

# इंटरनेट

# मानक

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IS 13360-6-17 (1997): Plastics - Methods of Testing, Part 6: Thermal Properties, Section 17: Determination of Temperature of Deflection Under Load - Plastics and Ebonite [PCD 12: Plastics]



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“Knowledge is such a treasure which cannot be stolen”



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IS 13360 (Part 6/Sec 17) : 2013

ISO 75-2 : 2004

भारतीय मानक  
प्लास्टिक — परीक्षण पद्धतियाँ

भाग 6 तापीय गुणधर्म

अनुभाग 17 भार के तहत विक्षेय का तापमान ज्ञात करना —

प्लास्टिक एवं इबोनाइट

( पहला पुनरीक्षण )

*Indian Standard*

PLASTICS — METHODS OF TESTING

PART 6 THERMAL PROPERTIES

Section 17 Determination of Temperature of Deflection Under Load —  
Plastics and Ebonite

( *First Revision* )

ICS 83.080.10

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**BUREAU OF INDIAN STANDARDS**

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NEW DELHI 110002

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## NATIONAL FOREWORD

This Indian Standard (Part 6/ Sec 17) (First Revision) which is identical with ISO 75-2 : 2004 'Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Plastics Sectional Committee and approval of the Petroleum, Coal and Related Products Division Council.

This standard was originally published in 1997 which was identical with ISO 75-2 : 1993. The first revision of this standard has been undertaken to harmonized it with the latest version of ISO 75-2 : 2004.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 75-1 : 2004 Plastics — Determination of temperature of deflection under load — Part 1: General test method	IS 13360 (Part 6/Sec 3) : 2013 Plastics — Methods of testing: Part 6 Thermal properties, Section 3 Determination of temperature of deflection under load — General test method ( <i>first revision</i> )	Identical
ISO 293 : 1986 Plastics — Compression moulding test specimens of thermoplastic materials	IS 13360 (Part 2/Sec 1) : 1992 Plastics — Methods of testing: Part 2 Sampling and preparation of test specimens, Section 1 Compression moulding test specimens of thermoplastic materials	Identical
ISO 2818 : 1994 Plastics— Preparation of test specimens by machining	IS 13360 (Part 2/Sec 4) : 1999 Plastics — Methods of testing: Part 2 Sampling and preparation of test specimens, Section 4 Preparation of test specimens by machining	Identical
ISO 3167 : 2002 Plastics — Multipurpose test specimens	IS 13360 ( Part 2/Sec 5) : 2012 Plastics — Methods of testing : Part 2 Sampling and preparation of test specimens, Section 5 Multipurpose test specimens ( <i>first revision</i> )	Identical

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## Introduction

ISO 75-1:1993 and ISO 75-2:1993 described three methods (A, B and C) using different test loads and two specimen positions, edgewise and flatwise. For testing in the flatwise position, test specimens with dimensions 80 mm × 10 mm × 4 mm were required. These can be moulded directly or machined from the central section of the multipurpose test specimen (see ISO 3167). These “ISO bars” cannot be easily used in the edgewise position, because this would require both a reduction in span and an increase in test load by the same factor, and this may be impossible to achieve on existing instruments for edgewise testing. Specimens for testing in the edgewise position are less closely specified. Using the 80 mm × 10 mm × 4 mm ISO bar has the following advantages:

- Thermal expansion of the test specimen has less influence on the test result.
- Draft angles do not influence the test result. The specimen does not stand “on edge”.
- The moulding parameters and the specimen dimensions are specified more closely.

This increases the comparability of the test results. Therefore, it was decided that the possibility of testing in the edgewise position would be deleted from the standard. In order to provide a sufficient transition period, in this edition the flatwise position is described as the preferred and recommended one, while testing in the edgewise position is optional and has been moved to a normative annex (in this part of ISO 75). This annex and all other references to edgewise testing will be deleted on occasion of the next revision of this document.

Earlier editions of this International Standard allowed methods other than using a heating bath for heating the test specimen, namely forced-circulation ovens or fluidized beds. None of these alternative methods is widely used and no proven instruments are commercially available. Furthermore, there is no general comparability between tests using different heating methods due to the differences in the heat transfer characteristics and the temperature control methods described in this standard.

Therefore only heating in heating baths is allowed in this edition.

In order to maintain consistency with ISO 10350-1:1998,  $T_f$  has been used as the symbol for temperature of deflection under load.



*Indian Standard*  
**PLASTICS — METHODS OF TESTING**

**PART 6 THERMAL PROPERTIES**

**Section 17 Determination of Temperature of Deflection Under Load —  
Plastics and Ebonite**

*( First Revision )*

## **1 Scope**

This part of ISO 75 specifies three methods, using different values of constant flexural stress, that can be used for the determination of the temperature of deflection under load of plastics (including filled plastics and fibre-reinforced plastics in which the fibre length, prior to processing, is up to 7,5 mm) and ebonite:

- method A, using a flexural stress of 1,80 MPa;
- method B, using a flexural stress of 0,45 MPa;
- method C, using a flexural stress of 8,00 MPa.

The standard deflection  $\Delta_s$  used to determine the temperature of deflection under load corresponds to a flexural-strain increase  $\Delta\epsilon_f$  defined in this part of ISO 75. The initial flexural strain due to the loading of the specimen at room temperature is neither specified nor measured in this part of ISO 75. The ratio of this flexural-strain difference to the initial flexural strain depends on the modulus of elasticity, at room temperature, of the material under test. This method is therefore only suitable for comparing the temperatures of deflection of materials with similar room-temperature elastic properties.

**NOTE** The methods give better reproducibility with amorphous plastics than with semi-crystalline ones. With some materials, it may be necessary to anneal the test specimens to obtain reliable results. Annealing procedures, if used, generally result in an increase in the temperature of deflection under load (see 6.6).

For additional information, see ISO 75-1:2004, clause 1.

## **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 75-1:2004, *Plastics — Determination of temperature of deflection under load — Part 1: General test method*

ISO 293, *Plastics — Compression moulding test specimens of thermoplastic materials*

ISO 294-1, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

ISO 2818, *Plastics — Preparation of test specimens by machining*



ISO 3167, *Plastics — Multipurpose test specimens*

ISO 10724-1, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 75-1 apply.

NOTE Depending on the selected value of the flexural stress (see clause 1), the temperature of deflection under load (see definition 3.7 in ISO 75-1:2004) is designated as  $T_{fx} 0,45$ ,  $T_{fx} 1,8$  or  $T_{fx} 8,0$  (where  $x = f$  for flatwise testing and  $x = e$  for edgewise testing).

### 4 Principle

See ISO 75-1:2004, clause 4.

### 5 Apparatus

#### 5.1 Means of producing a flexural stress

See ISO 75-1:2004, subclause 5.1.

The span (distance between the lines of contact between specimen and supports) shall be  $(64 \pm 1)$  mm for testing in the preferred (flatwise) position. See annex A for testing in the edgewise position.

#### 5.2 Heating equipment

See ISO 75-1:2004, subclause 5.2.

#### 5.3 Weights

See ISO 75-1:2004, subclause 5.3.

#### 5.4 Temperature-measuring instrument

See ISO 75-1:2004, subclause 5.4.

#### 5.5 Deflection-measuring instrument

See ISO 75-1:2004, subclause 5.5.

### 6 Test specimens

#### 6.1 General

See ISO 75-1:2004, subclause 6.1.

## 6.2 Shape and dimensions

See ISO 75-1:2004, subclause 6.2.

The preferred test-specimen dimensions are:

- length  $l$ : (80 ± 2,0) mm;
- width  $b$ : (10 ± 0,2) mm;
- thickness  $h$ : (4 ± 0,2) mm.

See annex A for dimensions of test specimens for edgewise testing.

## 6.3 Specimen inspection

See ISO 75-1:2004, subclause 6.3.

## 6.4 Number of test specimens

See ISO 75-1:2004, subclause 6.4.

## 6.5 Test-specimen preparation

Test specimens shall be produced in accordance with ISO 293 (and ISO 2818, if applicable), or in accordance with ISO 294-1 or ISO 10724-1, or as agreed by the interested parties. The test results obtained on moulded test specimens depend on the moulding conditions used in their preparation. The moulding conditions shall be in accordance with the standard for the material concerned, or as agreed by the interested parties.

In the case of compression-moulded specimens, the thickness shall be in the direction of the moulding force. For materials in sheet form, the thickness of the test specimens (this dimension is usually the thickness of the sheet) shall be in the range 3 mm to 13 mm, preferably between 4 mm and 6 mm.

The specimen can be taken from the narrow central part of the multipurpose test specimen specified in ISO 3167.

## 6.6 Annealing

Discrepancies in test results due to variations in moulding conditions can be minimized by annealing the test specimens before testing them. Since different materials require different annealing conditions, annealing procedures shall be employed only if required by the materials standard or if agreed upon by the interested parties.

## 7 Conditioning

See ISO 75-1:2004, clause 7.

## 8 Procedure (flatwise testing)

### 8.1 Calculation of force to be applied

See ISO 75-1:2004, subclause 8.1.

The flexural stress produced shall be one of the following:

- 1,80 MPa (preferred value), in which case the method is designated method A;

0,45 MPa, in which case the method is designated method B;

8,00 MPa, in which case the method is designated method C.

## 8.2 Initial temperature of the heating equipment

See ISO 75-1:2004, subclause 8.2.

## 8.3 Measurement

See ISO 75-1:2004, subclause 8.3.

Apply the force required to produce one of the flexural stresses specified in 8.1 of this part of ISO 75.

Calculate the standard deflection  $\Delta_s$  by means of equation (5) in ISO 75-1:2004, using a value of 0,2 % for the flexural-strain increase  $\Delta\epsilon_f$ .

Record the temperature at which the initial deflection of the bar has increased by the standard deflection. This temperature is the temperature of deflection under load. If the individual results for amorphous plastics or ebonite differ by more than 2 °C, or those for semi-crystalline materials by more than 5 °C, repeat tests shall be carried out.

NOTE 1 Table 1 gives examples of standard deflections for the preferred dimensions of test specimens tested in the flatwise position. See annex A for testing in the edgewise position.

**Table 1 — Standard deflections for different test-specimen heights for a 80 mm × 10 mm × 4 mm specimen tested in the flatwise position**

Test-specimen height (thickness $h$ of specimen) mm	Standard deflection mm
3,8	0,36
3,9	0,35
4,0	0,34
4,1	0,33
4,2	0,32

NOTE 2 The thicknesses in Table 1 reflect the acceptable variation in the test-specimen dimensions (see 6.2).

## 9 Expression of results

See ISO 75-1:2004, clause 9.

## 10 Precision

See Annex B.

## 11 Test report

See ISO 75-1:2004, clause 11.

The test report shall also include the following additional information:

l) the value of the standard deflection used.

In item i) of the test report, indicate the flexural stress used by means of the following designation system:

- for flatwise testing:  $T_{ff}$  0,45 for method B,  $T_{ff}$  1,8 for method A or  $T_{ff}$  8,0 for method C;
- for edgewise testing:  $T_{fe}$  0,45 for method B,  $T_{fe}$  1,8 for method A or  $T_{fe}$  8,0 for method C.

## **Annex A** (normative)

### **Testing in the edgewise position**

#### **A.1 General**

Carrying out the test in the flatwise position with the smaller (80 mm × 10 mm × 4 mm) specimen is preferred to testing in the edgewise position because it gives a number of advantages which increase the comparability of the test results (see the Introduction).

#### **A.2 Span between supports**

The span  $L$  shall be  $(100 \pm 1)$  mm.

#### **A.3 Dimensions of test specimens**

The dimensions of the test specimens shall be:

- length  $l$ :  $(120 \pm 10)$  mm;
- width  $b$ : 9,8 mm to 15 mm;
- thickness  $h$ : 3,0 mm to 4,2 mm.

#### **A.4 Calculation of force to be applied**

See ISO 75-1:2004, subclause 8.1, equation (2).

The flexural stress produced shall be one of the following:

- 1,80 MPa (preferred value), in which case the method is designated method A;
- 0,45 MPa, in which case the method is designated method B;
- 8,00 MPa, in which case the method is designated method C.

#### **A.5 Initial temperature of the heating equipment**

See ISO 75-1:2004, subclause 8.2.

#### **A.6 Measurement**

See ISO 75-1:2004, subclause 8.3.

Apply the force required to produce one of the flexural stresses specified in clause A.4.

Calculate the standard deflection  $\Delta_s$  by means of equation (6) in ISO 75-1:2004, using a value of 0,2 % for the flexural-strain increase  $\Delta\epsilon_f$ . Examples of standard deflections are given in Table A.1.

Note the temperature at which the initial deflection of the bar has increased by the standard deflection given in Table A.1. This temperature is the temperature of deflection under load. If the individual results for amorphous plastics or ebonite differ by more than 2 °C, or those for semi-crystalline materials by more than 5 °C, repeat tests shall be carried out.

**Table A.1 — Standard deflection for different test-specimen heights for a 120 mm × (3,0 to 4,2) mm × (9,8 to 15,0) mm specimen tested in the edgewise position**

Test-specimen height (width <i>b</i> of specimen) mm	Standard deflection mm
9,8 to 9,9	0,33
10,0 to 10,3	0,32
10,4 to 10,6	0,31
10,7 to 10,9	0,30
11,0 to 11,4	0,29
11,5 to 11,9	0,28
12,0 to 12,3	0,27
12,4 to 12,7	0,26
12,8 to 13,2	0,25
13,3 to 13,7	0,24
13,8 to 14,1	0,23
14,2 to 14,6	0,22
14,7 to 15,0	0,21

## A.7 Expression of results

See ISO 75-1:2004, clause 9.

## **Annex B** **(informative)**

### **Precision**

#### **B.1 General**

A round robin involving eight materials and ten laboratories was conducted in 1996 in accordance with ASTM E 691 to determine the precision of the method specified in this part of ISO 75.

#### **B.2 Test materials**

<b>Designation No. of material</b>	<b>Type of material</b>
1	PP 1
2	PP 2
3	ABS
4	POM 1
5	PBT
6	PET
7	POM 2
8	Composite

#### **B.3 Summary of results**

Eight materials were tested by ten laboratories. All test specimens were injection moulded by one laboratory. Each material was tested twice. PP 1 and PP 2 were tested at 0,45 MPa stress loading and the rest at 1,8 MPa stress loading, with the specimen in the flatwise position.

Not every laboratory tested every material. Only four laboratories tested material 8 and the data was therefore not included in the statistical calculation. Data from Lab 7 was significantly lower than data from the others and Lab 10 tested materials only once. Data from these two laboratories were therefore also excluded from the calculation.

Due to the limitations of the ASTM E 691 software, three separate precision statements were established. The results were combined and reported as one as shown in Table B.1.

Table B.1 — Precision data

Material	Number of labs	Loading  MPa	Average result  °C	$s_r$  °C	$s_R$  °C	$r$  °C	$R$  °C
PP 1	7	0,45	81,9	0,9	2,4	2,5	6,9
PP 2	7	0,45	115,2	1,0	3,4	2,9	9,7
ABS	8	1,8	79,3	0,3	0,7	0,9	2,0
POM 1	8	1,8	91,1	0,8	2,1	2,1	5,8
PBT	8	1,8	49,7	0,4	0,4	1,0	1,0
PET	8	1,8	65,4	0,1	1,0	0,4	2,8
POM 2	6	1,8	160,5	0,9	1,0	2,5	2,7

$s_r$  is the within-laboratory standard deviation of the average.

$s_R$  is the between-laboratories standard deviation of the average.

$r$  is the repeatability limit ( $= 2,83 \times s_r$ ).

$R$  is the reproducibility limit ( $= 2,83 \times s_R$ ).

## B.4 Precision statement

The data in Table B.1 should not be rigorously applied to acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, conditions, materials or laboratories. Users of this test method should apply the principles of ASTM E 691 to generate data specific to their laboratory and materials, or between specific laboratories. The following principles would then be valid for such data.

*Concept of repeatability  $r$  and reproducibility  $R$ .* If  $s_r$  and  $s_R$  have been calculated from a large enough body of data, then test results can be judged as follows:

- *Repeatability  $r$ :* Two test results should be judged not equivalent if they differ by more than the  $r$  value for the material.
- *Reproducibility  $R$ :* Two test results should be judged not equivalent if they differ by more than the  $R$  value for the material.

Any judgment made in accordance with  $r$  and  $R$  would have an approximately 95 % probability of being correct.



## Bibliography

- [1] ISO 10350-1:1998, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*
- [2] ASTM E 691 *Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method*

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The technical committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

<i>International Standard</i>	<i>Title</i>
ISO 294-1	Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens
ISO 10724-1	Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens

For tropical countries like India, the standard temperature and the relative humidity shall be taken as  $27 \pm 2^{\circ}\text{C}$  and  $65 \pm 5$  percent, respectively.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

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### Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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#### Amendments Issued Since Publication

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