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## **Plastics—Determination of flexural properties**

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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 Plastics Industry Federation (JPIF)/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 K 7171**:1994 is replaced with this Standard.

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# Plastics—Determination of flexural properties

## Introduction

This Japanese Industrial Standard has been prepared based on the fourth edition of **ISO 178** published in 2001 and Amendment 1 published in 2004 without modifying the technical contents. However, the amendment has been compiled in this Standard.

The major points of the recent revision of this Standard are as follows:

- a method of correcting for curvature at the beginning of the stress/strain curve is given (see **9.2**);
- a method of correcting for the compliance of the test machine is given (see Annex A);
- a precision statement is given (see Annex B).

Annex A forms a normative part of this Standard.

The portions given dotted underlines are the matters not stated in the original International Standard.

## 1 Scope

**1.1** This Standard specifies a method for determining the flexural properties of rigid and semi-rigid plastics by three point loading test (it applies to a freely supported beam, loaded at midspan) and specifies the specimens to be tested.

**1.2** The method is used to investigate the flexural behaviour<sup>[1]</sup> of the test specimens and for determining the flexural strength, flexural modulus and other aspects of the flexural stress/strain relationship under the conditions defined.

**1.3** The method is suitable for use with the following range of materials:

- thermoplastics moulding and extrusion materials, including filled and reinforced compounds in addition to unfilled types; rigid thermoplastics sheets;
- thermosetting moulding materials, including filled and reinforced compounds; thermosetting sheets.

In agreement with **JIS K 7140-1** and **JIS K 7140-2**, this Standard applies to fibre-reinforced compounds with fibre lengths  $\leq 7.5$  mm prior to processing. For long-fibre-reinforced materials (laminates) with fibre lengths  $> 7.5$  mm, see bibliography [2].

The method is not normally suitable for use with rigid cellular materials and sandwich structures containing cellular material<sup>[3, 4]</sup>.

**NOTE :** For certain types of textile-fibre-reinforced plastics, a four-point bending test is preferred. It is described in bibliography [2].

**1.4** The method is performed using specimens which may be moulded to the specified dimensions, machined from the central portion of a standard multipurpose test

specimen (see **JIS K 7139**) or machined from finished or semi-finished products such as mouldings, or extruded or cast sheet.

**1.5** The method specifies preferred dimensions for the test specimen. Tests which are carried out on specimens of different dimensions, or on specimens which are prepared under different conditions, may produce results which are not comparable. Other factors, such as the test speed and the conditioning of the specimens, can also influence the results. Especially for semi-crystalline polymers, the thickness of the oriented skin layer, which is dependent on moulding conditions and thickness, affects the flexural properties. Consequently, when comparable data are required, these factors must be carefully controlled and recorded.

**1.6** Flexural properties can only be used for engineering design purposes for materials with linear stress/strain behaviour. For non-linear behaviour, the flexural properties are only nominal. The bending test should preferentially be used with brittle materials, for which tensile tests are difficult.

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

ISO 178:2001 *Plastics—Determination of flexural properties* (IDT) and Amendment 1 (2004)

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**.

## 2 Normative references

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

JIS K 6272 *Rubber—Tensile, flexural and compression test equipment (constant rate of traverse)—Specification*

NOTE : Corresponding International Standard: ISO 5893:2002 *Rubber and plastics test equipment—Tensile, flexural and compression types (constant rate of traverse)—Specification* (MOD)

JIS K 7100 *Plastics—Standard atmospheres for conditioning and testing*

NOTE : Corresponding International Standard: ISO 291:1997 *Plastics—Standard atmospheres for conditioning and testing* (MOD)

JIS K 7139 *Plastics—Multipurpose test specimens*

NOTE : Corresponding International Standard: ISO 3167:2002 *Plastics—Multipurpose test specimens* (IDT)

JIS K 7140-1 *Plastics—Acquisition and presentation of comparable single-point data—Part 1: Moulding materials*

NOTE : Corresponding International Standard: ISO 10350-1:1998 *Plastics—Acquisition and presentation of comparable single-point data—Part 1: Moulding materials* (IDT)

JIS K 7140-2 *Plastics—Acquisition and presentation of comparable single-point data—Part 2: Long-fibre-reinforced plastics*

NOTE : Corresponding International Standard: ISO 10350-2:2001 *Plastics—Acquisition and presentation of comparable single-point data—Part 2: Long-fibre-reinforced plastics* (IDT)

JIS K 7144 *Plastics—Preparation of test specimens by machining*

NOTE : Corresponding International Standard: ISO 2818:1994 *Plastics—Preparation of test specimens by machining* (IDT)

JIS K 7151 *Plastics—Compression moulding test specimens of thermoplastic materials*

NOTE : Corresponding International Standard: ISO 293:1986 *Plastics—Compression moulding of test specimens of thermoplastic materials* (IDT)

JIS K 7152-1 *Plastics—Injection moulding of test specimens of thermoplastic materials—Part 1: General principles, and moulding of multipurpose and bar test specimens*

NOTE : Corresponding International Standard: ISO 294-1:1996 *Plastics—Injection moulding of test specimens of thermoplastic materials—Part 1: General principles, and moulding of multipurpose and bar test specimens* (IDT)

JIS K 7154-1 *Plastics—Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs)—Part 1: General principles and moulding of multipurpose test specimens*

NOTE : Corresponding International Standard: ISO 10724-1:1998 *Plastics—Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs)—Part 1: General principles and moulding of multipurpose test specimens* (IDT)

ISO 295 *Plastics—Compression moulding of test specimens of thermosetting materials*

ISO 2602 *Statistical interpretation of test results—Estimation of the mean—Confidence interval*

### 3 Terms and definitions

For the purposes of this Standard, the following terms and definitions apply.

#### 3.1 test speed $\nu$

rate of relative movement between the supports and the loading edge

NOTE : It is expressed in millimetres per minute (mm/min).

#### 3.2 flexural stress $\sigma_f$

nominal stress of the outer surface of the test specimen at midspan

NOTE 1 It is expressed in megapascals (MPa).

NOTE 2 It is calculated from the relationship given in 9.1, equation (5).

**3.3 flexural stress at break  $\sigma_{\text{FB}}$** 

flexural stress at break of the test specimen (see figure 1, curves a and b)

NOTE : It is expressed in megapascals (MPa).

**3.4 flexural strength  $\sigma_{\text{FM}}$** 

maximum flexural stress sustained by the test specimen during a bending test (see figure 1, curves a and b)

NOTE : It is expressed in megapascals (MPa).

**3.5 flexural stress at conventional deflection  $\sigma_{\text{FC}}$** 

flexural stress at the conventional deflection  $s_{\text{C}}$  defined in 3.7 (see figure 1, curve c)

NOTE : It is expressed in megapascals (MPa).

**3.6 deflection  $s$** 

distance over which the top or bottom surface of the test specimen at midspan deviates from its original position during flexure

NOTE : It is expressed in millimetres (mm).

**3.7 conventional deflection  $s_{\text{C}}$** 

deflection equal to 1.5 times the thickness  $h$  of the test specimen

NOTE 1 It is expressed in millimetres (mm).

NOTE 2 Using a span  $L$  of  $16h$ , the conventional deflection corresponds to a flexural strain (see 3.8) of 3.5 %.