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Indian Standard

METHOD FOR BEND TEST

(Second Revision)

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Indian Standard

METHOD FOR BEND TEST

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 28 February 1985, after the draft finalized by the Methods of Physical Tests Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1960 and was revised in 1974. While reviewing this standard in the light of the work done by ISO/TC 164 'Mechanical Testing of Metals' at the international level, the Sectional Committee responsible for this standard decided to revise this standard so as to have a single Indian Standard on Method for bend test amalgamating three other Indian Standards on the subject.

0.2.1 This standard thus supersedes the following Indian Standards:

IS : 1692-1974	Method for simple bend testing of steel sheet and strip less than 3 mm thick
IS : 3260-1965	Method for bend test for copper and copper alloys
IS : 4598-1968	Method for single bend test for aluminium and aluminium alloy sheet and strip of thickness between 0·2 mm and 7 mm

0.3 This standard is based on the International Standard ISO 7438-1985 'Metallic materials — Bend test' issued by the International Organization for Standardization.

0.4 In reporting the results of 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*).

1. SCOPE

1.1 This standard specifies the method of conducting bend test for determining the ability of metallic materials to undergo plastic deformation in bending. It applies to the bend test of test pieces taken from metallic products as specified in the relevant product standard.

1.2 This standard is not applicable to certain materials and/or products, for example tubes in full section or welded joints, for which other standards exist.

2. PRINCIPLE

2.1 The bend test consists of submitting a test piece of round, square, rectangular, or polygonal cross section to plastic deformation by bending, without changing the direction of loading, until a specified angle of bend is reached.

2.2 The axes af the two legs of the test piece remain in a plane perpendicular to the axis of bending. In the case of 180° bend, the two lateral surfaces may, depending on the requirements of the material standard, lie flat against each other or may be parallel at a specified distance, an insert being used to control this distance.

3. SYMBOLS AND DESIGNATIONS

3.1 Symbols and designations used in the bend test are shown in Fig. 1 and 2 and specified in Table 1.

TABLE 1 SYMBOLS AND DESIGNATIONS

SYMBOLS	DESIGNATION	UNIT
a (as shown in Figures)	Thickness or diameter of test piece (or diameter of the inscribed circle for pieces of polygonal cross-section)	mm
b	Width of test piece	mm
L	Length of test pice	mm
l	Distance between supports	mm
D	Diameter of mandrel	mm
α	Angle of bend	degree
r	Internal radius of bend portion of test piece after bending	mm

4. TEST EQUIPMENT

4.1 The bend test shall be carried out in testing machines or presses equipped with the following devices:

a) Bending device with two supports and a mandrel as shown in Fig. 1,

b) Bending device with a V-block and a mandrel as shown in Fig. 2, and

c) Bending device with a clamp as shown in Fig. 3.

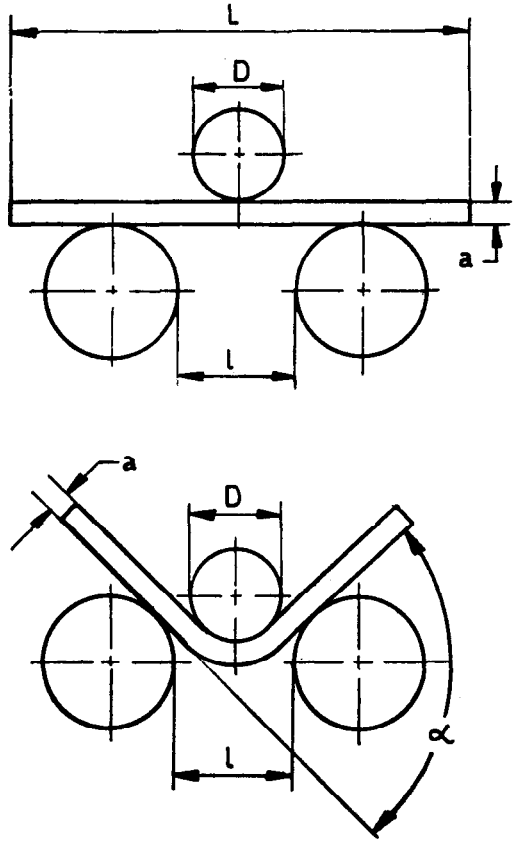

FIG. 1 SIMPLE BEND TEST

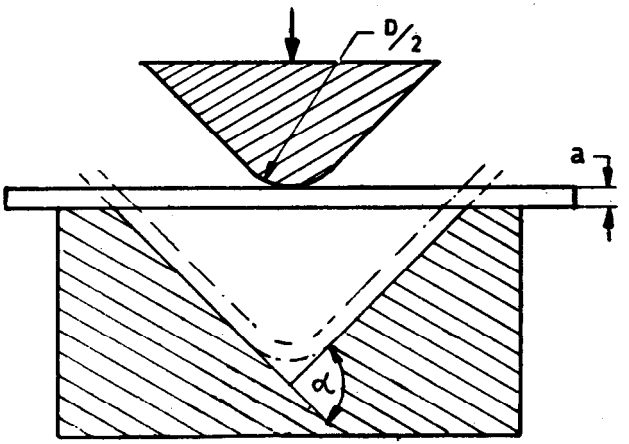

FIG. 2 BEND TEST BY THE USE OF V-BLOCK

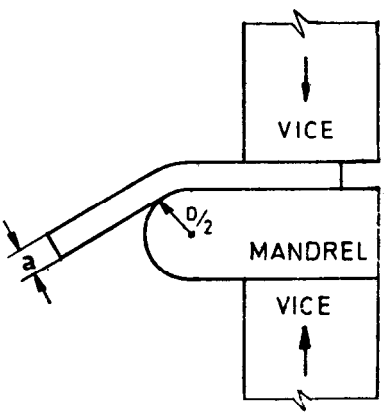

FIG. 3 BEND TEST THROUGH AN ANGLE OVER A SPECIFIED RADIUS

4.2 Bending Device with Supports and a Mandrel

4.2.1 The length of the supports and the width of the mandrel shall be greater than the width or diameter of the test piece. The diameter of the mandrel is determined by the material standard. The test piece supports shall be rounded to a radius between 1 and 10 times the thickness of the test piece and shall be sufficiently hard (*see* Fig. 1).

4.2.2 Unless otherwise specified, the distance between the supports l shall be taken as approximately:

$$l = D + 3a$$

and shall not change during the bend test.

4.3 Bending Device with a V-Block

4.3.1 The tapered surfaces of the V-block shall form an angle of $180° - \alpha$ (*see* Fig. 2).

4.3.2 The edges of the V-block shall be rounded to a radius between 1 and 10 times the thickness of the test piece and shall be sufficiently hard.

4.4 Bending Device with a Clamp — The device consists of a clamp and a mandrel of sufficient hardness; it may be equipped with a lever for applying force to the test piece (*see* Fig. 3).

5. TEST PIECE

5.1 Round, square, rectangular or polygonal cross section test pieces are used in the test. Any areas of the material affected by shearing or flame cutting and similar operations during the cutting of test pieces shall be removed. However, testing a test piece, the affected parts of which have not been removed, is acceptable provided the resultant bend is satisfactory.

5.2 The edges of rectangular test pieces shall be rounded to a radius not exceeding one-tenth of the thickness of test pieces. The rounding shall be made in such a way that no transverse, burrs, scratches or marks are formed which might adversely affect the test result. However, testing a test piece, the edges of which have not been rounded, is acceptable provided the resultant bend is satisfactory.

5.3 Unless otherwise specified in the relevant standard, the width of the test piece shall be as follows:

a) The same, when the width of the product is equal to or less than 20 mm; and

b) When the width of a product is more than 20 mm:

   i) 20 ± 5 mm for products of thickness less than 3 mm, and

   ii) Between 20 and 50 mm for products of thickness equal to or greater than 3 mm.

5.4 Thickness of the Test Piece

5.4.1 The thickness of the test piece from sheets, strips and sections shall be equal to the thickness of the product to be tested. If the thickness of the product is greater than 25 mm, it may be reduced by machining one surface to not less than 25 mm. During bending, the unmachined side shall be the tension-side surface of the test piece.

5.4.2 The round or polygonal cross section test piece shall be submitted to the bend test in the cross section equal to that of the product. In case the diameter (for a round cross section) or the inscribed circle diameter (for polygonal cross section) does not exceed 50 mm. When the diameter or the inscribed circle diameter, of the test piece exceed 30 mm up to and including 50 mm, it may be reduced to not less than 25 mm. When the diameter or the inscribed circle diameter, of the test piece exceeds 50 mm, it shall be reduced to not less than 25 mm (*see* Fig. 4). During bending, the urmachined side shall be the tension-side surface of the test piece.

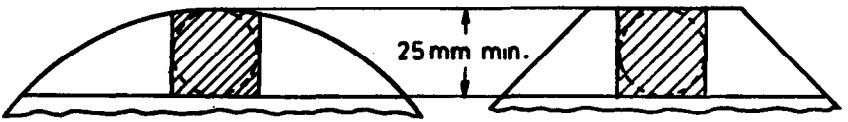

FIG. 4 POSITION OF BEND TEST PIECE IN ROUND OR POLYGONAL SECTIONS

5.5 In the case of forgings, castings and semifinished products, the dimensions of the test piece and sampling shall be as specified in the relevant standard or by agreement.

5.6 By agreement but not in cases of dispute, test pieces of a greater thickness and width than those specified in **5.3** and **5.4** may be subjected to the bend test.

5.7 The length of a test piece depends on the thickness of the test piece and the test equipment used.

6. PROCEDURE

6.1 In general, the test is carried out at ambient temperature between 10 and 35°C. Tests carried out under controlled conditions shall be made at a temperature of 23 ± 5°C.

6.2 The bend test is carried out using one of the following methods specified in the relevant standard:

a) That a specified angle of bend is achieved under the force and for the given conditions (*see* Fig. 1, 2 and 3);

b) That the legs of the test piece are parallel to each other at a specified distance apart while under the force (*see* Fig. 6); and

c) That the legs of the piece are in direct contact while under the force (*see* Fig. 7).

6.3 In the bend test to a specified angle of bend, lay the test piece on the supports (*see* Fig. 1) or on the V-block (*see* Fig. 2) and bend it in the middle between the supports by the action of a continuously increasing force. Apply the bending force slowly so as to permit free plastic flow of the material.

6.3.1 If it is not possible to bend the test piece to the specified angle in the manner described in **6.3**, complete the bend by pressing directly on the ends of the legs of the test piece (*see* Fig. 5).

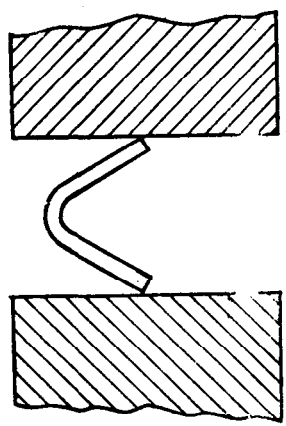

FIG. 5 BEND TEST THROUGH A SPECIFIED ANGLE

6.4 In the bend test to parallelism of the legs, the test piece may be bent first, as indicated in **6.3** and then placed between the parallel plates of the press (*see* Fig. 6) where it is further formed by application of a continuously increasing force to obtain parallelism of the legs. The test may be carried out with or without the insert. The thickness of the insert shall be defined in the relevant standards or by agreement.

An alternate method of test is that of bending over a mandrel (*see* **4.4**).

6.5 If specified, the test piece, after its preliminary bending, is further bent between the parallel plates of the press, by application of a continuously increasing force, to obtain direct contact between the legs of the test piece (*see* Fig. 7).

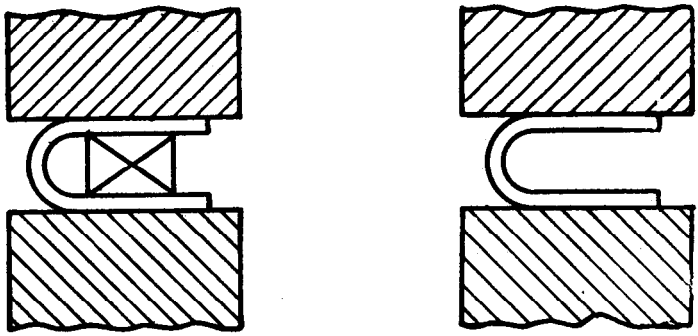

FIG. 6 BEND TEST THROUGH AN ANGLE OF 180° OVER A SPECIFIED RADIUS

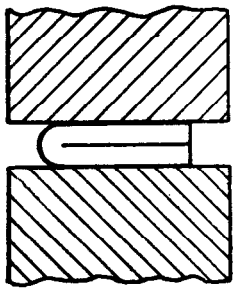

FIG. 7 BEND TEST TO FLAT CONDITION

7. INTERPRETATION OF RESULTS

7.1 The interpretation of the bend test is carried out according to the requirements of the material standards. When these requirements are not specified, absence of cracks visible without the use of magnifying aids is considered as the evidence that the test piece withstood the bend test.

7.2 The angle of bend, specified in material standards, is always considered as a minimum. If the internal radius of a bend is specified, it is considered as a maximum.

8. TEST REPORTS

8.1 The test report shall include the following information:

a) Reference to this standard;

b) Identification of the test piece (type of the material, cast number, direction of the test piece axis relative to a product, etc);

c) Shape and dimensions of the test piece;

d) Test method; and

e) Test result.