

BS EN 10218-1:2012



BSI Standards Publication

Steel wire and wire products — General

Part 1: Test methods

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National foreword

This British Standard is the UK implementation of EN 10218-1:2012. It supersedes BS EN 10218-1:1994 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/106, Wire Rod and Wire.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 10218-1:2012) has been prepared by Technical Committee ECISS/TC 106 “Wire rod and wires”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2012, and conflicting national standards shall be withdrawn at the latest by July 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10218-1:1994.

The standard will comprise the following parts:

- *Part 1: Test methods;*
- *Part 2: Wire dimensions and tolerances.*

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1 Scope

This European Standard specifies the methods for the general testing of steel wire and wire products which have been cold worked, annealed or oil hardened and tempered and/or coated and are of constant cross section, either round, or special section. It includes tensile testing, torsion testing, reverse bend testing, wrapping test, bend test, reverse torsion test, compression test, deep etch test, hardness test, quench hardenability test, fatigue test, wire cast measurement, artificial ageing, decarburization test, non-destructive tests, grain size tests, segregation test, non-metallic inclusion test and chemical analysis.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10021, *General technical delivery conditions for steel products*

EN 10247, *Micrographic examination of the non-metallic inclusion content of steels using standard pictures*

CEN/TR 10261, *Iron and steel — Review of available methods of chemical analysis*

EN ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997)*

EN ISO 643, *Steels — Micrographic determination of the apparent grain size (ISO 643:2003)*

EN ISO 3887, *Steels — Determination of depth of decarburization (ISO 3887:2003)*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

EN ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-1:2005)*

EN ISO 6508-2, *Metallic materials — Rockwell hardness test — Part 2: Verification and calibration of testing machines (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-2:2005)*

EN ISO 6508-3, *Metallic materials — Rockwell hardness test — Part 3: Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-3:2005)*

EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

EN ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

EN ISO 16120-1, *Non-alloy steel wire rod for conversion to wire — Part 1: General requirements*

ISO 7800, *Metallic materials — Wire — Simple torsion test*

ISO 7801, *Metallic materials — Wire — Reverse bend test*

ISO 7802, *Metallic materials — Wire — Wrapping test*

ISO 9649, *Metallic materials — Wire — Reverse torsion test*

3 Tensile test

3.1 General

The tensile test shall be in accordance with EN ISO 6892-1 for testing at ambient temperature and EN ISO 6892-2 for testing at elevated temperature with the modifications specified in 3.2 to 3.6.

NOTE For fine wires 0,5 mm diameter or less, any requirements for elongation values should not be mandatory but for information only.

3.2 Type of samples

Samples shall be selected in accordance with EN ISO 377 using the full cross section, i.e. be an unmachined portion of wire.

3.3 Preparation of test piece

The test piece shall be straightened with care so as not to cause damage (see EN ISO 6892-1 and EN ISO 377).

3.4 Cross-sectional area

In EN ISO 6892-1, the actual dimensions are used for tensile calculations but the nominal dimensions may be used if specified in the product standard or order. For non-circular wire, the original cross-sectional area may be determined from the mass of known length and its appropriate density.

3.5 Method of gripping

To avoid breakages of the wire at the gripping zone, when testing the smaller diameters less than or equal to 1 mm, it is recommended the wire ends are wrapped round a circular bar or disc and fastened.

3.6 Tensile test on knotted wire

The tensile test on knotted wire shall be carried out in accordance with EN ISO 6892-1 with a simple knot approximately in the middle of the test piece.

4 Simple torsion test

The simple torsion test shall be in accordance with ISO 7800. In this event of initial failure, a retest shall be carried out (see EN 10021). Where possible, the retest shall be conducted at a speed conforming to requirements of ISO 7800 (as a function of wire diameter).

Where the fracture in the torsion test is required to be characterized, it shall be done on the basis of Table 1.

NOTE For small diameter wires, it may not be possible to make a distinction between some of the classes in Table 1 (e.g. 2b versus 3b).

5 Reverse bend test

The reverse bend test shall be in accordance with ISO 7801 with the following amendment for automatic counters.

If the testing machine has an automatic counter operating at the limit stops, then the first bend down through 90° counts as one bend and the second bend is represented by the 180° bend in the opposite direction. The last figure obtained before fracture occurs counts as the number of bends.

6 Wrapping test

The wrapping test shall be in accordance with ISO 7802 and may be applied to assess coilability, ductility or the adherence of coatings as specified in the relevant product standard.

7 Bend test

The bend test comprises bending the wire, which is allowed to move freely over a mandrel of specified diameter through a specified angle in one operation at ambient temperature. Details will be given in the relevant product standard.

8 Reverse torsion test

The reverse torsion test shall be in accordance with ISO 9649 with the following amendment:

The test shall be used to detect surface defects as well as to assess ductility.

9 Compression test

9.1 Purpose

The purpose of the test is to detect surface defects. This test is not suitable for wires of less than 4,0 mm diameter.

9.2 Principle

A straight test pieces of wire equal in length to 1 (or 1,5 times), the diameter of the wire is cut, with cuts at right angles to the wire axis. The test piece is placed on a flat surface of a compression machine and compressed at room temperature in the direction of the wire axis to a specified percentage of its original length. The compressed test piece is examined for surface cracking. The degree of acceptability is specified in the product standard.

10 Deep etch test

10.1 Purpose

The deep etch test is used for the detection of surface defects.

10.2 Principle

A cold test piece is suitably degreased where appropriate. The test piece which has undergone deformation by drawing is washed and dried and in the case of high carbon steel, the test piece is stress relieved at 400 °C to 500 °C for 15 min and allowed to cool to ambient temperature before etching. With the exception of test pieces greater than 5,00 mm and test pieces of annealed structures, the test piece is immersed in a solution of 50 % by volume concentrated hydrochloric acid and 50 % by volume of water, at a minimum temperature of 60 °C for a period of time equivalent to 2 s for every 0,025 mm of diameter with a maximum of 5 min. Test pieces greater than 5,00 mm and test pieces of annealed structures may be left in the solution for 10 min.

The test piece is examined for surface defects. To ascertain the depth of defect, the test piece is filed until the defect disappears, the difference in thickness before and after filing being recorded as the defect depth. For a definitive assessment of a defect, optical micrographical analysis shall be used.

11 Hardness test

Hardness test shall be in accordance with EN ISO 6506-1 or EN ISO 6508 (Part 1 to Part 3) as specified in the product standard or in the order.

A distinction should be made between surface hardness, core hardness and through hardness.

NOTE There is no relevant relationship between hardness and tensile strength.

12 Quench hardenability test

The test pieces for the quench hardening test shall be heated in neutral or reducing furnace atmosphere up to the austenitising temperature specified for the steel type, and maintained at this temperature until they are completely austenitised. They shall then be taken out of the furnace and promptly quenched down, in a high-duty quenching oil, to complete temperature equalization. The high-duty quenching oil shall be at a temperature of (50 ± 10) °C, be of sufficient volume and agitated such that together with the speed of immersion, the test pieces shall achieve the temperature of the quenching medium without significant delay. The hardness test shall be carried out in accordance with Clause 11 on a suitably prepared test piece. A distinction should be made between core hardness and through hardness. In case of dispute, reference to the Jominy value of the original feedstock shall be made for the particular steel.

13 Fatigue test (bend and axial)

The tests to be applied for wire are an axial fatigue test or a rotating bend fatigue test and within the scope of these tests, there are a number of variations. The subsequent interpretation of the test results of any one test should be carefully considered in relation to the results obtained from another test. Such is the complexity of interpretation, that specific references will appear in the appropriate product standard.

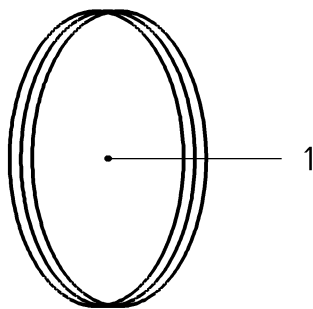
14 Wire cast measurement

14.1 General

14.1.1 The cast of wire is characterised by the diameter of the free laying unrestrained wap of wire taken from coil or reel. For coil, ends can be together (closed cast) or apart (open cast).

NOTE For the purposes of this standard, the terms "coil", "reel", "spool" and "bobbin" are synonymous.

14.1.2 Sufficient wire from a coil or reel is cut off to produce a full free wap (single convolution of wire) ensuring that it is not bent or damaged (see Figure 1).



Key

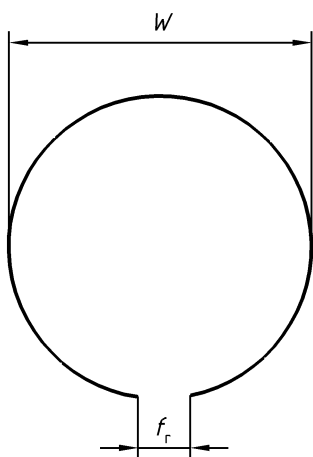
- 1 Take several waps (convolutions of wire) and at one point cut the sample to provide an unrestrained wap

Figure 1 — Sampling of wire

14.1.3 The test specified in 14.2 to 14.4 shall be carried out, if specified, to determine the degree of circular, helix and spiral cast.

14.2 Circular cast

To measure circular cast, being the inside diameter of the wap, place the wap on a flat horizontal surface and measure the average diameter (see Figure 2 which also show the definition of closed and open circular cast).



Key

- W diameter of the wap in mm
- f_r radial displacement in mm
- where
- $f_r > 0$ mm open circular cast
- $f_r \leq 0$ mm closed circular cast

Figure 2 — Circular cast

14.3 Helix cast

14.3.1 General

To measure the displacement of the cut ends at right angles to the wap either method A or method B as specified in 14.3.2 and 14.3.3 shall be used. The inspection document shall indicate the test method.

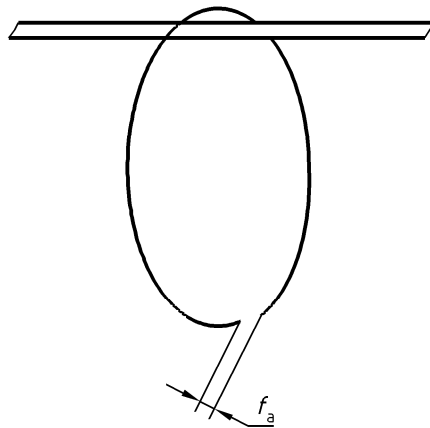
14.3.2 Method A

Suspend the wap from the mid-point of a piece of rod or a pencil, so that the cut ends are at the lowest point and the two ends hang free diametrically below the point of suspension. Measure the separation of the ends at right angles to the plane of the wap (see Figure 3).

14.3.3 Method B

Place the wap on a flat horizontal surface and measure the vertical distance between the ends of the wap (see Figure 4).

NOTE This test method should only be used when the combination of wire diameter and circular cast does not create conditions, which reduce or eliminate the helix.

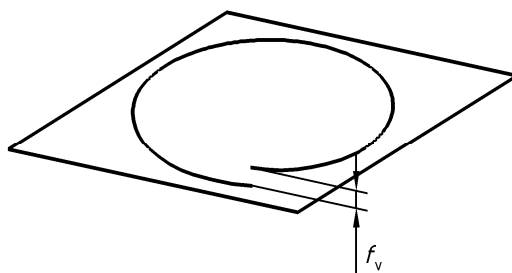


Key

f_a axial displacement in mm

NOTE Wap is suspended vertically and horizontal displacement of cut ends (cast open or closed) is measured.

Figure 3 — Helix cast (Method A)



Key

f_v vertical displacement in mm

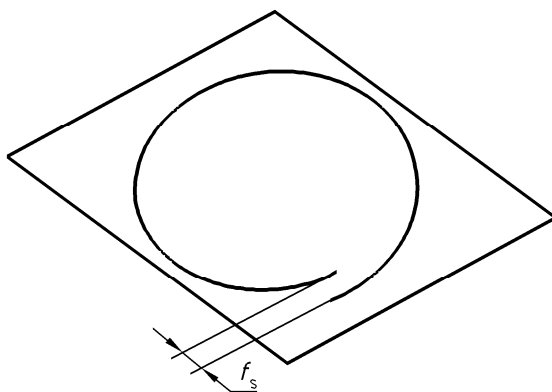
NOTE The wap is laid on a flat surface and the vertical displacement of cut ends (cast open or closed) is measured.

Figure 4 — Helix cast (Method B)

14.4 Spiral cast

To assess spiral cast, place the wap on a flat horizontal surface and check whether there is any horizontal displacement between the ends of the wap (see Figure 5).

NOTE Spiral cast is the term used when one end of the wap is curling inside the natural diameter of the wap. It is possible that a wap of wire in this condition will also exhibit helix (see Figures 3 and 4).



Key

f_s spiral displacement in mm

NOTE Wap is laid on flat surface and any horizontal displacement of cut ends is assessed.

Figure 5 — Spiral cast

15 Artificial ageing

If natural ageing conditions are to be simulated, the test piece shall be heated to a minimum of (100 ± 5) °C and held at that temperature for at least $(60 \text{ min} \pm 5)$ min prior to the relevant test being carried out on the cold specimen.

16 Decarburization test

Method of testing for the depth of decarburization shall be in accordance with EN ISO 3887. Details of any product-specific test method are found in the relevant product standard.

17 Non-destructive tests

Wire or wire products intended for certain uses may be continuously inspected by eddy current or ultrasonic methods of agreed sensitivity. Where relevant, appropriate details are specified in product standards.

18 Grain size test

Grain size test shall be in accordance with EN ISO 643.

19 Segregation test

Segregation test shall be in accordance with EN ISO 16120-1.

20 Non-metallic inclusion test

Non-metallic inclusion test shall be in accordance with EN 10247.

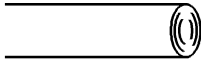


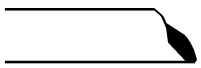
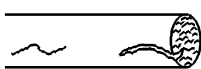


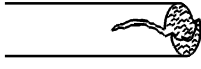
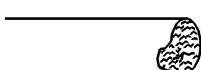







21 Chemical analysis

The chemical composition shall be determined in accordance with the appropriate European Standards (for a list of the different methods, see CEN/TR 10261).

22 Retests

EN 10021 shall apply in respect of all retests.

Table 1 — Evaluation of fractures occurring during torsion test

| Type of fracture | Type N° | | Aspect | Description and characteristics | Fracture plane |
|--|---------|---|---|---|--|
| | Product | | | | |
| Normal torsion fracture | 1 | a |  | Smooth – Fracture plane perpendicular to wire axis (or slightly oblique). No cracks in fracture plane |  or  |
| | | b |  | Brittle – Fracture plane at an angle of 45° to wire axis. No cracks in fracture plane | |
| Fracture with local cracks | 2 | a |  | Smooth – Fracture plane perpendicular to wire axis and partially cracked |  or  |
| | | b |  | Stepped – A part of the fracture plane is still smooth – Partially cracked | |
| Irregular fracture (material defects) | | c |  | Irregular fracture plane – No cracks in fracture plane |  |
| Fracture with spiral cracks over the whole length (or a large part of it) Cracked formation already occurs after a low number (3 to 5) of torsions and is best visible at that moment | 3 | a |  | Smooth – Fracture plane perpendicular to wire axis and partially or entirely cracked |  or  |
| | | b |  | Stepped – A part of the fracture plane is still smooth and partially or entirely cracked | |
| | | |  | Brittle – Fracture plane at an angle of 45° and partially or entirely cracked | |
| | | c |  | Irregular fracture plane and partially or entirely cracked | |

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