



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS Z 0235 : 2002
(JPI/JSA)

**Cushioning materials for
packaging—Determination of
cushioning performance**

ICS 55.040; 83.100

Reference number : JIS Z 0235 : 2002 (E)

PROTECTED BY COPYRIGHT

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 0235 : 1997** is replaced with this Standard.

Date of Establishment: 1970-09-01

Date of Revision: 2002-03-20

Date of Public Notice in Official Gazette: 2002-03-20

Investigated by: Japanese Industrial Standards Committee
Standards Board
Technical Committee on Logistics and
Distribution of Goods

JIS Z 0235 : 2002, First English edition published in 2003-08

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2003

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Definitions	1
4 Classification of tests	2
5 Impact load test	2
5.1 Principle of test	2
5.2 Testing apparatus and measuring instrument	3
5.2.1 Testing apparatus	3
5.2.2 Measuring instrument	3
5.3 Test pieces	4
5.3.1 Sampling of test pieces	4
5.3.2 Dimensions of test piece	4
5.3.3 Direction of test	4
5.4 Testing method	4
5.4.1 Conditioning of test piece	4
5.4.2 Measurement of test piece	4
5.4.3 Environmental condition of test	5
5.4.4 Implementation of test	5
5.5 Calculation	5
5.6 Record and report of test	6
5.6.1 Record of test	6
5.6.2 Report of test result	7
6 Compression creep test	7
6.1 Principle of test	7
6.2 Test apparatus and test piece	7

6.2.1	Test apparatus and measuring instrument	7
6.2.2	Test pieces	8
6.3	Testing method	8
6.3.1	Conditioning of test piece	8
6.3.2	Measurement of test piece	8
6.3.3	Environmental condition of test	8
6.3.4	Implementation of test	8
6.4	Calculation	8
6.5	Record and report of test	8
6.5.1	Record of test	8
6.5.2	Report of test result	9
Annex 1 (normative)	Compression test method as simplified method	10
Annex 2 (normative)	Impact load test method corresponding to International Standard	13
Annex 3 (informative)	Record diagram of impact load test and compression creep test	16
Annex 4 (informative)	How to obtain static cushion factor	20
Annex 5 (informative)	Comparison table between JIS and corresponding International Standard	23

Cushioning materials for packaging— Determination of cushioning performance

Introduction This Japanese Industrial Standard has been made based on the corresponding International Standard as to the relating part (impact load test) of **ISO 4651 Cellular rubbers and plastics—Determination of dynamic cushioning performance** with some modifications of the technical contents.

Portions underlined with dots or given sidelines in this Standard are the matters not specified in the original International Standard.

1 Scope This Standard specifies the determination of cushioning performance and compression creep test method of the cushioning materials for packaging composed of the materials from which the non-proportional test pieces can be sampled or of the material of granular form.

Remarks : The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 4651 : 1988 *Cellular rubbers and plastics—Determination of dynamic cushioning performance* (MOD)

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7733 Verification of the force measuring system of the compression testing machine

JIS Z 0203 Packaged freights—Conditioning for testing

JIS Z 8401 Guide to the rounding of numbers

3 Definitions For the purpose of this Standard the following definitions apply.

- a) **cushioning material for packaging** The material used mainly for mitigating the impact and vibration given to the contents packaged (hereafter referred to as “cushioning materials”).
- b) **impact load** The load generated in the test piece by the drop of hammer in the impact load test and its value is obtained by multiplying the total mass of the hammer by the acceleration generated.
- c) **static stress** The total mass of the hammer and any additional masses multiplied by the gravitational acceleration divided by the original area of the test piece. It is expressed in the load per unit area.

- d) **impact strain** The rate of change of thickness in loading direction of the test piece generated by the impact load in the impact load test, expressed in percentages by dividing by the thickness of the test piece before the test.
- e) **equivalent drop height** The free fall height which would result in the same impact velocity as the hammer striking on the test piece in the impact load test using a drop tester.
- f) **impact permanent strain** The value in percentages obtained by dividing the reduction in thickness of the test piece which passed a specified time after the impact load test by the thickness before the test.
- g) **compression creep strain** The value in percentages obtained by dividing the rate of change in thickness of the test piece after the completion of the compression creep test by the thickness before the test.
- h) **compressive stress** The value expressed in the compression load per unit area obtained by dividing the compression load of the test piece after completion of the compression test at each change in the thickness by the area of the test piece before the test.
- i) **compression strain** The value in percentages obtained by dividing the rate of thickness change in compression direction of each test piece after the completion of the compression test by the original thickness.
- j) **cushion factor** The value which indicates the performance of the cushion materials to absorb impact energy and is classified into static cushion factor and dynamic cushion factor. The static cushion factor is the value of the compressive stress obtained as a result of compression test and divided by the compression energy per unit volume. The dynamic cushion factor is the value obtained as a result of the impact load test.

4 Classification of tests The tests are classified into the following two types and shall be carried out according to the purposes.

- a) **Cushioning performance test** Any one of the impact load test, the compression test as simplified method (Annex 1), and the impact load test corresponding to International Standard (Annex 2).

Remarks : Usual cushioning performance test is carried out by impact load test. If this test is impossible to be carried out, the compression test as simplified method (Annex 1) may be conducted by the agreement between the interested parties. Moreover, if requested in the trade with abroad, the impact load test corresponding to International Standard (Annex 2) may be adopted in accordance with the agreement between the interested parties.

- b) **Compression creep test**

5 Impact load test

5.1 Principle of test The test is to evaluate the cushioning performance of the cushioning materials in such a way that a hammer of variable mass strikes vertically the surface of the test piece at a specified velocity and the acceleration generated in the hammer and rate of change in thickness of the test piece are measured.

5.2 Testing apparatus and measuring instrument

5.2.1 Testing apparatus The tester shall be of vertical-drop type. Each part of the tester shall conform to the following requirements:

- a) The hammer is of such rigidity that the vibration generated to the hammer itself by the impact given to the test piece does not affect the measurement, of the variable mass and of the structure capable of fixing an accelerometer and displacement meter.
- b) The hammer drops vertically onto the base plate and the velocity of the hammer at the time of impact is at least 95 % of the velocity at the time of free dropping from a specified height.
- c) The base plate is of the rigidity suitable for giving the impact energy of the hammer correctly to the test piece and has the mass at least 50 times the maximum mass of the hammer used. The mass of the base plate includes the mass of the foundation of the rigidity considered to be integral with the base plate in the direction of impact load.
- d) The testing apparatus is capable of testing repetitively the optionally selected number of times at intervals of 60 ± 5 s.
- e) The function to prevent secondary impact which may arrive after the impact of the hammer given to the test piece is desirable.

5.2.2 Measuring instrument For the measuring instrument, accelerometer, displacement meter and speedometer having the following function and characteristics respectively shall be used.

- a) The accelerometer is for measuring the acceleration generated in the hammer and consists of acceleration pickup, amplifier and indicator or recorder and, without regarding to their type and combination, the frequency range is flat (± 1 dB) in a range from 1 Hz to 1 000 Hz. The value of acceleration is measured with an accuracy of ± 5 %. The cut-off frequency of the low pass filter for removing the output of unnecessary high frequency is at least five times the frequency corresponding to the predicted impact time.

Remarks : The frequency characteristic of the acceleration pickup of strain gauge type is flat from 0 Hz but that of piezoelectric type may lead to a low response at low frequency, so that care shall be taken.

- b) The displacement meter is for measuring the change in thickness of the test piece at the time of impact of the hammer on to the test piece and consists of displacement pickup, amplifier and indicator or recorder, and the value of displacement shall be measured with an accuracy of ± 5 %.

The speedometer is for measuring the velocity of the hammer at the time of colliding with the test piece and consists of velocity pickup, amplifier and indicator or recorder, and the value of velocity shall be measured with an accuracy of ± 1 %.

5.3 Test pieces

5.3.1 Sampling of test pieces The test pieces shall be taken at random out of the samples after 72 h or more elapsed from the manufacture.

When the test pieces of the specified dimensions can not be obtained from one sample, the sample manufactured under the same condition may be used.

5.3.2 Dimensions of test piece The dimensions of the test piece are usually, 150 ± 5 mm in length, 150 ± 5 mm in width, and 50 ± 5 mm in thickness. Other dimensions may be accepted when subjected to the agreement between the parties concerned with delivery. At most two test pieces may be stacked so that the thickness is not less than 20 mm, and the test may be carried out with different thickness as necessary.

When the sample is of shred or granular state, the sample shall be put into a box whose internal dimensions are, in general, at least 150 mm in length, 150 mm in width, and 100 mm in thickness, and which no deformation is generated due to the load (hereafter, the box is referred to as "compression box").

The clearance between the compression box and the pressurizing plate shall be approximately 2 mm in the whole periphery.

5.3.3 Direction of test The test piece shall be tested in the direction to be coincident with that of the impact load applied when the material is used. When the test in this direction is impossible, the direction in which the test is carried out shall be recorded.

5.4 Testing method

5.4.1 Conditioning of test piece In the conditioning, the test piece shall be left in general for 16 h or more at a temperature of 23 ± 2 °C, and relative humidity of (50 ± 5) %. In the conditioning of the hygroscopic test piece, the test piece shall be left for 24 h or more. The method of conditioning shall be in accordance with JIS Z 0203.

If other specific test condition than the above is required, it may be carried out in accordance with the agreement between the interested parties and it shall be reported in the record.

5.4.2 Measurement of test piece The test piece shall be measured in the following methods:

- a) **Measurement of thickness** Place a flat plate on the test piece on the surface plate, apply a pressure of 0.2 ± 0.02 kPa, after keeping this state for 30 s, measure the centre part or four corners of the test piece by a height gauge, or the like of minimum scale of 0.1 mm, and calculate the average value if four corners are measured. The measured values shall be recorded to the nearest 0.1 mm. The difference in thickness between test pieces shall not exceed 2 mm from the average thickness of all test pieces. When the sample is of shred or granular state, the depth of the sample in the compression box shall be measured.
- b) **Measurement of dimensions of length and width** Measure the length and width of the test piece at 3 points, that is, the both ends and the centre part

using a straight rule of minimum scale of 0.5 mm, calculate the average value, and record it to the nearest 0.1 mm. The variance of the length and width among the test pieces shall not exceed ± 5 mm. When the sample is of shred or granular state, the internal dimensions of the compression box shall be measured.

- c) **Measurement of density** Measure the dimensions of the test piece following a) and b) above, calculate the volume, measure the mass to the nearest 0.01 g, and calculate the density by dividing the mass by the volume. The density shall be calculated in the unit of g/cm^3 to the third decimal place and rounded off in accordance with **JIS Z 8401**, to two significant digits. The density of each test piece shall not exceed ± 10 % in difference from the average density of all test pieces.

5.4.3 Environmental condition of test The test shall be carried out under the same environmental condition as the conditioning of the test piece. When the test is carried out under the different environmental condition from that of the conditioning of the test piece, the actual test condition shall be fully described in the test record.

5.4.4 Implementation of test The test shall be carried out on three test pieces separately in the same test conditions by the following procedures:

- a) Fix the test piece lightly on the centre of base plate of the impact load test apparatus so that the test piece does not move under the impact load. Make a large number of holes of approximately 3 mm on the sides of the compression box to be used in the test of the test piece in shred or granular state. The equivalent free fall height of the hammer shall be 60 cm as standard. Apply five impact loads each consecutively to the same test piece at the intervals of 60 ± 5 s, and measure the peak acceleration generated in the hammer at each application, and the thickness of the test piece in which the strain comes to the maximum. After applying the specified five impact loads, immediately remove the hammer from the test piece, and after five minutes, measure the thickness of the test piece again. Stop the test if the test piece is recognized to be broken or have lost its cushioning performance while applying impact load repeatedly five times.

The test equivalent to the free fall height of the impact velocity other than 60 cm/s shall be carried out when necessary.

- b) Change the test condition, and repeat the test using a new test piece. As for the mass of the hammer, select 5 or more static stress values so that the maximum acceleration—static stress diagram of the sample can be plotted.

5.5 Calculation Calculation shall be as follows:

- a) **Maximum acceleration** As for the maximum acceleration, of the 5 measurements under the same test condition for each test piece, the average value of the first measurements of three test pieces and the average value from the second to fifth measurements shall be expressed in terms of m/s^2 . The average value of an arbitrary number of times up to five, or the average value by the combination of arbitrary number of times may be used as necessary. In any case, clarify the number of falls of the hammer by which the average value has been obtained.

- b) **Static stress** The static stress shall be calculated by the following formula.

$$\sigma_{st} = \frac{W}{A} \dots\dots\dots (1)$$

where, σ_{st} : static stress (MPa);
 W : load (N);
 A : area of the surface of test piece to receive the load (mm²).

- c) **Maximum impact strain** The average value of the maximum impact strain shall be obtained in the same manner as the maximum acceleration, and calculated by the following formula.

$$S_d = \frac{T_0 - T_M}{T_0} \times 100 \dots\dots\dots (2)$$

where, S_d : maximum impact strain (%);
 T_0 : thickness of test piece before the test (mm);
 T_M : thickness of test piece at the moment of the largest strain (mm).

- d) **Impact permanent strain** The impact permanent strain shall be calculated by the following formula.

$$S_p = \frac{T_0 - T_D}{T_0} \times 100 \dots\dots\dots (3)$$

where, S_p : impact permanent strain (%);
 T_0 : thickness of test piece before the test (mm);
 T_D : thickness of test piece after the test (mm).

5.6 Record and report of test

5.6.1 Record of test The following items shall usually be described in the test report.

- a) Date of the test, temperature and relative humidity during the test
- b) Details of test piece (name of product, type, etc.)
- c) Mass, dimensions, density or apparent density and material of test piece
- d) Water content of test piece
- e) Number of test pieces tested
- f) Free fall height of hammer, equivalent free fall height or impact speed of hammer
- g) Total mass of hammer
- h) Number of drops of hammer
- i) Type and capacity of testing machine used