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**Mechanical-shock fragility testing
methods for packaging and
products design**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by the Japan Packaging Institute (JPI)/the Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS Z 0119 : 1994** is replaced with this Standard.

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In the event of any doubts arising as to the contents,
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Mechanical-shock fragility testing methods for packaging and products design

1 Scope This Japanese Industrial Standard specifies the testing methods for evaluating the strength of products against shock by means of damage boundary curve based either on the permissible acceleration or permissible velocity change, or on both of them for the purpose of packaging and products design.

Remarks : The products mentioned here are the goods treated on the market as the commodities.

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. If the indication of the year of publication is given to these referred standards, only the edition of indicated year constitutes the provisions of this Standard but the revision and amendment made thereafter are not applied. The normative references without the indication of the year of coming into effect apply limiting only to the most recent edition (including amendments).

JIS B 0153 *Glossary of terms used in mechanical vibration and shock*

JIS Z 0108 *Glossary of terms for packaging*

JIS Z 0203 *Packaged freights—Conditioning for testing*

Remarks : **ISO 2233 : 2000** *Packaging—Complete, filled transport packages and unit loads—Conditioning for testing* is identical with the said standard.

JIS Z 9015-0 *Sampling procedures for inspection by attributes—Part 0 : Introduction to the JIS Z 9015 attribute sampling system*

Remarks : **ISO 2859-0 : 1995** *Sampling procedures for inspection by attributes—Part 0 : Introduction to the ISO 2398 attribute sampling system* is identical with the said standard.

ISO 8568 : 1989 *Mechanical shock—Testing machines—Characteristics and performance*

3 Definitions For the purposes of this Standard the definitions given in **JIS B 0153** and **JIS Z 0108**, and the following definitions apply:

- a) **mechanical-shock fragility** Permissible acceleration and permissible velocity change on the boundary in which damage, that might make the products lose their value, does not arise when applying a mechanical shock to the products by the methods specified in this Standard.
- b) **permissible acceleration** The maximum input acceleration durable without damage when applying a specified shock-pulse to the products.
- c) **velocity change** Sum of the absolute values of the shock velocity and rebound velocity of the shock table. Equivalent to the area of shock pulse.

- d) **permissible velocity change** The maximum input velocity change durable without damage when applying a specified shock-pulse to the products.
- e) **damage boundary curve** In the acceleration-velocity change curve diagram (Fig. 5), the curve indicating the boundary of the damage of the products by means of the permissible acceleration and permissible velocity change. It means that, in the damage zone, the products are damaged if a shock of acceleration and velocity change within its range are applied and the damage does not arise no matter how the acceleration or velocity change within the non-damage zone may be large. The damage boundary curve is based on the shock response spectrum (see Annex 1 and Annex 2).
- f) **adjustment acceleration** Acceleration obtained in such a way that, by reason why the acceleration measured with an instrument includes usually higher harmonic vibration component and, therefore, is not of smooth waveform, the form adjustment is carried out by drawing the parallel lines at the middle of the higher harmonic amplitude of the measured acceleration so that the peak values of the vibration lying on the both sides become equal. In addition, the maximum adjustment acceleration is the maximum acceleration obtained therein (see Fig. 1 and Fig. 2).

4 Specimen The specimen shall be an actual product or a trial manufacture and, in the latter case, the dimensions, mass, construction and function shall be equivalent to the case of the actual product. As the damage boundary curve in one direction of the specimen is usually determined by the permissible velocity change test (see 7.1) and permissible acceleration test (see 7.2), at least one specimen each is necessary for one test. In the case of the products the strength dispersion of which becomes a question, the number of specimens required for statistical treatment are prepared in accordance with the provisions in **ISO 2859-0** and **JIS Z 9015-0**. If the sufficient number of specimens cannot be prepared and the damage caused by the test is partial, the test may be carried out only by replacing that part.

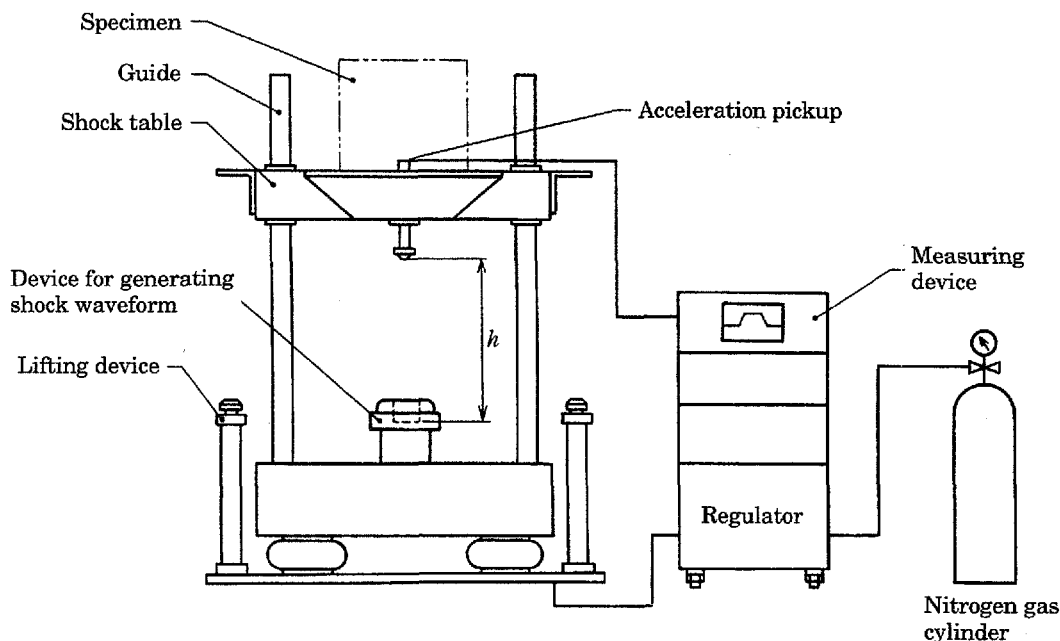
5 Pre-conditioning If the trade and use environment (temperature and humidity, etc.) affects the shock fragility of the specimen, the specimen shall be pre-conditioned prior to the test in accordance with **ISO 2233** and **JIS Z 0203**.

6 Testing machines and measuring devices

6.1 Shock-testing machines Shock testing machines shall comply with the following condition. Their main structure shall conform to **ISO 8568**. As a typical example, the required condition for free drop type is shown below (see Informative Fig. 1).

- a) The shock table to which the specimen is mounted is of sufficient rigidity, can be kept horizontal during the test and can lead the specimen so as not to move to other than dropping direction.
- b) The shock-pulse of half-sine wave and trapezoidal wave specified in 7.1 and 7.2 can be generated on the shock table.
- c) The acceleration and velocity change of the shock-pulse can be set independently of each other.

- d) The range of repeated dispersion of the acceleration and velocity change is $\pm 5 \%$.
- e) The shock table has a function to prevent the secondary shock after the generation of the required shock-pulse.



Informative Fig. 1 An example of free-drop type shock-testing machine

6.2 Measuring devices The measuring devices such as acceleration pickup, amplifier, arithmetic unit and recorder shall comply with the following conditions:

- a) The frequency characteristics is 1 Hz to 2 000 Hz in the permissible velocity change test (method A) and is within a range of 1 Hz to 1 000 Hz and flat (within ± 1 dB) in the permissible acceleration test (method B). If the characteristic lowers at the low stage of not higher than 2 Hz to 3 Hz, a phenomenon of strain of shock-pulse or under shoot arises, so that the use of a measuring device with DC response is recommended in the permissible acceleration test (method B).
- b) Acceleration can be measured with an accuracy of $\pm 2 \%$.
- c) Velocity change can be measured with an accuracy of $\pm 3 \%$.
- d) Cut-off frequency of the low pass filter for removing unnecessary high frequency in 7.1 and 7.2 is at least 1 000 Hz or at least five times the fundamental frequency of shock-pulse in the case of permissible velocity change test (method A) in order not to strain the fundamental wave form. In the case of permissible acceleration test (method B), it is at least 300 Hz or at least five times the fundamental frequency of shock-pulse.
- e) Shock acceleration wave form, acceleration, working time and velocity change can be measured or recorded separately.

6.3 Mounting of acceleration pickup The acceleration pickup is firmly fixed on a place where the acceleration given to the specimen on the shock table is represented (middle of the shock table as far as possible). The connecting cord is so kept as not to be affected by the movement of shock table.

Information : For mounting the acceleration pickup, see **ISO 5348**.

7 Testing methods In the test for measuring the shock fragility of products, both of permissible velocity change test (method A) and permissible acceleration test (method B) or, according to the purpose, any one of them are carried out.

7.1 Permissible velocity change test (method A)

7.1.1 Purpose In the test, the permissible velocity change the products can endure under a condition of not packaged such as in manufacturing process, in service, etc. is determined. Based on the results and compared with the velocity change given under the condition of manufacture, trade and use, the products are assessed whether shock absorbing package or strengthening of the products are necessary (see Annex 3).

7.1.2 Shock pulse The shock pulse for carrying out this test may be of optional wave form but half-sine wave should be standard with a view to being generated and controlled easily (Fig. 1) (see Annex 1).

The effective working time of the shock-pulses is required to satisfy the following formula (1) according to the natural frequency of the damageable part of the product so that the product responds in proportion to the shock velocity.

$$D_e \leq 1\,000/(2\pi f_c) \dots\dots\dots (1)$$

where, D_e : effective working time of the shock-pulses given to the specimen (ms);

Effective working time = velocity change/maximum adjustment acceleration.

f_c : natural frequency of damageable part of the product (Hz).

Example : The natural frequency of the damageable part of the product f_c which can be tested by using a half-sine wave of 3 ms in shock working time D is 83 Hz or under.

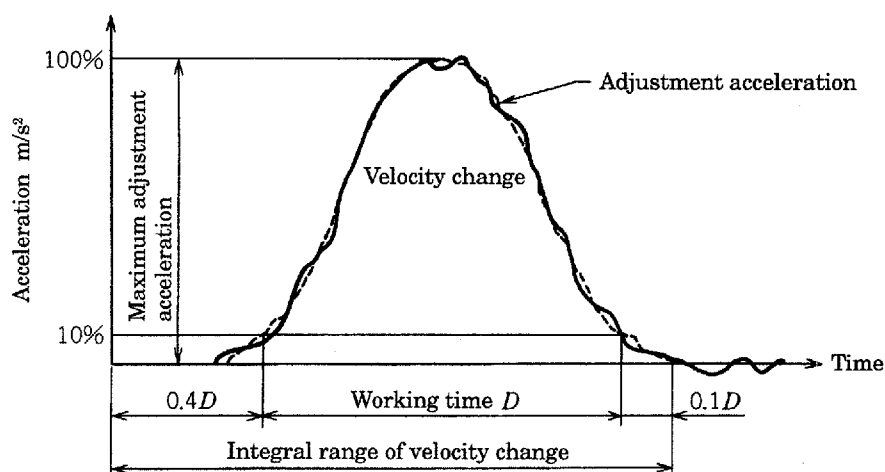


Fig. 1 Half-sine wave shock-pulse

7.1.3 Procedure

- Inspection and mounting of specimen** After carrying out the inspection on the construction and function of the specimen, fix the specimen on the shock table in accordance with the method specified in 7.3.
- Setting of velocity change at the start of test** Set the drop height of the shock table within a range in which a velocity change to be given to the specimen is supposed not to damage the specimen. In this case, it is recommended to set the drop height of the shock table on the basis of the velocity change obtained by the following formula (2):

$$V_s = V_c - (5 \text{ or } 6) \cdot \Delta V \dots\dots\dots (2)$$

where, V_s : velocity change applied first;
 V_c : estimated permissible velocity change of specimen;
 ΔV : amplitude of velocity change increase.

If V_c cannot be estimated, the test is carried out in general with the drop height of shock table set at 5 cm to 10 cm and the drop height increase amplitude set to 1 cm to 2 cm (see Annex 5).

- Damage inspection** Apply the first shock to the specimen and inspect whether damage arises or not.
- Measurement of velocity change** Measure the shock-pulses applied to the specimen using the measuring devices specified in 6.2 and record the velocity change, acceleration and working time in accordance with the Fig. 1.
- Increase of velocity change** If no damage is found on the specimen, mount the specimen on the shock table in the same way as afore-mentioned and repeat the test increasing the velocity change until damage is found. The number of times of the test to be repeated until damage is found should be 5 or 6 times at the most in order to avoid the effect due to the stored fatigue caused by repeated shocks (see Annex 5).