

Methods for test for

Determination of properties of cushioning materials for package design purposes

Committees responsible for this British Standard

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- British Paper and Board Industry Federation
- British Rubber Manufacturers Association Ltd.
- EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)
- Institute of Packaging
- Ministry of Defence
- PIRA International

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Foreword

This British Standard has been prepared under the direction of the Packaging and Freight Containers Standards Policy Committee to provide a standard listing methods of test for the determination of those properties of cushioning materials which are particularly relevant for purposes of package design.

Certain methods are based closely on methods of test given in BS 4443 but these have been modified to make them more specific to package design and the basic cushion design guidance given in BS 1133-12.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

0 Introduction

A packaged article, depending on its nature, may require the package to provide protection against shocks occurring during transit. Such shocks may be of high or medium intensity but intermittent, caused by drops or other impacts or, more usually, of lower intensity but repeated, due to vehicle vibration.

One method of protecting the article is to cushion it against anticipated shocks using materials which deflect on impact. Such cushioning materials reduce the level of shock from impacts by allowing controlled movement of the packaged article within the package at the instant of impact, so reducing the deceleration and the resulting force transmitted to the article. Cushioning materials can also be used to reduce the transmission of vibration to the article when this is likely to be a problem.

In order to design a package providing adequate protection, various properties of the available cushioning materials need to be considered. The methods described in this standard are particularly appropriate for measuring those properties relevant to package design.

Design data obtained by these methods, while essential for rational design of the cushion, provide only an estimate of package performance, which is influenced by many other factors including:

- a) the type of container and the material from which it is constructed;
- b) the orientation of the package on impact;
- c) the nature of the surface on which it falls;
- d) the ratio of overall cushion volume to internal air volume (open cell materials only);
- e) friction between the packaged article and any side cushions.

Instrumented tests on a prototype package are always advisable to check that the required level of protection has been achieved.

BS 1133-12 gives information on the various types of cushioning materials and outlines a basic cushion design procedure.

1 Scope

This British Standard describes methods for the determination of those properties of sheet or block cushioning materials particularly relevant for package design purposes; dynamic cushioning performance, creep strain and residual compression set.

The standard also includes methods for the determination of relevant properties of loose fill materials and for the measurement of fungal growth of both cushioning and loose fill materials.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1

static stress

the force exerted by the drop hammer of the test apparatus (method 1) or the test block (method 3) when at rest, divided by the original area of the test piece (method 1) or the base area of the block (method 3), expressed in kPa

2.2

peak deceleration

the maximum deceleration of the drop hammer during the impact on the test piece (method 1) or the maximum deceleration of the test block during the test drop (method 3)

2.3

corrected value of peak deceleration G_c

the value of the measured peak deceleration (G_m) after correction for any small deviation of the original thickness of the test piece from the standard reference thickness at which it was intended to test. This is obtained by multiplying the measured peak deceleration by the original thickness divided by the standard reference thickness

2.4

standard gravitational acceleration g_n

the acceleration due to the effect of the earth's gravitational pull. Although this value varies slightly from place to place, it is usually considered to be a constant with the value of 9.81 m/s^2

2.5

nominal drop height h_n

the height specified for drop testing the package under free fall conditions

NOTE In order to achieve the same impact velocity on the drop test machine (method 1) a slightly greater actual drop height h_c is required because of friction effects (see 4.1.2).

2.6

residual compression set

the percentage loss in thickness of the test piece after impact or after a selected period under static stress and a short period of recovery

2.7

creep strain

the percentage change in strain exhibited by a test piece under static stress as determined by measurements after 15 min and a selected period after loading

2.8

compression stress

the static force per unit area of the original cross section of the test piece



Section 2. Method 1. Determination of dynamic cushioning performance of sheet or block material

3 General

This method describes the procedure for determining the dynamic cushioning performance of sheet or block material by measuring the peak deceleration of a mass when it is dropped onto a test piece of the material. It is based on method 9 of BS 4443-3 which is intended primarily for quality assurance purposes for packaging applications.

4 Apparatus

4.1 Drop test machine, in accordance with 4.1.1 to 4.1.3.

4.1.1 The apparatus is a guided vertical drop tester comprising a drop hammer with a flat base, with an impacting area greater than that of the impacted test piece, and an anvil whose face is parallel to the base of the drop hammer. The mass of the drop hammer shall be adjustable in the range of static stresses required; alternatively a range of hammers can be used. The mass of the anvil and the base to which it is attached shall be at least 100 times that of the hammer to prevent undesirable vibrations which may conceal or modify the true shape of the deceleration time curve. The natural frequency of vibration of the hammer should be as high as practicable, preferably above 1 000 Hz.

It is essential that the drop hammer mechanism is such that the safety of the operator is assured when the test pieces are being placed on the anvil; some form of safety interlock is recommended.

4.1.2 Due to contact with the guides the drop hammer will lose energy during the fall, and the actual drop height (h_c) has to be greater than the theoretical drop height to ensure that at impact the velocity of the hammer is the same as would be achieved under free fall conditions from the selected nominal drop height (h_n).

The impact velocity under free fall conditions for any drop height is calculated using the following equation:

$$V = \sqrt{2 g_n h_n}$$

where

V is the impact velocity (in m/s);

g_n is the acceleration due to gravity (9.81 m/s²);

h_n is the nominal drop height (in m).

4.1.3 The instrumentation for measuring, recording and storing the deceleration on impact shall be capable of an accuracy to within $\pm 5\%$.

5 Test pieces

5.1 Number of test pieces

Three test pieces shall be tested at each of, as a minimum, five values of static stress for each combination of drop height and thickness. For the minimum test sequence 45 test pieces are required.

5.2 Dimensions of test pieces

Each test piece shall be a right parallelepiped with the following dimensions:

Length and width (to be equal):	either 150 ± 5 mm or 250 ± 5 mm;
Thickness:	within the range 25 mm to 150 mm.

NOTE For commercial purposes this test can also be used for thinner pieces.

The difference in the mean thickness between the test pieces in a set of 10 shall be not greater than 2 mm. Measure the dimensions in accordance with Appendix A.

5.3 Preparation of test pieces

Test pieces of thickness 25 mm and more can, where necessary, be obtained by plying up two sheets without the use of adhesive. Cut such sheets to identical shapes and sizes and ensure that they are of the same orientation with respect to any known direction of anisotropy.

Cut the test piece by any suitable means which does not alter the dynamic cushioning characteristics, for example a band saw or a sharp knife. Hot wire cutting shall not be used.

NOTE The presence of skin in the test piece may affect the test result. Where skin will form an integral part of the article in use, the preparation of the test piece should be a matter for agreement between the purchaser and the supplier.

The presence of skin on the test piece shall be noted in the test report.

6 Conditioning and test conditions

Materials shall not be tested less than 72 h after manufacture. Prior to testing, condition the test pieces for at least 16 h under the following standard conditions:

23 ± 2 °C, $50 \pm 5\%$ r.h.

NOTE The conditioning period may form the latter part of the 72 h following manufacture.

Carry out the test at the same conditions unless design data are required on performance under other specific conditions.