INTERNATIONAL STANDARD

ISO 8568

Second edition
2007-07-01

Mechanical shock — Testing machines — Characteristics and performance

Chocs mécaniques — Machines d'essai — Caractéristiques et performance

Reference number
ISO 8568:2007(E)

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8568 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 6, *Vibration and shock generating systems*.

This second edition cancels and replaces the first edition (ISO 8568:1989), which has been technically revised.

Mechanical shock — Testing machines — Characteristics and performance

1 Scope

This International Standard specifies performance parameters and methods of inspection of mechanical shock-testing machines and gives guidelines for describing their characteristics. It is intended to ensure that the potential user of a particular shock-testing machine is provided with an adequate description of the characteristics of the machine, and also to give guidance on the selection of such machines.

This International Standard is applicable to the shock-testing machines that are used for demonstrating or evaluating the effect of shock conditions representative of the service environment in accordance with the relevant part of IEC 60068 and also for diagnostic testing. The purpose of the shock test is to reveal mechanical weakness and/or degradation in specified performance. It can also be used to determine the structural integrity of a test specimen or as a means of quality control.

Machines used for simulation of earthquakes, sonic booms, explosions and implosions, bursting tests, metalworking, forming, etc. are not covered in this International Standard.

Several techniques for generating the desired shock motion are discussed. Both simple-pulse and complex transients can be produced. The simulation of transients can be achieved by control of the test with a specified shock-response spectrum.

NOTE 1 Annex A gives a description of pulse-shaping devices. Annex B defines methods of application of the shock response spectra. Annex C considers a method of evaluating the possibility of using a vibration generator for producing a shock pulse. Annexes D and E deal with the methods of measurement of some characteristics in inspection methods (or procedures) of shock-testing machines.

NOTE 2 Characteristics of vibration-generating equipment are covered in ISO 5344, ISO 6070 and ISO 8626.

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.

ISO 2041:1990, *Vibration and shock — Vocabulary*

ISO 5347 (all parts), *Methods for the calibration of vibration and shock pick-ups*

ISO 5348, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

ISO 15261, *Vibration and shock generating systems — Vocabulary*

ISO 16063 (all parts), *Methods for the calibration of vibration and shock transducers*

IEC 60068-1:1988, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-27:1987, *Environmental testing — Part 2: Tests — Test Ea and guidance: Shock*

IEC 60068-2-81, *Environmental testing — Part 2-81: Tests — Test Ei: Shock — Shock response spectrum synthesis*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041, ISO 15261 and the following apply.

3.1
check point
fixing point nearest to the centre of the table surface of the shock-testing machine, unless there is a fixing point having a more rigid connection to the table, in which case the latter point is used

3.2
nominal load
maximum load used for the testing of a shock-testing machine as specified by the manufacturer

3.3
shock-testing machine
device for subjecting a system to controlled and reproducible mechanical shock

[ISO 2041:1990, 3.23]

NOTE Shock-testing machines can be classified as specially designed shock generators, gravity and powered, and vibration generators of electrodynamic and servo-hydraulic types used in a shock mode.

4 Performance

4.1 General

The performance of a shock-testing machine is based on a relatively slow accumulation of energy used to reproduce a shock, and its consequent discharge in an energy-transducing device for a short period of time.

The energy needed to create a shock may be achieved by the work against gravity (in free-fall machines) or, if the shock is in a direction other than upwards or if the free-fall machine does not provide enough velocity change, the necessary potential energy may be supplied by elastic cords, springs or hydraulic and pneumatic means.

The shock can also be achieved by releasing compressed gas, by explosives or by transfer of momentum from one moving mass to another.

4.2 Operation principles

According to the principle used, shock-testing machines are classified as free-fall or accelerated shock-testing machines, or as gas guns or explosive guns, hydraulic and pneumatic, as well as servo-hydraulic and electrodynamic.

The shock pulse (either a single-pulse or a transient vibration) is produced by a shock pulse-shaping device mounted on the table or carriage, on the reaction mass, or on both. A wide selection of pulse shapes can be produced depending on how the kinetic energy is transferred by pulse-shaping devices. Annex A gives some guidelines on the selection of pulse-shaping devices.

Pulse-shaping devices can be used in a rebounding or non-rebounding mode. Usually the device that attaches the test specimen is initially accelerated and a shock is produced during the rebound of the test specimen. Sometimes (for large masses or when the acceleration of the test specimen during shock pre-history is undesirable) a reaction mass or a hammer can be initially accelerated and the shock is produced as a result of the impact between the reaction mass and the device that attaches the test specimen. This mode is classified as non-rebounding.

As an alternative to the shaping of the shock pulse, for electrodynamic or servo-hydraulic vibration generators, a shock-response spectrum of the impulse to be applied to the specimen may be shaped to be similar to the required shock-response spectrum.

When the test specification requires some tolerance for a test shock-response spectrum (e.g. +3 dB, −1,5 dB), electrodynamic and servo-hydraulic test equipment for generating vibration may also be used for shock testing. These machines can generate classical shock waveforms (half-sine, trapezoidal, saw-tooth, etc.) as well as arbitrary waveforms which have the required shock-response spectra, and are usually produced by means of digital control, but generally have limited velocity and displacement capability. A method for maintaining the above limitations is briefly treated in Annex C. Characteristics of vibration-generating equipment are covered in ISO 5344, ISO 6070 and ISO 8626.

4.3 Test types

4.3.1 Shock pulse generation

Classical shock pulse shapes in accordance with IEC 60068-2-27 are generated with additional pre-pulse and post-pulse shaping to limit velocity and displacement. The amplitude of the pre-pulse and post-pulse shapes is limited to a small fraction of the primary pulse amplitude.

4.3.2 Shock-response spectrum generation

A brief, low-level oscillatory transient impulse is typically applied to the specimen. The shock-response spectrum is measured, compared with the desired shock-response spectrum, and the difference used to modify the shape of the next impulse. Typically, this process is repeated several times until the desired shock spectrum is achieved, and then an input transient impulse of the desired level is applied to the specimen. The desired shock spectrum may be either standardized (i.e. one of the shock spectra of Annex B) or the shock spectrum of a field environment.

4.4 Shock-testing machine components

A shock-testing machine consists of the following:

a) a rigid table or carriage with means of attaching test specimens and shock pulse-shaping devices;

b) a set of guides that controls the movement of the carriage;

c) a means for storing the potential energy necessary for imparting the shock, such as provisions for hoisting or preloading springs and cords attached to the carriage;

d) a means for securing the carriage at a selected drop height or position, prior to initiation of the shock pulse;

e) a release mechanism;

f) a reaction mass or base upon which the carriage impacts;

g) a pulse-shaping and rebound braking system, or means to generate and control the shock spectra;

h) control equipment;

i) shock-measuring system;

j) auxiliary power, cooling and other equipment, as required.

5 Shock-testing machine specification

The motion of the table or carriage may be specified by shock-response spectra and/or time-history parameters. Depending on the type of shock-testing machine (specially designed shock generators or vibration generators used in a shock mode), where applicable, data together with tolerances, shall be given for the following items:

a) available pulse shapes for free fall and accelerated tables;

b) maximum velocity change;

c) maximum displacement;

d) range of reproducible shock-pulse peak accelerations versus pulse durations;

e) initial or pre-pulse acceleration and final or post-pulse acceleration;

f) minimum shock-pulse duration;

g) frequency range of wavelets to reproduce a shock-response spectrum;

h) shock-response spectrum flatness with resolution in 1/3, 1/6 or 1/12 octave;

i) maximum drop height, preload pressure or charge;

j) tare mass of table or carriage and total moving mass;

k) maximum allowable axial force of specimen-mounting screw;

l) natural frequencies of the table or carriage;

m) natural frequencies of the machine on its foundation;

n) required pressure and volume of gas and liquids;

o) quantities and flow rates of fluid or gas for the operation of the machine;

p) type of rebound braking system and braking force;

q) size and overall dimensions of the machine and its parts, especially the table or carriage and its accessories;

r) dimensions, mass and mounting method of reaction masses and floor-loading requirements;

s) maximum size and mass of test specimen;

t) mounting facilities for test specimen and transducers;

u) number of shocks (shock pulses) possible per unit time, or, alternatively, minimum period between two shocks;

v) specification of the shock-measuring system employed;

w) centre of gravity of the table, plus the effect of any off-centre load;

x) acceptable range of environmental conditions, i.e. temperature, humidity, etc.

6 Requirements for shock-testing machines

6.1 General

The performance of shock-testing machines shall be defined and specified by the manufacturer.

Detailed installation, operation and maintenance instruction manuals shall be provided by the manufacturer.

Instructions shall include requirements for periodic inspection, maintenance and lubrication of the equipment. Signs of wear of replaceable components and possible structural failure shall be described by the manufacturer. Appropriate steps shall be proposed for replacing deteriorating pulse-shaping devices and for repairing leaks in the pneumatic and hydraulic systems.

Application and mounting of test specimens, adapter plates and fixtures to the table or carriage shall be thoroughly described. The effects on the test of eccentric or faulty loading of the carriage shall be explained.

Installation dimensions shall include adequate working room, overhead clearances and walk-ways around the equipment.

Electrical power requirements shall be stated and the normal operation of the machine shall not cause any interference in the power network that might affect the test monitoring instrumentation.

If a shock-testing machine operates by means of compressed gases or fluids, then adequate seals shall be used to prevent blow-out of gases or fluids during the test. All sections of barrels, cylinders and piping shall be designed with an adequate safety factor. The maximum expected pressures produced throughout the worst-case test should be considered.

6.2 Safety requirements

The overall machine design and installation shall provide sufficient safety and shall protect personnel from flying objects if the equipment or test specimen fails structurally.

Guns shall be located in restricted remote areas, with adequate blast-proof enclosures for the protection of personnel. Maximum gas pressures external to the gun and sound pressure levels shall be specified.

The table or carriage, piston or sabot shall be securely retained and fixed when being made ready for testing. The table or carriage shall be prevented from striking the reaction mass while personnel are assembling pulse-shaping devices.

Release or firing shall be possible only on command. The release mechanism shall be fail-safe and impossible to activate accidentally, for example by providing two simultaneously activated switches, one of which is lockable.

Gases that are likely to be compressed during testing shall not present any risk of spontaneous combustion by self-ignition.

It should be remembered that shock-testing machines can be used for human exposure testing and should therefore have proven reliability and safety. For such machines, the table or carriage shall be accessible immediately after the impact so that the human subject can be released quickly.

Protection shall be provided to protect human subjects from electrical terminals. The complete system shall meet appropriate safety requirements.

6.3 Table or carriage

The table of a vibration generator or the carriage of a shock generator (piston, sabot, spigot or tubes) and all accessories used for movement of the test specimen during the shock test shall be designed for maximum stiffness, strength and damping.

The means of attaching a test specimen and the limits of torque to be applied to the fixing screws shall be indicated.

In the case of test tables, it shall be stated whether or not they are fitted with replaceable threaded inserts, and whether they are recessed or raised. All test specimen mounting surfaces shall be geometrically flat and of minimum roughness and the applicable tolerances shall be stated. If the surface is fitted with recessed inserts, the flatness of the whole surface shall be indicated for normal reference atmospheric conditions (see IEC 60068-1:1988, Clause 5). If replaceable raised inserts are provided, the resulting co-planarity of the insert surfaces shall be given, based on the thickness tolerance of the insert flanges and the flatness of the insert-mounting surface.

The maximum torque to be applied to replaceable inserts during installation shall be stated, together with the types of materials being mated.

A drawing or diagram shall be provided giving all dimensions of the table or carriage, the dimensions and positional tolerances of the inserts, and the material from which they are made.

The maximum permissible torque and axial force that may be applied to the inserts shall be stated, together with the required perpendicularity of the test specimen fixing screws with respect to the mounting surface.

6.4 Hoisting or pre-loading

The free-fall and the accelerated shock-testing machines, and machines that use a hammer or a pendulum, shall be supplied with mechanisms for hoisting and pre-loading the carriage to a predetermined drop height or tension, for example by means of a built-in height- or angle-measuring scale with a residual indicator. The precision of the drop height or pre-load setting shall be specified, together with tolerances. The machine shall be fitted with devices to stop the carriage automatically or to indicate to the operator when the carriage has reached a predetermined drop height or pre-load. The manufacturer shall specify the maximum drop height or pre-load.

If the test has to be aborted, it shall be possible to disarm the machine and safely lower the table or carriage.

6.5 Braking systems

Shock-testing machines should be equipped with adequate braking systems. Braking may be achieved by mechanical, electrical, pneumatic or hydraulic devices. Shock-absorbing materials or parachutes may be employed on devices that are in free trajectory and these shall be recovered with minimum damage.

The design of the braking system shall ensure that minimum vibration is superimposed on the pulse trace and that shock tests can be limited to a single pulse.

Acceleration limits for braking shall be given by the manufacturer, together with information on the braking force required for controlled braking. The magnitude of acceleration applied during braking shall not exceed 25 % of that applied during the test pulse.

A shock-testing machine not equipped with a braking system should be adequately marked and shall be prevented by other means from causing damage.

6.6 Reaction mass

If a reaction mass is used, it shall be a large and rigid structure compared to the table or carriage.

The resonance of the reaction mass shall have sufficiently high frequencies to avoid distortion of the shortest shock pulse duration for which the machine is rated.

Seismically suspended reaction masses may be used. They may be installed when the shock has to be isolated from the surroundings and where reduced dynamic floor loading is required. They may also be used to control the recoil motion of the shock table or carriage by momentum transfer to the reaction mass.

The manufacturer shall provide or recommend the dimensions, masses and the ratio between the moving masses, including the test specimen and the reaction mass, together with mounting methods.

6.7 Shock pulse-shaping devices and methods

The springs, impact pads and pulse programmers or generators used for controlling the shock pulse (i.e. the pulse shape, duration and acceleration) depend on the dynamic force-deflection characteristics of the pulse-shaping device.

If two or more masses are involved in a momentum exchange, the shock motion of each mass shall be taken into consideration in the design of the shock pulse-shaping device.

Any special equipment needed to form the pulse-shaping devices (e.g. moulds for making lead forms) shall also be specified. Guidelines for choosing shock-shaping devices are given in Annex A

Similarly, a special electronic shock synthesizing controller typically is used to generate the input signal to an electrodynamic or servo-hydraulic vibration generator used to generate a shock impulse (see Annex B).

7 Inspection of a shock-testing machine

7.1 General

A procedure shall be specified for performing a shock inspection test for periodic evaluation of system performance. A periodic inspection of the test equipment characteristics shall be carried out in accordance with the specified control method or manual.

The inspection interval for a shock-testing machine should be recommended by the manufacturer, and may be changed by the user depending on the constancy of the characteristics to be certified and the use of the shock-testing machine with respect to time.

7.2 Preparation procedure

The shock-testing machine shall be supplied with at least two equivalent loads of m_{nom} and 0,5 m_{nom}, where m_{nom} is the mass of the nominal load. If the shock-testing machine is used for testing specimens whose mass (including the mass of the means for attaching a test specimen) is less then 0,1 m_{nom}, calibration may be done with zero load. A monolithic metal cylinder or prism with the ratio of height to diameter from 0,2 to 1,0 is recommended as an equivalent load. (For electrodynamic vibration generators used in a shock mode, see ISO 5344.)

NOTE It is possible to use models, adapter plates and attachment fixtures as equivalent load test specimens. In this case, the results of the calibration of the shock-testing machine are valid only for the mentioned test specimens.

The design of an equivalent load shall enable mounting of an accelerometer at the check point of the table or carriage. Generally, check point coordinates coincide with the geometrical centre of the table or carriage surface if there are no other instructions provided by the manufacturer.

Shock-measuring instruments used for the calibration of the shock-testing machine shall provide measurements in the range of the shock accelerations and pulse durations corresponding to the range of the shock-testing machine. The total uncertainty of the shock-measuring instruments, including amplitude nonlinearity of the transducer and dynamic errors of the transducer and amplifier, shall provide the true value of the shock process as measured in the intended direction at the check point to be within the tolerances required by IEC 60068-2-27 and IEC 60068-2-81, or within the tolerances specified by the manufacturer.

For a tolerance value equal to 20 %, the total uncertainty related to shock-measuring instruments shall not exceed 7 % at a confidence level of 95 %. Calibration of the shock-measuring instruments shall be carried out in accordance with the corresponding part of ISO 5347 or ISO 16063.