, and shall not vary more than $1/10F_H$ seconds between 0,03 F_H and F_H.

4.4 Time

4.4.1 Time base

A time base shall be recorded and give at least 0,01 s with an accuracy of 1 %.

4.4.2 Relative time delay

The relative time delay between the signals of two or more data channels, regardless of their frequency class, shall not exceed 1 ms, excluding phase delay caused by phase shift. Two or more data channels of which the signals are combined shall have the same frequency class and shall not have a relative time delay greater than $1/10F_H$ seconds.

This requirement applies to analog signals, synchronization pulses and digital signals.

4.5 Transducer transverse sensitivity ratio

The transducer transverse sensitivity ratio shall be less than 5 % in any direction.

4.6 Calibration

4.6.1 General

A data channel shall be calibrated at least once a year against reference equipment traceable to known standards. The methods used to carry out a comparison with reference equipment shall not cause an error greater than 1 % of the CAC. The use of reference equipment is limited to the range of frequencies for which they have been calibrated.

Subsystems of a data channel may be evaluated individually and the results factored into the accuracy of the entire channel. This can be done, for example, using an electrical signal of known amplitude to simulate the output signal of the transducer, allowing a check to be made on the gain of the data channel (except for the transducer).

1) No method for the evaluation of the dynamic response during calibration of data channels for forces and displacements is included in this International Standard since no satisfactory method is known at present. The problem will be reconsidered later.

4.6.2 Accuracy of reference equipment for calibration

4.6.2.1 Certification

The accuracy of the reference equipment shall be certified or endorsed by an approved metrology service.

4.6.2.2 Static calibration

4.6.2.2.1 Accelerations

The error shall be less than 1,5 % of the channel-amplitude class.

4.6.2.2.2 Forces and displacements

The error shall be less than 1 % of the channel-amplitude class.

4.6.2.3 Dynamic calibration

4.6.2.3.1 Accelerations

The error in the reference accelerations expressed as a percentage of the channel amplitude class shall be less than 1,5 % below 400 Hz, less than 2 % between 400 Hz and 900 Hz, and less than 2,5 % between 900 Hz and the maximum frequency at which the reference acceleration is used (see 4.6.4).

4.6.2.3.2 Forces and displacements

See the footnote on page 3.

4.6.2.4 Time

The relative error in the reference time shall be less than 10^{-5}.

4.6.3 Sensitivity coefficient and linearity error

The sensitivity coefficient and the linearity error shall be determined by measuring the output signal of the data channel against a known input signal, for various values of this signal.

The calibration of the data channel shall cover the whole range of the amplitude class.

For bidirectional channels, both the positive and negative values shall be used.

If the calibration equipment cannot produce the required input due to the excessively high values of the quantity to be measured, calibrations shall be carried out within the equipment's limits, and these limits shall be recorded in the report.

A total data channel shall be calibrated at a frequency, or spectrum of frequencies, with a significant value of between F_L and $F_H/2,5$.

4.6.4 Calibration of frequency response

The response curves of phase and amplitude against frequency shall be determined by measuring the output signals of the data channel in terms of phase and amplitude against a known input signal, for various values of this signal between F_L and 10 times the CFC or 3 000 Hz, whichever is the lower.

4.7 Environmental effects

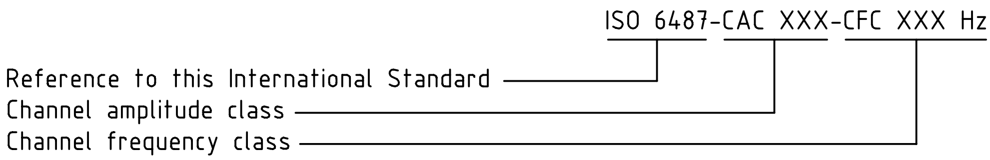
The existence or absence of an influence of environmental effects (e.g. electric or magnetic flux, cable velocity) shall be checked regularly. For instance, this might be done by recording the output of spare channels equipped with dummy transducers.

If significant output signals are obtained, corrective action shall be taken — the reallocation or replacement of cables, for example.

4.8 Choice and designation of data channel

The data channel is defined by the CAC and CFC [2]. The CAC shall be 1, 2 or 5 multiplied by a power of ten.

A data channel consistent with the specifications of this International Standard shall be designated according to the following code:



The type of filters used, whether phaseless or phase-shifting, shall be declared for each channel.

In the cases of CFC 180 and CFC 60, use of the Butterworth four-pole phaseless filter described in annex A is recommended.

If an analog filter is used in these two cases, its characteristics shall comply with the corridors in Figure 2.

Where the calibration of the amplitude or frequency response does not cover the complete CAC or CFC owing to limitations of the calibration equipment, the CAC or CFC shall be marked with an asterisk.

EXAMPLE

ISO 6487-CAC* 200 m/s^2-CFC 1 000 Hz

signifies that:

— the measurement was carried out according to this International Standard;

— the channel-amplitude class is 200 m/s^2;

— the frequency class is 1 000 Hz;

— the calibration of the amplitude response did not cover the complete CAC.

The test report shall indicate the limits of calibration.

4.9 Choice of reference coordinate system

Coordinate systems shall be defined either by reference to an agreed standard, or by an explicit and complete description (see B.5).

2) Their values are chosen for a given application by the party requiring the application.