



International Standard

ISO 7801

Metallic materials — Wire — Reverse bend test

Matériaux métalliques — Fils — Essai de pliage alterné

**Second edition
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 2, *Ductility testing*.

This second edition cancels and replaces the first edition (ISO 7801:1984), which has been technically revised.

The main changes are as follows:

- symbols for typical shaped wires have been added;
- examples of the cross-section of round wire, shaped wire and clad wire are shown in [Figure 1](#);
- [Table 1](#) has been adjusted to include the limits of the diameter and the symbol, *y*, of distance and tolerance;
- the rule of tensile force for reverse bend test has been updated;
- the definition of test ending criterion has been changed for ease of application;
- [Annex A](#) has been added to provide information on the testing cylindrical support radius for shaped wires;
- [Annex B](#) has been added to provide information on devices applying force to test pieces.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Metallic materials — Wire — Reverse bend test

1 Scope

This document specifies a method for determining the ability of metallic wire of diameter or characteristic dimension from 0,3 mm to 10 mm to undergo plastic deformation during reverse bend test.

The range of applicable diameters or characteristic dimensions is more precisely specified in the relevant product standard.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Symbols

The symbols and designations used in reverse bend test of round wires and shaped wires are shown in [Figure 1](#).

d	diameter of a round wire (if clad wire, it means outer diameter)	mm
d_g	diameter of guide hole	mm
F	applied tension force	N
h	characteristic dimension for a shaped wire (e.g. the characteristic dimension for some shaped wires is the height of the cross-section and is usually specified in the relevant standard)	mm
L	distance from the top tangential plane of cylindrical supports to the bottom face of guide	mm
N_b	number of reverse bends	—
r	radius of cylindrical supports	mm
y	distance from a plane, defined by the axes of the cylindrical supports, to the top edge of gripping faces	mm

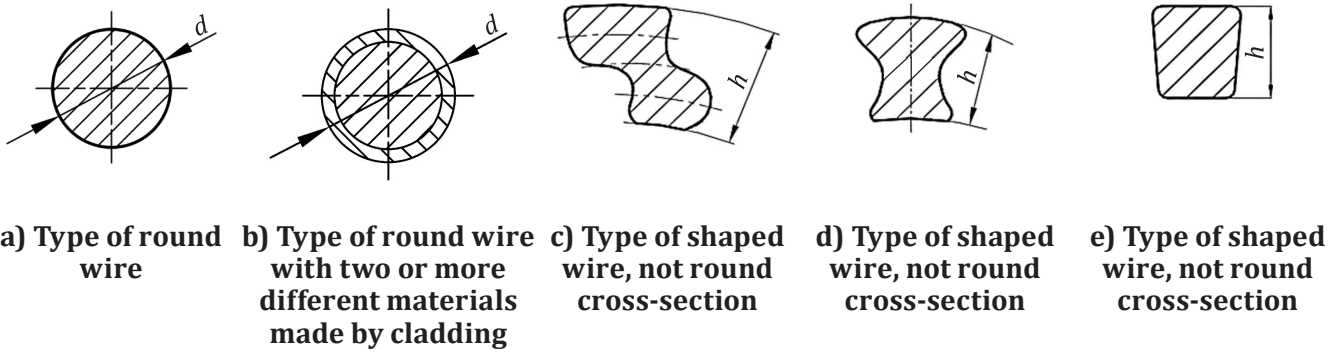
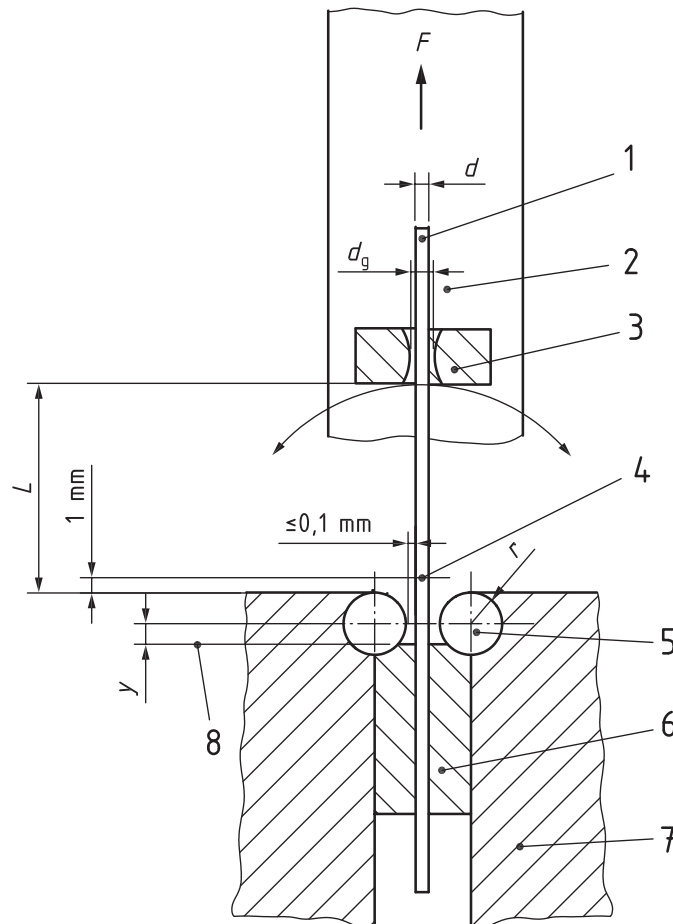


Figure 1 — Typical cross-sections of wires

5 Principle

The reverse bend test consists of repeated bending, through 90° in opposite directions, of a tested piece at one end, each bend being over a cylindrical support of a specified radius shown in [Figure 2](#).



Key

- | | | | |
|---|----------------------------------|---|--------------------------------|
| 1 | test piece | 5 | cylindrical supports A and B |
| 2 | bending arm | 6 | gripping faces of supports |
| 3 | guide | 7 | supports |
| 4 | pivoting axis of the bending arm | 8 | top edge of the gripping faces |

Figure 2 — Principle of reverse bend test

6 Testing equipment

6.1 General

The testing machine shall be constructed so as to conform with the principles indicated in [Figure 2](#) and the essential dimensions for round wires given in [Table 1](#) as well as those for shaped wires given in [Table A.1](#) and [Table A.2](#); the number of reverse bends shall be recorded.

Table 1 — Testing parameters in reverse bend test for round wires

Dimensions and tolerances in millimetres

Nominal diameter of wires d	Radius of cylindrical support and tolerance r	Distance L	Diameter of guide hole ^a d_g	Distance and tolerance y
$0,3 \leq d < 0,5$	$1,25 \pm 0,05$	15	2,0	$1,10 \pm 0,05$
$0,5 \leq d < 0,7$	$1,75 \pm 0,05$	15	2,0	$1,50 \pm 0,05$
$0,7 \leq d < 1,0$	$2,5 \pm 0,1$	15	2,0	$1,50 \pm 0,05$
$1,0 \leq d < 1,5$	$3,75 \pm 0,1$	20	2,0	$3,0 \pm 0,1$
$1,5 \leq d < 2,0$	$5,0 \pm 0,1$	20	$2,0 < d_g \leq 2,5$	$3,0 \pm 0,1$
$2,0 \leq d < 3,0$	$7,5 \pm 0,1$	25	$2,5 < d_g \leq 3,5$	$3,0 \pm 0,1$
$3,0 \leq d < 4,0$	$10,0 \pm 0,1$	35	$3,5 < d_g \leq 4,5$	$3,0 \pm 0,1$
$4,0 \leq d < 6,0$	$15,0 \pm 0,1$	50	$4,5 < d_g \leq 7,0$	$3,0 \pm 0,1$
$6,0 \leq d < 8,0$	$20,0 \pm 0,1$	75	$7,0 < d_g \leq 9,0$	$3,0 \pm 0,1$
$8,0 \leq d \leq 10,0$	$25,0 \pm 0,1$	100	$9,0 < d_g \leq 11,0$	$3,0 \pm 0,1$

^a Where appropriate, the smaller diameter of hole is used for the smaller nominal diameter of wire (see column 1) and larger diameter of hole for the larger nominal diameter of wire (see also column 1). For diameters within ranges given in column 1, the appropriate size of the hole is chosen to ensure free movement of the wire.

NOTE For clad wires, the outer part of wire diameter is the nominal diameter of wire.

6.2 Cylindrical supports and gripping faces

6.2.1 The hardness of cylindrical supports and the gripping faces shall be higher than that of the test piece to provide resistance to abrasion.

6.2.2 The radius of cylindrical supports shall not differ from its nominal dimension by more than the tolerance given in [Table 1](#) for round wires and in [Annex A](#) for shaped steel wires.

6.2.3 The axes of the cylindrical supports shall be perpendicular to the plane of bend and shall be parallel and in the same plane to within 0,1 mm.

6.2.4 The gripping faces shall project slightly beyond the face of the cylindrical supports to a distance which does not exceed 0,1 mm, as measured by the clearance between the test piece and each cylindrical support on a line joining the centres of curvature.

6.2.5 The top edge of the gripping faces shall be below the centres of curvature of the cylindrical supports by a distance y , which shall be in accordance with [Table 1](#).

6.3 Bending arm and guide

6.3.1 The distance of the pivoting axis of the bending arm from the top of cylindrical supports shall be 1 mm for all sizes of supports.

6.3.2 The holes of the guide shall widen out at each end to have a diameter in accordance with [Table 1](#) for round wires. As for shaped wires, inscribed circular holes with minimum diameter and enclosed shaped wires in the guide, also can be used.

7 Test piece

7.1 The wire to be used as the test piece should be as straight as possible, but it can exhibit a slight curvature in the plane in which it will be bent during the test.

7.2 If straightening is necessary, it shall be done by hand. If this is not possible, straightening by hammer on a level surface of wood, plastic material, copper or similar material may be performed.

NOTE To ensure continuous contact between the test piece and the cylindrical supports during the test, careful straightening is much more necessary for thinner wires.

7.3 During straightening, the surface of the wire shall not be damaged and the test piece shall not be subjected to any twisting.

7.4 Wire with sudden sharp curvature towards longitudinally neutral axis of cross-section shall not be used as a test piece.

8 Procedure

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

8.2 For round wires, the radius of the support, r , the distance, L , with the distance from a plane, y , and the diameter of the guide hole, d_g , shall be selected according to the wire diameter as given in [Table 1](#). For shaped steel wires, the radius of the support, r , shall be selected in accordance with the characteristic dimension, h , as given in [Annex A](#).

8.3 Insert test piece for either of round wires or shaped wires, with the bending arm vertical, through one of the holes in the guide as indicated in [Figure 2](#). Hold the lower end of the test piece for either of round wires or shaped wires between the grips so that the test piece is perpendicular to the axes of the cylindrical supports.

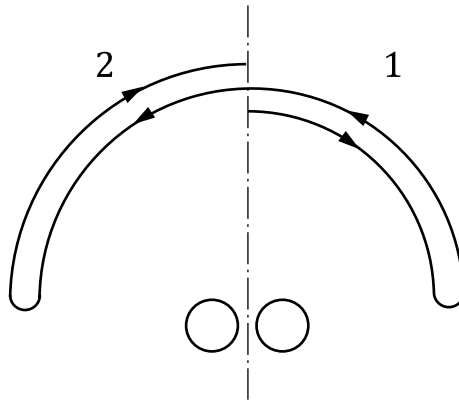
8.4 The gripping for non-circular test pieces of shaped wires, including bending direction applied bending stress are usually specified in relevant product standards or agreement. If not, the shaped gripping faces, matched with shaped wires, may be specially designed and used as shown in [Figure 3](#) or other types. The bending direction is an important factor to test results because different positions of a portion of test pieces that are directly in contact with the gripping face will have different stress concentration effects during the reverse bend test.



Figure 3 — Recommended gripping methods for shaped wires

8.5 Bending the test piece through 90° alternately in opposite directions around the pivoting axis of the bending arm. One bend consists of bending the free end of the test piece through 90° and returning it to its original position. The following bending shall follow the opposite direction as shown in [Figure 4](#). Do not

interrupt the testing between successive bends. The lateral deflection of the test piece during bending shall be minimized.



Key

- 1 first bend
- 2 second bend

Figure 4 — Reverse bends and counting method of N_b

8.6 Bend at a uniform rate without shock, not exceeding one bend per second. If necessary, reduce the rate of bending to ensure that the heat generated does not affect the results of the test.

8.7 To ensure continuous contact between the test piece and the cylindrical supports during the test, some form of constraint may be applied. This may be in the form of a tensile force no greater than 2 % of the force value of the nominal tensile strength, unless otherwise specified in the relevant standard. [Annex B](#) gives some examples of such devices which can apply force during an entire test.

NOTE Applying different amounts of tensile force to the test piece can cause different test results in most cases.

When disputing, the tensile force shall be equal to 2 % of the force value of the nominal tensile strength of the tested samples. If continuous contact between the test piece and the cylindrical supports during the test is not ensured using all methods mentioned above, a larger tensile force may be applied after agreement among relevant parties.

8.8 Continue the test until the number of bends specified in the relevant standard is completed, or continue the test until complete fracture of the test piece occurs. Testing completion shall not be based on the crack detection criterion.

Alternatively, if specified in the relevant standard, continue the test until cracking is visible without the use of magnifying aids.

NOTE The separation between outer material and inner base metal during the reverse bend test also is critical failure for its application of clad wires besides the cracking of outer surface [1],[2].

8.9 The bend during which the failure of test piece occurs shall not be counted into the number of bends, N_b .

9 Test report

The test report shall include the following information:

- a) a reference to this document, e.g. ISO 7801:2024;
- b) identification of the test piece (type of the material, heat number, etc.);

- c) the nominal diameter, d , or characteristic dimension, h , of the test piece;
- d) details regarding the test piece preparation (method of straightening, etc.);
- e) the testing conditions (radius, r , of the cylindrical supports, application of tensile force, F , etc.);
- f) the criterion for ending the test;
- g) the number of bends, N_b .

Annex A (normative)

Testing parameter during reverse bend test for shaped steel wires

Unless specified in the relevant standards, for shaped steel wires for static and dynamic applications, the radius of the support, r , shall be selected according to characteristic dimension, h , as given in [Table A.1](#) and [Table A.2](#) respectively [3],[4].

Table A.1 — Radius of the cylindrical supports, r , for bright and coated steel wires for static applications

Dimensions and tolerances in millimetres

Type of cross-section		Radius of the cylindrical supports r
Type	Characteristic dimension h	
Z type	$2,0 \leq h < 3,0$	$5,0 \pm 0,1$
	$3,0 \leq h < 4,0$	$7,5 \pm 0,1$
	$4,0 \leq h < 5,0$	$10,0 \pm 0,1$
	$5,0 \leq h < 7,5$	$15,0 \pm 0,1$
	$7,5 \leq h \leq 8,5$	$20,0 \pm 0,1$
H type	$1,2 \leq h < 3,0$	$5,0 \pm 0,1$
	$3,0 \leq h < 4,0$	$7,5 \pm 0,1$
	$4,0 \leq h < 5,0$	$10,0 \pm 0,1$
	$5,0 \leq h < 7,5$	$15,0 \pm 0,1$
	$7,5 \leq h \leq 8,5$	$20,0 \pm 0,1$
T type	$3,0 \leq h < 4,0$	$7,5 \pm 0,1$
	$4,0 \leq h < 5,0$	$10,0 \pm 0,1$
	$5,0 \leq h < 5,5$	$15,0 \pm 0,1$

For the definitions of Z, H and T types, refer to [Figure 1](#) c), d) and e).

Table A.2 — Radius of the cylindrical supports, r , for bright and coated steel wires for dynamic applications

Dimensions and tolerances in millimetres

Type of cross-section		Radius of the cylindrical supports r
Types	Characteristic dimension h	
Z type	$2,00 \leq h < 2,80$	$5,0 \pm 0,1$
	$2,80 \leq h < 3,80$	$7,5 \pm 0,1$
	$3,80 \leq h \leq 4,70$	$10,0 \pm 0,1$
H type	$1,25 \leq h < 2,50$	$5,0 \pm 0,1$
	$2,50 \leq h < 3,56$	$7,5 \pm 0,1$

For the definitions of Z, H and T types, refer to [Figure 1](#) c), d) and e).

Annex B **(informative)**

Examples of devices applying force to test pieces

This Annex shows some examples of device applying tensile force to test pieces during the reverse bend test.

A spring is used in [Figure B.1](#) and the force can be controlled by adjusting spring scale to a constant length. This device is simple and is also easily handled, but the force will gradually decrease as the plastic extension generates and increases along the length of test piece during the reverse bend test.

A set of weights are used in [Figure B.2](#) and the force can be adjusted by the change of weight and always keep constant during the reverse bend test.

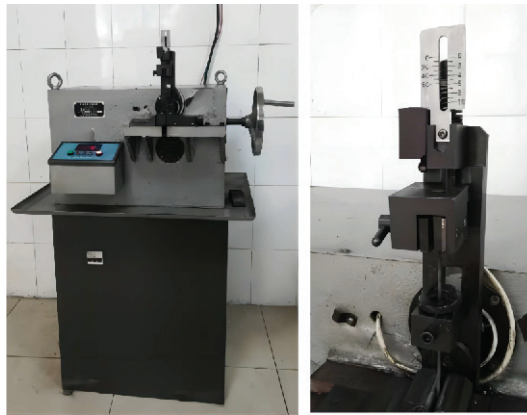


Figure B.1 — Device that applies force by spring

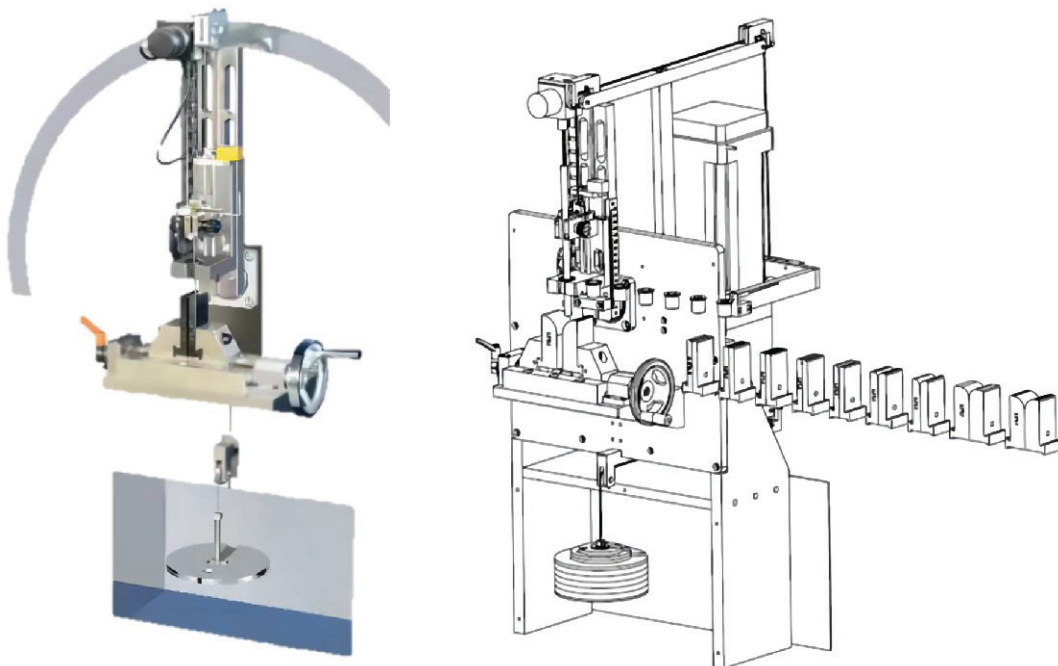


Figure B.2 — Device that applies force by weights

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- [1] GB/T 29197-2012, *Copper-clad aluminium* (in Chinese)
- [2] JB/T 11868.2-2014, *Copper-clad steel wire for electrical purposes — Part 2: Annealed copper-clad steel wires* (in Chinese)
- [3] EN 10264-3:2012, *Steel wire and wire products — Steel wire for ropes — part 3 Round and shaped non alloyed steel wires for high duty application*
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