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STANDARD

BS EN
10218-1:1994

Steel wire and wire products — General —

Part 1: Test methods

The European Standard EN 10218-1:1994 has the status of a British Standard

UDC 669.14-426:620.1

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This British Standard, having been prepared under the direction of the Iron and Steel Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 June 1994

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National foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Policy Committee. It is the English language version of EN 10218-1 *Steel wire and wire products — General — Part 1: Test methods* drawn up by ECISS (European Committee for Iron and Steel Standardization) and published by the European Committee for Standardization (CEN).

It supersedes BS 4545:1970 which is withdrawn.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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EN STANDARD
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March 1994

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English version

Steel wire and wire products — General — Part 1: Test methods

Fils et produits tréfilés en acier —
Généralités
Partie 1: Méthodes d'essai

Stahldraht und Drahterzeugnisse —
Allgemeines —
Teil 1: Prüfverfahren

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Foreword

The European Committee for Iron and Steel Standardization (ECISS) asked Technical Committee 30, Steel wire and wire products, (Secretariat UK) to prepare a European Standard on general test methods and general dimensions and tolerances for steel wire and wire products.

The standard will comprise the following Parts:

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

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 September 1994, and conflicting national standards shall be withdrawn at the latest by September 1994.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

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Introduction

In this Part of EN 10218 in some cases reference is simply made to other test standards whereas in other cases the test is described in detail. The standard is intended to be referenced in whole or part in steel wire and wire products standards.

1 Scope

This Part of EN 10218 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

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to EN 10218-1 only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 10002, *Metallic materials: Tensile testing — Part 1: Method of test (at ambient temperature) — Part 5: Method of test (at elevated temperature)*.

EN 10003-1, *Metallic materials: Hardness testing — Brinell — Part 1: Method of test*.

EN 10109-1, *Metallic materials: Hardness testing — Part 1: Rockwell test (scales A-B-C-D-E-F-G-H-K) and Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T and 45T)*.

EN 10016-1, *Non-alloy steel rod for drawing and/or cold rolling — Part 1: General requirements*.

EN 10021, *General technical delivery conditions for steel and iron and steel products*.

EURONORM 5, *Vickers hardness test for steel*¹⁾.

EURONORM 18, *Selection and preparation of samples and test pieces for steel and iron and steel products*¹⁾.

EURONORM 103, *Micrographic determination of ferritic or austenitic grain size of steel*¹⁾.

EURONORM 104, *Determination of the depth of decarburization of non-alloy and low alloy structural steels*¹⁾.

ISO 7800, *Metallic materials: Wire: Simple torsion test*²⁾.

ISO 7801, *Metallic materials: Wire: Reverse bend test*²⁾.

ISO 7802, *Metallic materials: Wire: Wrapping test*²⁾.

ISO 9649, *Metallic materials: Wire: Reverse torsion test*²⁾.

3 Tensile test

The tensile test shall be in accordance with EN 10002-1 for testing at ambient temperature and Part 5 for testing at elevated temperature with the modifications specified in 3.1 to 3.5.

NOTE For fine wires 0.5 mm diameter or less any requirements for elongation values should not be mandatory but for information only.

3.1 Type of test piece

Test pieces shall be selected in accordance with EURONORM 18 using the full cross section, i.e. be an unmachined portion of wire.

3.2 Preparation of test piece

The test piece shall be straightened with care so as not to cause damage. (See EN 10002-1 and EURONORM 18.)

3.3 Cross-sectional area

In EN 10002-1 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 a known length and its appropriate density.

3.4 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.

¹⁾ It may be agreed at the time of ordering, until this EURONORM has been adopted as a European Standard, that either this EURONORM or a corresponding national standard should be applied.

²⁾ The ISO standards are referenced in the absence of European Standards. It is probable the ISO standards could be adopted as European Standards in due course.

3.5 Tensile test on knotted wire

The tensile test on knotted wire shall be carried out in accordance with EN 10002-1 with a simple knot in the middle of the test piece.

4 Simple torsion test

The simple torsion test shall be in accordance with ISO 7800. In the event of initial failure a retest shall be carried out (see EN 10021). Where possible the retest shall be conducted at a speed of $1 \pm 0,2$ turns/s.

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 piece 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 testing shall be in accordance with EN 10003-1, EN 10109-1 or EURONORM 5 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 a neutral or reducing furnace atmosphere up to the hardening temperature specified for the steel type, and maintained at this temperature until they are completely austenitized. 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 $(50 \pm 10) ^\circ\text{C}$, 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 standards.

14 Wire cast measurement

14.1 General

14.1.1 The cast of wire is characterized 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.

Table 1 — Evaluation of fractures occurring during torsion test

| Type of fracture | Type no. | | Aspect | Description and characteristics | Fracture plane |
|--|----------|---|--------|--|----------------|
| | Prod. | | | | |
| Normal torsion fracture | 1 | a | | Smooth — fracture plane perpendicular to wire axis (or slightly oblique). No cracks in fracture plane. | |
| | | 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. | |
| | | b | | Stepped — a part of the fracture plane is still smooth — partially cracked. | |
| | | c | | Irregular fracture plane — no cracks in fracture plane. | |
| Fracture with spiral cracks over the whole length (or a large part of it) Crack 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. | |
| | | b | | Stepped — a part of the fracture plane is still smooth and partially or entirely cracked. | |
| | | c | | Brittle — fracture plane at an angle of 45° and partially or entirely cracked, or irregular fracture plane and partially or entirely cracked. | |

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).

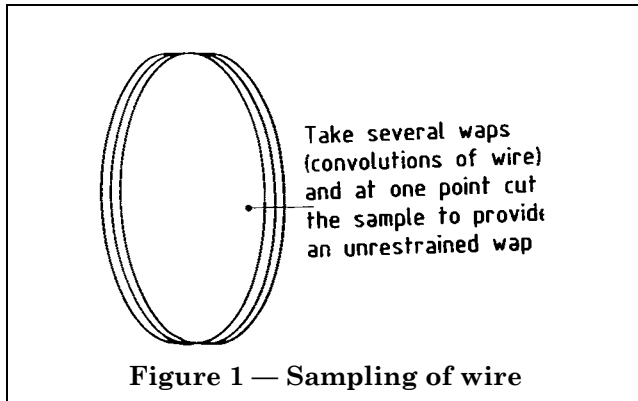


Figure 1 — Sampling of wire

14.1.3 The tests 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 ring 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 and Figure 3 which also show the definition of closed and open circular cast.)

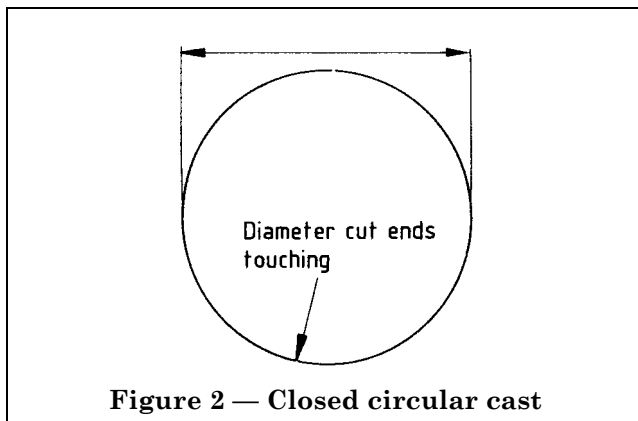


Figure 2 — Closed circular cast

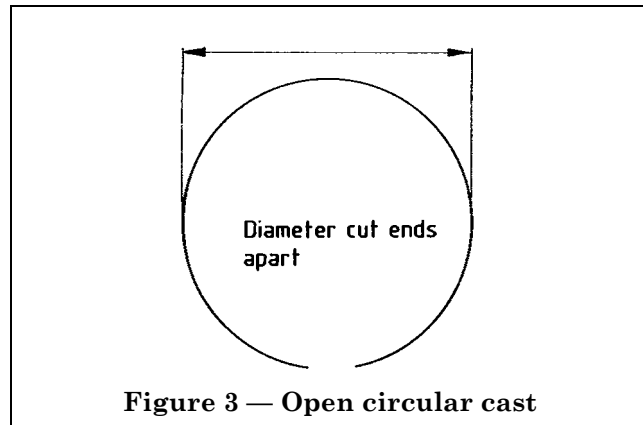


Figure 3 — Open circular cast

14.3 Helix cast

To measure the displacement of the cut ends at right angles to the wap either method A or method B as specified in 14.3.1 and 14.3.2 shall be used. The inspection document shall indicate the test method.

14.3.1 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 4).

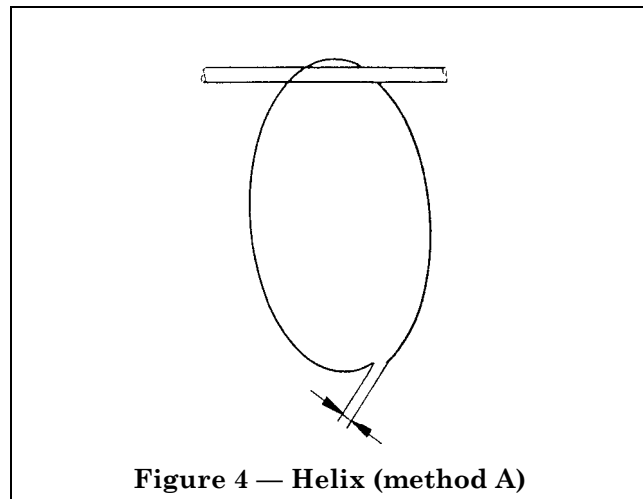


Figure 4 — Helix (method A)

14.3.2 Method B

Place the wap on a flat horizontal surface and measure the vertical distance between the ends of the wap (see Figure 5).

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.

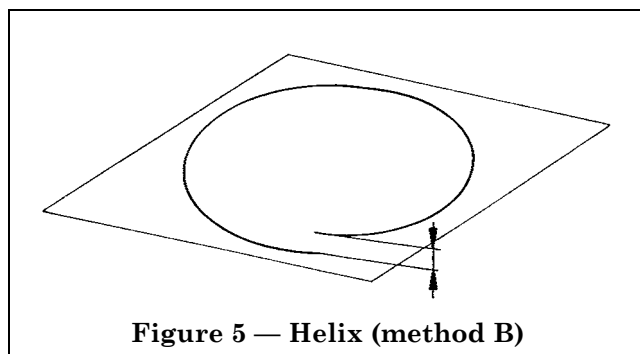


Figure 5 — Helix (method B)

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 6).

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 Figure 4 and Figure 5).

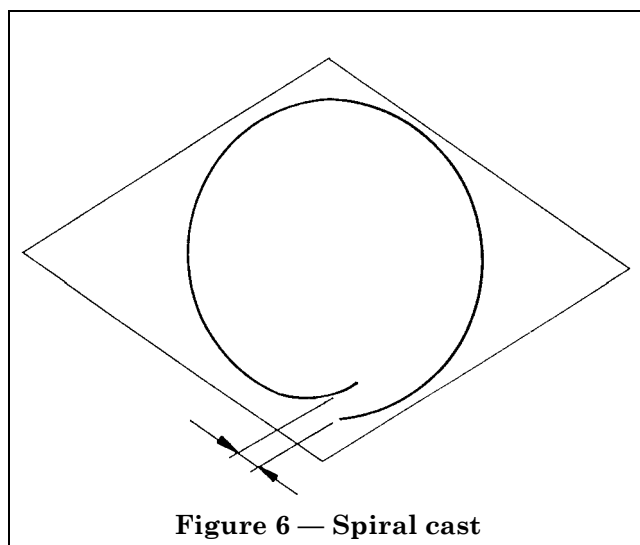


Figure 6 — Spiral cast

15 Artificial ageing

If natural ageing conditions are to be simulated the test piece shall be heated to a minimum of $(100 \pm 5)^\circ\text{C}$ and held at that temperature for at least $1\text{ h} \pm 5\text{ min}$ 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 EURONORM 104. 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 EURONORM 103.

19 Segregation test

Segregation test shall be in accordance with EN 10016-1.

20 Non-metallic inclusion test

Non-metallic inclusion test shall be in accordance with EN 10YYY (in preparation).

21 Chemical analysis

The chemical composition shall be determined in accordance with the appropriate European Standards or Euronorms.

22 Retests

EN 10021 shall apply in respect of all retests.



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National annex NA (informative)

Committees responsible

The United Kingdom participation in the preparation of this European Standard was entrusted by the Iron and Steel Standards Policy Committee (ISM/-) to Technical Committee ISM/26 upon which the following bodies were represented:

Aluminium Federation
 Bicycle Association of GB
 British Cable Makers' Confederation
 British Rubber Manufacturers' Association Ltd.
 British Steel Industry
 Federation of Wire Rope Manufacturers of Great Britain
 Forestry Commission
 Health and Safety Executive
 National Centre of Tribology
 Society of Chain Link Fencing Manufacturers
 Society of Motor Manufacturers and Traders Limited
 Spring Research and Manufacturers' Association
 Stainless Steel Fabricators' Association of Great Britain
 Stainless Steel Wire Industry Association
 Welding Manufacturers' Association (BEAMA Ltd.)
 Woven Wire Association
 Zinc Development Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

BEAMA Ltd.
 British Industrial Fasteners Federation
 Fencing Industry Association
 Wire Products Association

National annex NB (informative)

Cross-references

| Publication referred to | Corresponding British Standard |
|-------------------------|---|
| EN 10002-1:1990 | BS EN 10002 <i>Tensile testing of metallic materials</i> Part 1:1990 <i>Method of test at ambient temperature</i> |
| EN 10002-5:1991 | Part 5:1992 <i>Method of test at elevated temperatures</i> |
| EN 10003-1 ^a | BS EN 10003 ^a <i>Metallic materials: Hardness testing — Brinell</i> Part 1 <i>Method of test</i> |
| EN 10016-1 ^a | BS EN 10016 ^a <i>Non-alloy steel rod for drawing and/or cold rolling</i> Part 1 <i>General requirements</i> |
| EN 10021 ^a | BS EN 10021 ^a <i>General technical delivery conditions for steel and iron and steel products</i> |
| EN 10109-1 ^a | BS EN 10109 ^a <i>Metallic materials: Hardness testing</i> Part 1 <i>Rockwell test (scales A-B-C-D-E-F-G-H-K) and Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T and 45T)</i> |

^a In preparation.

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