

# Plastics — Determination of multi-axial impact behaviour of rigid plastics —

## Part 1: Falling dart method

The European Standard EN ISO 6603-1:1996 has the status of a British Standard

IMPORTANT NOTE. Before reading this method it is essential to read BS 2782-0, Introduction, issued separately.

ICS 83.080.01

# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics and Rubber Standards Policy Committee (PRM/-) to Technical Committee PRM/21, upon which the following bodies were represented:

- British Plastics Federation
- British Steel Industry
- British Telecommunications plc
- British Textile Confederation
- Department of the Environment (Building Research Establishment)
- Department of Trade and Industry (National Physical Laboratory)
- EEA (The Association of Electronics, Telecommunications and Business Equipment Industries)
- Electrical and Electronic Insulation Association (BEAMA Ltd.)
- Electrical Installation Equipment Manufacturers' Association (BEAMA Ltd.)
- Ministry of Defence
- Packaging and Industrial Films Association
- Plastic Industrial Containers Association
- Plastics and Rubber Institute
- PIRA International
- RAPRA Technology Ltd.
- Yarsley Technical Centre Ltd.

The following body was also represented in the drafting of the standard, through subcommittees and panels:

Malaysian Rubber Producers' Research Association

This British Standard, having been prepared under the direction of the Plastics and Rubber Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 29 November 1991

© BSI 10-1999

First published as Methods 306B and 306B in BS 2782 November 1970  
Second edition November 1991

The following BSI references relate to the work on this standard:  
Committee reference PRM/21  
Draft for comment 83/38641 DC

ISBN 0 580 20308 5

## Amendments issued since publication

| Amd. No. | Date      | Comments                              |
|----------|-----------|---------------------------------------|
| 8640     | June 1997 | Indicated by a sideline in the margin |
|          |           |                                       |
|          |           |                                       |
|          |           |                                       |

# Contents

|                                                                                                      | Page               |
|------------------------------------------------------------------------------------------------------|--------------------|
| Committees responsible                                                                               | Inside front cover |
| National foreword                                                                                    | ii                 |
| Foreword                                                                                             | 2                  |
| 1 Scope and field of application                                                                     | 3                  |
| 2 References                                                                                         | 3                  |
| 3 Definitions                                                                                        | 3                  |
| 4 Principle                                                                                          | 4                  |
| 5 Apparatus                                                                                          | 4                  |
| 6 Test specimens                                                                                     | 4                  |
| 7 Procedure                                                                                          | 4                  |
| 8 Test report                                                                                        | 6                  |
| Annex A Examples of calculation                                                                      | 8                  |
| Annex B Alternative method                                                                           | 18                 |
| Figure 1 — Sections through specimens damaged by a “crack”                                           | 10                 |
| Figure 2 — Sections through specimens damaged by a “break”                                           | 11                 |
| Figure 3 — Example for failure in case of shattering                                                 | 11                 |
| Figure 4 — Examples for the failure criterion “indentation” for two materials of differing toughness | 12                 |
| Figure 5 — Characteristics of apparatus (example)                                                    | 13                 |
| Figure 6 — Test specimen support                                                                     | 14                 |
| Figure 7 — Example of method A (staircase) test results with constant height of fall (0,66 m)        | 15                 |
| Figure 8 — Example of method A (staircase) test results with constant mass (1 kg)                    | 16                 |
| Figure 9 — Example of plot of method B (statistical) with constant height of fall (1 m)              | 17                 |
| Table 1                                                                                              | 8                  |
| Table 2                                                                                              | 9                  |
| Publication(s) referred to                                                                           | Inside back cover  |

# National foreword

This method has been prepared under the direction of the Plastics and Rubber Standards Policy Committee and is the English language version of EN ISO 6603, *Plastics — Determination of multi-axial impact behaviour of rigid plastics — Part 1:1996 Falling dart method*, published by the European Committee for Standardization (CEN). It is identical with ISO 6603-1:1985 published by the International Organization for Standardization (ISO).

Annex B refers to ISO 6603-2. This was published in 1989 and has been implemented as BS EN ISO 6603-1:1997.

### Cross-references

| International Standard | Corresponding British Standard                                                                                                                                       |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | BS 2782 <i>Methods of testing plastics</i>                                                                                                                           |
| ISO 291:1977           | Part 0:1982 <i>Introduction</i><br>(Appendix A is identical)                                                                                                         |
| ISO 293:1986           | Method 901A:1988 <i>Compression moulding test specimens of thermoplastic materials</i><br>(Identical)                                                                |
| ISO 294:1975           | Method 910A:1977 <i>Injection moulding test specimens of thermoplastic materials</i><br>(Identical)                                                                  |
| ISO 2557-2:1986        | Method 940B:1989 <i>Preparation of test specimens of amorphous thermoplastics with a specified reversion by injection moulding rectangular plates</i><br>(Identical) |

WARNING NOTE. This British Standard, which is identical with ISO 6603-1, does not necessarily detail all the precautions necessary to meet the requirements of the Health and Safety at Work etc. Act 1974. Attention should be paid to any appropriate safety precautions and the method should be operated only by trained personnel.

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.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

### Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN ISO title page, pages 2 to 18, 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.

---

ICS 83.080

Descriptors: Plastics, rigid plastics, tests, impact tests, test equipment

English version

# Plastics — Determination of multi-axial impact behaviour of rigid plastics — Part 1: Falling dart method

(ISO 6603-1:1985)

Plastiques — Détermination du comportement  
des plastiques rigides sous un choc  
multiaxial —  
Partie 1: Essai par chute de projectile  
(ISO 6603-1:1985)

Kunststoffe — Bestimmung des mehrachsigen  
Stoßverhaltens von festen Kunststoffen —  
Teil 1: Fallbolzenversuch  
(ISO 6603-1:1985)

This European Standard was approved by CEN on 1994-12-14. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

## CEN

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

---

© 1996 Copyright reserved to CEN members

Ref. No. EN ISO 6603-1:1996 E  
 Documents  
Document Sharing Hub

## Foreword

The text of the International Standard from Technical Committee ISO/TC 61, Plastics, of the International Organization for Standardization (ISO) has been taken over as a European Standard by Technical Committee CEN/TC 249 "Plastics", the secretariat of which is held by IBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 1997, and conflicting national standards shall be withdrawn at the latest by June 1997.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

## 1 Scope and field of application

This International Standard specifies a method for the determination of impact properties of rigid plastic materials in the form of disks or square pieces of standard dimensions, moulded directly or cut from sheets (see note 1).

This falling dart method is used for the assessment of plastic sheeting or mouldings under an impact stress applied at right angles to the plane of the sheet (see note 2). Part 1 of this International Standard can be used if it is sufficient to characterize the impact behaviour of plastics by an impact-failure energy. If recording of the force-deformation curve is necessary, Part 2 shall be used (see Annex B).

Two methods of test are described.

The preferred method is method A, the staircase method. In this technique, a uniform energy increment is employed during testing and the energy is decreased or increased by the uniform increment after testing each test specimen, depending upon the result (fail or not fail) observed for the preceding test specimen.

Method B is the statistical method. In this technique, successive groups of at least ten test specimens each are tested. Impact failure energy is calculated by statistical methods (see note 3).

This method shall be used where both brittle and ductile failures occur within a homogeneous group of test specimens.

**NOTE 1** The test results obtained by testing specimens prepared separately from moulding materials cannot be simply related to mouldings of other shapes because the results of these tests depend on the shape of the moulding and the conditions of their production.

**NOTE 2** This International Standard is not suitable for thin films.

**NOTE 3** The variable energy can be realized either by choosing a variable falling mass at constant height or by choosing a variable falling height at constant falling mass. The variable height procedure is velocity dependent and differing results may be observed depending upon the material's strain rate. Therefore, the constant falling height method is preferred.

## 2 References

ISO 291, *Standard atmospheres for conditioning and testing*.

ISO 293, *Plastics — Recommended practice for compression moulding test specimens of thermoplastic materials*.

ISO 294, *Plastics — Recommended practice for injection moulding test specimens of thermoplastic materials*.

ISO 2557-2, *Plastics — Amorphous thermoplastic moulding materials — Preparation of test specimens with a defined level of shrinkage — Part 2: Test specimens in the form of rectangular plates (Injection moulding)*.

## 3 Definitions

For the purpose of this International Standard, the following definitions apply:

### 3.1 Failure-criteria terms

The following definitions of failure-criteria terms describe definite alterations of the test specimens caused by the falling mass. The criterion of failure shall be that specified in the International Standard for the material or shall be agreed upon by the interested parties.

#### 3.1.1 crack

any fissure that can be observed by the unaided eye and that does not penetrate the full thickness of the material (see Figure 1)

#### 3.1.2 break

any fissure through the full thickness of the material (see Figure 2)

#### 3.1.3 penetration

failure in which the indenter wholly penetrates the test specimen (see Figure 3)

#### 3.1.4 shattering

breaking of the test specimen into two or more parts (see Figure 3)

#### 3.1.5 indentation

an irreversible deformation without cracking. The amount of indentation is measured by the depth of the dent ( $d_t$ ) (see Figure 4). The value of  $d_t$  that constitutes the pass-fail criterion shall be agreed by the interested parties

**NOTE** If other criteria of failure (crazing, stress whitening, etc.) are of importance, these criteria must be defined and included in the test report.

### 3.2 Impact-failure terms

#### 3.2.1

#### 50 % impact-failure energy, $E_{50}$

the energy that will cause 50 % of the test specimens to fail according to one of the criteria in 3.1

**3.2.2****50 % impact-failure mass,  $M_{50}$** 

the mass that will cause 50 % of the test specimens to fail, according to one of the criteria in **3.1**, at a given falling height

**3.2.3****50 % impact-failure height,  $H_{50}$** 

the height that will cause 50 % of the test specimens to fail, according to one of the criteria in **3.1**, using a given falling mass

**4 Principle**

The impact strength of suitably sized test specimens is determined by striking them with a weight dropped vertically from a known height.

Two methods of adjusting the energy at impact are permitted: altering the mass at constant height (preferred) and altering the height at constant mass.

Two methods of test are also given: staircase (preferred) and statistical.

**5 Apparatus**

The apparatus shall be constructed (for example, Figure 5) using the following components:

**5.1 Test specimen support**

A hollow steel cylinder of internal diameter  $40 \pm 2$  mm with a minimum height of 12 mm (see Figure 6). The support shall be placed on a solid base and shall be designed such that air cannot be trapped under the test specimen, thus avoiding a possible spring effect.

**5.2 Clamping device (optional)**

A two-piece annular specimen clamp having an inside diameter of  $40 \pm 2$  mm is recommended. Pneumatically operated clamps have been successfully employed. If a clamping device is used, ensure that no slippage occurs.

NOTE The results for clamped and unclamped specimens are likely to be different.

**5.3 Falling dart system**

Device capable of holding and releasing a weighted striker, such that the striker may fall contained by guide(s). The fall shall be substantially without friction or losses through windage, or the amount of friction has to be taken into account in the calculations.

**5.4 Weighted striker**

The preferred striker shall have a polished hardened hemispherical striking surface of diameter  $20 \pm 0,2$  mm. Alternatively, a  $10 \pm 0,1$  mm diameter striking surface may be used. The strikers shall be constructed of steel.

**5.5 Weights (masses)**

Appropriate weights that can be firmly attached to the striker. The combined mass of the weights to be attached and the mass of the striker shall be known to within 1 %.

**5.6 Appropriate device for catching the dart after drop**

To prevent multiple impact and damage of the striker.

**6 Test specimens****6.1 Preparation and sampling of test specimens**

The test specimens shall be prepared and sampled in accordance with the instructions in the relevant International Standards (see clause 2), or in accordance with the specifications for the material to be tested, or as agreed by the interested parties.

**6.2 Standard test specimens**

The standard test specimen shall be  $60 \pm 2$  mm in diameter or  $60 \pm 2$  mm square. For moulding and extrusion materials, the test specimen shall preferably be  $2 \pm 0,1$  mm thick, prepared from sheet moulded under the conditions described in ISO 293, ISO 294, or ISO 2557-2. For sheet, the thickness shall be that of the sheet under test, but not less than 1 mm or more than 4 mm.

If the thickness of any test specimen differs from the average thickness of the test specimens in that sample by more than 5 %, it shall be discarded.

**6.3 Number of test specimens**

Method A (staircase method): At least 30 test specimens shall be used (10 for the pretest to determine the starting energy).

Method B (statistical method): At least 40 test specimens shall be used (10 for pretest and 30 for the main test).

Each test specimen shall be struck only once.

**6.4 Conditioning of test specimens**

The test specimens shall be conditioned as required by the specification for the material or as agreed by the interested parties. Otherwise, select the most appropriate condition from ISO 291.

**7 Procedure****7.1 Test atmosphere**

Carry out the test in one of the standard atmospheres specified in ISO 291.