
International Standard



7438

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Metallic materials — Bend test

Matériaux métalliques — Essai de pliage

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[ISO 7438:1985](#)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7438 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*.

It cancels and replaces ISO Recommendations ISO/R 85-1959, ISO/R 87-1959, ISO/R 398-1964 and ISO/R 954-1969, of which it constitutes a technical revision.

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Metallic materials — Bend test

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1 Scope and field of application

Table 1

This International Standard specifies the method for determining the ability of metallic materials to undergo plastic deformation in bending.

This International Standard applies to the bend test of test pieces taken from metallic products as specified in the relevant product standard. It 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

The bend test consists in 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.

The axes of the two legs of the test piece remain in a plane perpendicular to the axis of bending. In the case of a 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

Symbols and designations used in the bend test are shown in figures 1 and 2, and specified in table 1.

Symbol	Designation	Unit
a	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 piece	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

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

- bending device with two supports and a mandrel as shown in figure 1;
- bending device with a V-block and a mandrel as shown in figure 2;
- bending device with a clamp as shown in figure 3.

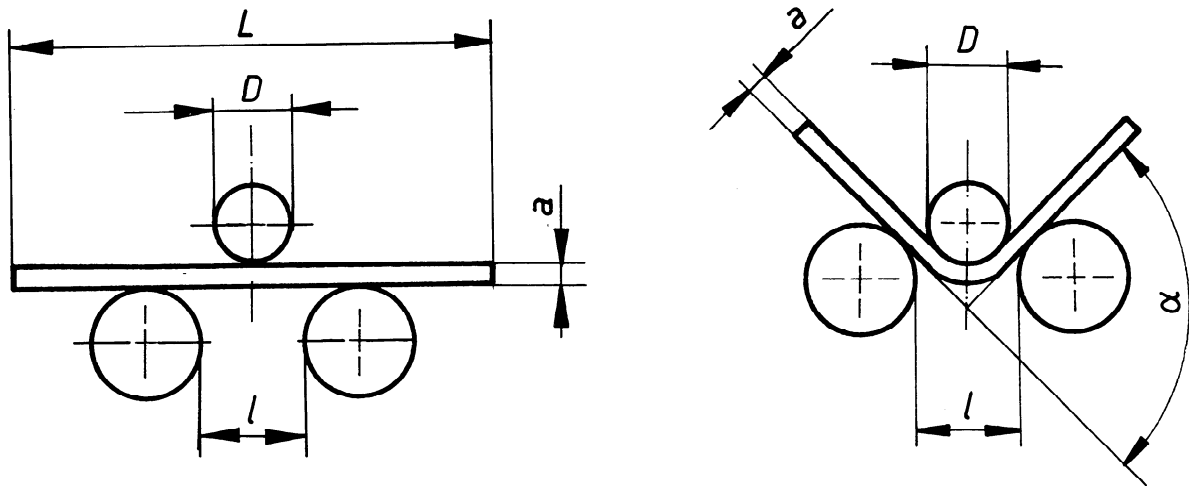


Figure 1

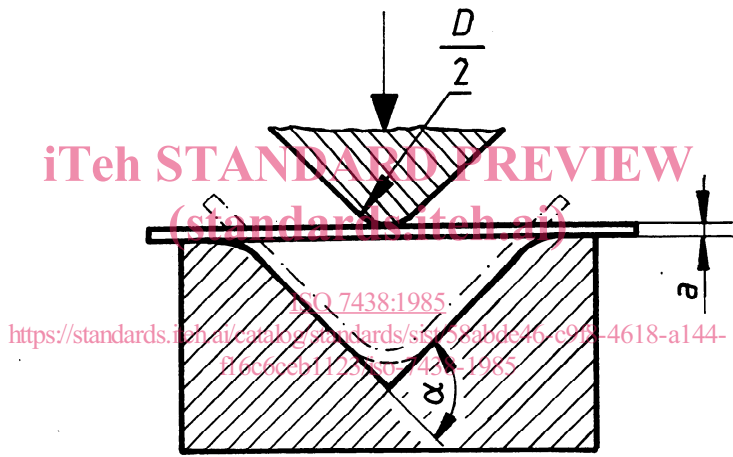


Figure 2

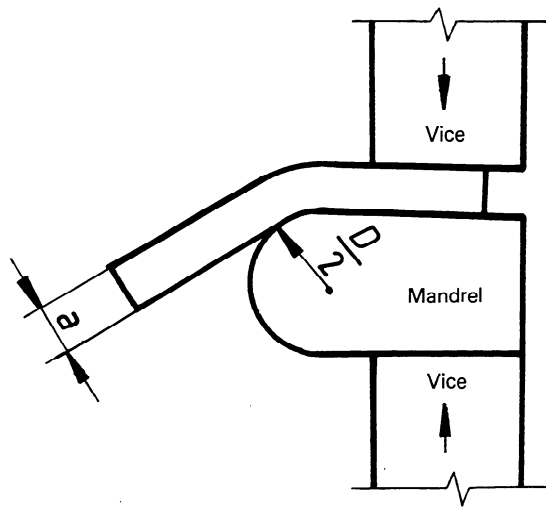


Figure 3

4.1 Bending device with supports and a mandrel

4.1.1 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 and the mandrel shall be of sufficient hardness (see figure 1).

4.1.2 Unless otherwise specified, the distance between the supports, l , shall be:

$$l = (D + 3a) \pm a/2$$

and shall not change during the bend test.

4.2 Bending device with a V-block

The tapered surfaces of the V-block shall form an angle of $180^\circ - \alpha$ (see figure 2). This angle is specified in the relevant standard.

The edges of the V-block shall have a radius between 1 and 10 times the thickness of the test piece and shall be of sufficient hardness.

4.3 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 figure 3).

5 Test piece

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

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

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

- the same as the product width, if the latter is equal to or less than 20 mm;
- when the width of a product is more than 20 mm:
 - 20 ± 5 mm for products of thickness less than 3 mm,
 - 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 pieces 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 give a thickness not less than 25 mm. During bending, the unmachined side shall be on the tension-side surface of the test piece.

5.4.2 The round or polygonal cross-section test pieces shall be submitted to the bend test while having a cross-section equal to that of the product if the diameter (for a round cross-section) or the inscribed circle diameter (for a polygonal cross-section) does not exceed 50 mm. When the diameter, or the inscribed circle diameter, of the test piece exceeds 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 figure 4). During bending, the unmachined side shall be on the tension-side surface of the test piece.

5.5 In the case of forgings, castings and semifinished products, the dimensions of the test piece and sampling shall be defined in the general delivery requirements 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 shall be 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.



Figure 4

6.2 The bend test shall be 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 figures 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 figure 6);
- c) that the legs of the test piece are in direct contact while under the force (see figure 7).

6.3 In the bend test to a specified angle of bend, the test piece shall be placed on the supports (see figure 1) or on the V-block (see figure 2) and bent in the middle between the supports by the action of a continuously increasing force.

For the three methods (figures 1, 2 and 3) the bending force shall be applied slowly so as to permit free plastic flow of the material.

If it is not possible to bend the test piece directly to the specified angle in the manner described above, the bend shall be completed by pressing directly on the ends of the legs of the test piece (see figure 5).

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 figure 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 4.3).

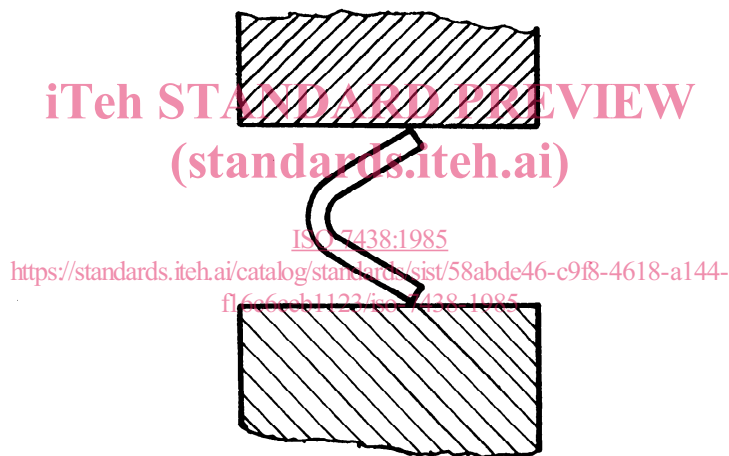


Figure 5

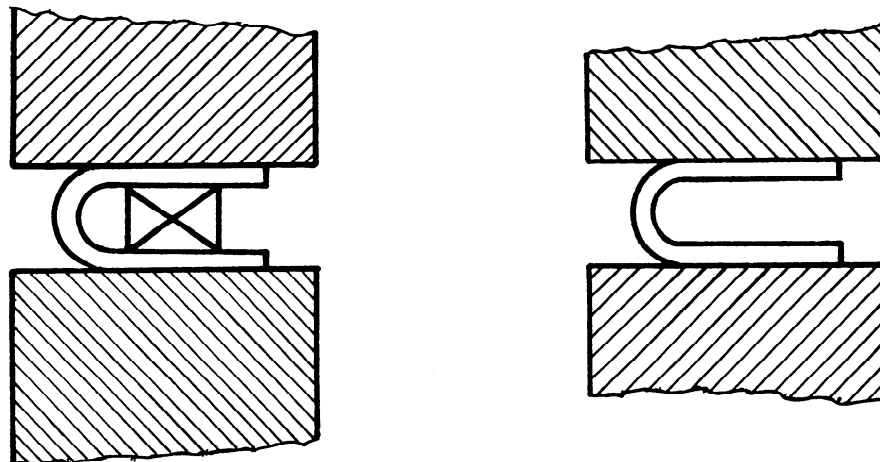


Figure 6

6.5 If specified, the test piece, after its preliminary bending, shall be 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 figure 7).

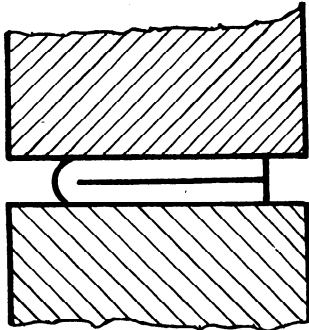


Figure 7

7 Interpretation of results

7.1 The interpretation of the bend test shall be 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 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 report

The test report shall include the following information:

- a) reference to this International 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;
- e) test result.

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