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(FGMAJ/JSA)

**Glass in building — Determination of the
bending strength of glass — Part 3: Test
with specimen supported at two points
(four-point bending)**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Flat Glass Manufacturers Association of Japan (FGMAJ)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act.

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Glass in building — Determination of the bending strength of glass — Part 3 : Test with specimen supported at two points (four-point bending)

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 1288-3 : 2016**, Edition 1, with some modifications of the technical contents to bring them into alignment with conditions of the Japanese market.

Annex JA and Annex JB are unique to **JIS** and not given in the corresponding International Standard. The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JC.

1 Scope

This Standard specifies a method for determining the bending strength, including the effects of the edges, of flat soda lime glass mainly for use in building. This Standard applies to flat glass with a nominal thickness¹⁾ of 3 mm to 19 mm, and does not apply to perforated glass or glass consisting of two or more panes (laminated glass and double glazing glass).

Note ¹⁾ A nominal designation of glass thickness, which is a value of thickness in millimetres expressed either to a whole number or to one decimal place.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 1288-3 : 2016 *Glass in building — Determination of the bending strength of glass — Part 3 : Test with specimen supported at two points (four point bending)* (MOD)

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 21-1**.

2 Normative references

Part or all of the provisions of the following standards, 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 B 7502 *Micrometers*

JIS B 7507 *Vernier, dial and digital callipers*

JIS B 7512 *Steel tape measures*

JIS B 7516 *Metal rules*

JIS K 6253-2 *Rubber, vulcanized or thermoplastic — Determination of hardness — Part 2 : IRHD method (hardness between 10 IRHD and 100 IRHD)*

NOTE 1 Normative reference in the corresponding International Standard : ISO 48 : 2010 *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

NOTE 2 ISO 48 above was withdrawn in 2018 and replaced with ISO 48-2 without any changes in technical contents.

JIS Z 8401 *Rounding of numbers*

3 Terms and definitions

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

3.1

bending stress

tensile bending stress induced in the surface of a specimen by a bending test

3.2

bending strength

bending stress at breakage of the specimen in a bending test

Note 1 to entry The method described in this Standard can be used to measure the bending strength of glass including its edges and also the bending strength of glass edges only (see 8.2 and 8.3).

3.3

equivalent thickness

arithmetic mean of the variation of thickness within a sheet of patterned glass, wired glass or other type of glass (arithmetic mean of the thickness of the convex part and the thickness of the concave part), or the thickness of the convex part if the thickness of the concave part is not measurable

Note 1 to entry The thicknesses of the convex and concave portions of patterned glass are shown in Figure 1.

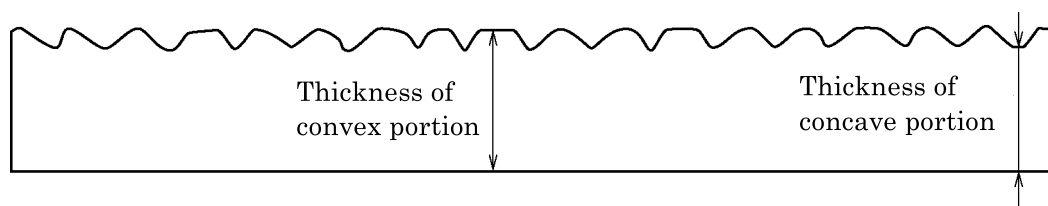


Figure 1 Thicknesses of convex and concave portions in a sheet of patterned glass

3.4

equivalent bending strength

apparent bending strength obtained by taking the equivalent thickness as the thickness of the flat glass

Note 1 to entry For flat glass products with irregularities in thickness which do not allow precise calculation of the bending stress, the equivalent bending strength is applied instead of the bending strength.

Note 2 to entry The equivalent bending strength is applicable to patterned glass, wired glass or other types of glass having irregularities in the thickness.

3.5

prestressed glass

any glass plate product given a surface prestress to enhance its strength

Note 1 to entry This includes, for example, tempered glass, heat-strengthened glass, tempered fire resistance glass, chemically strengthened glass, etc.

3.6

edges

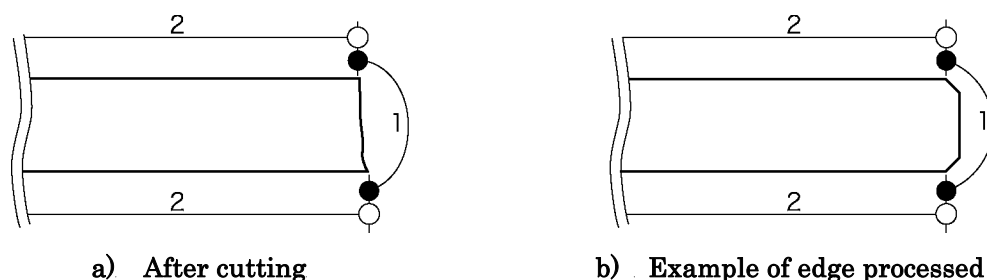
faces of the edges of the specimen including the cutting lines at the edge of the specimen and lines generated on the opposite side of the thickness direction, or the faces of the processed edges of the specimen

3.7

surface

surface of glass excluding the edges

Note 1 to entry Examples of edge and surface of flat glass are shown in Figure 2.



Key
1 : edge
2 : surface
● : including ridges on the surface side
○ : not including ridges on the surface side

NOTE The drawing a) shows the edge and surface of the glass when the glass edge after cutting is viewed from the cross-sectional direction, and the drawing b) shows an example of edge and surface of the glass when the edge shown in the drawing a) is processed.

Figure 2 Edge and surface of flat glass

3.8

soda lime silica glass

glass composed mainly of silicon dioxide, sodium oxide, calcium oxide and magnesium oxide

Note 1 to entry This includes float glass and polished plate glass (see **JIS R 3202**), patterned glass (see **JIS R 3203**), wired glass (see **JIS R 3204**), tempered glass (see **JIS R 3206**), heat absorbing glass (see **JIS R 3208**), silvered, flat-glass mirror (see **JIS R 3220**), optical coated glass (see **JIS R 3221**), heat-strengthened glass (see **JIS R 3222**) and tempered fire resistance glass (see **JIS R 3223**).

4 Symbols and units

The symbols and units for quantities are given in Table 1.

Table 1 Symbols and units

Symbol	Quantity	Unit
B	specimen width	m
E	Young's modulus of the specimen	Pa
F	test force (force exerted on the specimen)	N
$F_{\max}$	maximum force	N
g	acceleration due to gravity	m/s ²
h	specimen thickness (measured value)	m
h_{eq}	equivalent thickness of the specimen	m
k	dimensionless factor	—
k_s	dimensionless factor related to the bending strength of the surface area including edges	—
k_e	dimensionless factor related to the bending strength of the edges	—
L	specimen length	m
L_s	distance between the centre lines of the supporting rollers	m
L_b	distance between the centre lines of the bending rollers	m
y	central deflection of the specimen relative to the supporting rollers	m
σ_{bB}	bending strength	Pa
σ_{beqB}	equivalent bending strength	Pa
σ_{bG}	bending stress imposed by the self-weight of the specimen	Pa
ρ	density of the specimen	kg/m ³

5 Apparatus and instruments

5.1 Test apparatus

The test apparatus shall consist of a stressing device, a force measuring device, rollers, supporting jigs, a loading jig, rubber strips, and an adhesive film meeting the fol-

lowing (see Figure 3).

5.1.1. Stressing device, capable of stressing the specimen from zero force up to specimen failure in a manner which minimizes shock and is stepless, and capable of setting the displacement speed of the bending rollers to enable the specified rate of stressing (hereafter referred to as the bending stress rate).

5.1.2. Force measuring device, with a limit of error of $\pm 2.0\%$, calibrated according to the following (see Clause 8 of ISO 1288-1).

- a) The test operator shall calibrate the force measuring device within three months before a test.
- b) For the purposes of calibration, the glass specimen can be replaced by a metal (e.g. steel) plate of appropriate thickness.
- c) To perform the calibration of the force measuring device, an officially calibrated force gauge with independent instrument reading, accuracy $\pm 1\%$, should be placed in series with the force measuring device of the testing machine. Officially calibrated gauges shall be recalibrated every three years by an official calibration laboratory using a traceable method.
- d) The test force shall be increased in at least five approximately equidistant steps covering the ranges of measurement.
- e) At every step, the readings from the force measuring device and that from the officially calibrated gauge shall be recorded.
- f) Both readings, i.e. the reading from the force measuring device and that from the officially calibrated gauge, shall coincide within $\pm 1\%$ over the whole measuring range.
- g) If the differences between the two readings exceed $\pm 1\%$, the force measuring device shall be adjusted accordingly.

5.1.3 Rollers The supporting rollers and bending rollers shall meet the following.

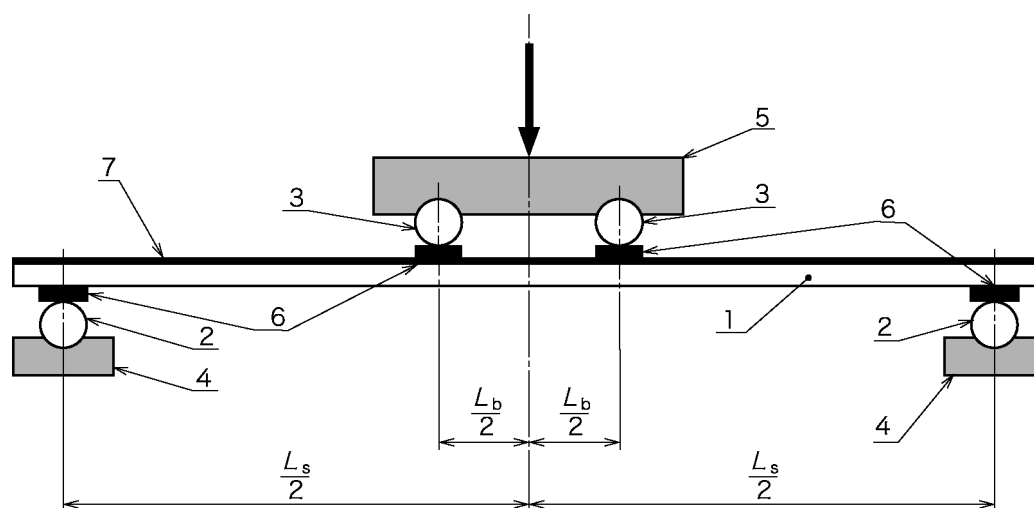
- a) The rollers shall have a cylindrical shape, a diameter of $50\text{ mm} \pm 1\text{ mm}$ and a length of not less than 365 mm , and be sufficiently rigid. All rollers shall be free to rotate without any resistance. The centre position of the distance between the centre lines of the bending rollers, L_b , and that of the supporting rollers, L_s , shall coincide with each other.
- b) The distance between the centre lines of supporting rollers and bending rollers shall be as follows :
 - distance between the centre lines of supporting rollers, L_s : $1\,000\text{ mm} \pm 2\text{ mm}$ (if the nominal thickness of the specimen is more than 5 mm);
 $800\text{ mm} \pm 2\text{ mm}$ [if the nominal thickness of the specimen is 5 mm or less (see JB.2)];
 - distance between the centre lines of bending rollers, L_b : $200\text{ mm} \pm 1\text{ mm}$.

5.1.4 Supporting jigs The supporting jigs shall not prevent the free rotation of the supporting rollers, shall not deform when subjected to the test force, and shall fix the distance between the centre lines of the rollers so that the force is equally applied by the two supporting rollers.

5.1.5 Bending jig The bending jig shall not prevent the free rotation of the bending rollers, shall not deform when subjected to the test force, and shall fix the distance between the centre lines of the rollers so that the force is equally applied to the two bending rollers.

5.1.6 Rubber strips Strips of rubber, 3 mm thick and having a hardness of (40 ± 10) IRHD specified in **JIS K 6253-2** shall be used. They shall be at least 365 mm long, and wide enough to stably support the bending rollers and supporting rollers without coming off during the test.

5.1.7 Adhesive film The adhesive film shall be a resin film with adhesiveness to glass, of such a thickness that it will not affect the test result.



Key

1 : specimen

2 : supporting roller

3 : bending roller

4 : supporting jig

5 : bending jig

6 : rubber strip

7 : adhesive film

L_b : 200 mm $\pm$ 1 mm

L_s : 1 000 mm $\pm$ 2 mm or 800 mm $\pm$ 2 mm

Figure 3 Installation of specimen

5.2 Measuring instruments

The following measuring instruments shall be used.