BS EN 10270-3:2011

BSI Standards Publication

Steel wire for mechanical springs

Part 3: Stainless spring steel wire

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National foreword

This British Standard is the UK implementation of EN 10270-3:2011. It supersedes BS EN 10270-3:2001 which is withdrawn.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.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 10270-3:2011) 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of an identical text or by endorsement, at the latest by April 2012, and conflicting national standards shall be withdrawn at the latest by April 2012.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 10270-3:2001.

This European Standard for steel wire for mechanical springs is composed of the following parts:

— *Part 1: Patented cold drawn unalloyed spring steel wire*;

— *Part 2: Oil hardened and tempered spring steel wire*;

— *Part 3: Stainless spring steel wire*.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

1.1 This European Standard applies to the grades of stainless steels listed in Table 1, which are usually used in the cold drawn condition in the form of wire of circular cross-section up to 10,00 mm in diameter, for the production of springs and spring parts that are exposed to corrosive effects and sometimes to slightly increased temperatures (see A.1).

1.2 In addition to the steels listed in Table 1 certain of the steel grades covered by EN 10088-3 e.g. 1.4571, 1.4539, 1.4028 are also used for springs, although to much lesser extent. In these cases the mechanical properties (tensile strength, etc.) should be agreed between purchaser and supplier. Similarly, diameters between 10,00 mm and 15,00 mm may be ordered according to this standard; in this case the parties should agree upon the required mechanical characteristics.

1.3 In addition to this European Standard the general technical delivery requirements of EN 10021 are applicable.

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 10027-1:2005, *Designation systems for steels — Part 1: Steel names*

EN 10027-2:1992, *Designation systems for steels — Part 2: Numerical system*

EN 10088-3, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 10218-1, *Steel wire and wire products — General — Part 1: Test methods*

EN 10218-2, *Steel wire and wire products — General — Part 2: Wire dimensions and tolerances*

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 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1:2009)*

EN ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

3 Information to be supplied by the purchaser

The purchaser shall clearly state in his enquiry or order the product and following information:

a) the desired quantity;

b) the term spring steel wire or straightened and cut lengths;

c) the number of this European Standard: EN 10270-3;

d) the steel grade (see Table 1) and for grade 1.4301, 1.4310 and 1.4462 also the tensile strength level (see Table 2);

e) the nominal wire diameter (see Table 4) and for cut length the length and the length tolerance class (see Table 6);

f) the surface finish (see 4.3, i.e. coating);

g) the form of delivery (see 4.2);

h) the type of inspection document to be supplied (see 5.1);

i) any particular agreement made.

EXAMPLE 2 t stainless steel spring wire according to this standard, grade 1.4310, normal tensile strength level and nominal diameter 2,50 mm, nickel coated in coils with inspection document 3.1 according to EN 10204:2004:

2 t spring steel wire EN 10270-3 – 1.4310-NS – 2,50 - Ni-coated in coils, EN 10204:2004 – 3.1

4 Requirements

4.1 Manufacturing process

Unless otherwise agreed in the order, the manufacturing process used in the making of the stainless steel wire is left to the discretion of the manufacturer. The starting condition (+AT: solution annealed) of the wire (rod) is specified in EN 10088-3.

4.2 Form of delivery

The wire shall be supplied in coils, on spools, on spoolless cores or carriers. Several coils may be assembled on a carrier. Unless otherwise specified the form of delivery shall be at the manufacturer's discretion. They shall however inform the purchaser about the form of delivery.

The delivery requirements are specified in 4.7.

Wire in straight lengths is normally supplied in bundles.

4.3 Surface finish

The wire may be coated or not. The specific coating and finish for stainless steel spring wire shall be agreed upon at the time of enquiry and order - e.g. uncoated, polished finish, nickel coated.

4.4 Chemical composition

4.4.1 The requirements for the chemical composition given in Table 1 apply to the heat analysis.

4.4.2 The permissible deviation of the product analysis from the values specified in Table 1 shall be in accordance with the provision in EN 10088-3. For a single heat the deviation of an element in the product analysis may be only below the minimum or only above the maximum value of the range specified for the heat analysis, but not both at the same time.

Table 1 — Chemical composition — Heat analysis[a] (% by mass)

Steel grade		C	Si	Mn	P	S	Cr	Mo	Ni	Other elements
			max.	max.	max.	max.				
Name[b]	Number[b]									
X10CrNi18-8	1.4310	0,05 to 0,15	2,00	2,00	0,045	0,015	16,0 to 19,0	≤ 0,80	6,0 to 9,5	N ≤ 0,11
X5CrNiMo17-12-2	1.4401[c]	≤ 0,07	1,00	2,00	0,045	0,015	16,5 to 18,5	2,00 to 2,50	10,0 to 13,0	N ≤ 0,11
X7CrNiAl17-7	1.4568[d]	≤ 0,09	0,70	1,00	0,040	0,015	16,0 to 18,0	-	6,5 to 7,8	Al: 0,70 to 1,50
X5CrNi18-10	1.4301	≤ 0,07	1,00	2,00	0,045	0,015	17,5 to 19,5	-	8,0 to 10,5	N ≤ 0,11
X1NiCrMoCu25-20-5	1.4539	≤ 0,020	0,70	2,00	0,030	0,010	19,0 to 21,0	4,0 to 5,0	24,0 to 26,0	N ≤ 0,15 Cu: 1,20 to 2,00
X2CrNiMoN22-5-3	1.4462[e]	≤ 0,030	1,00	2,00	0,035	0,015	21,0 to 23,0	2, 50 to 3,5	4,5 to 6,5	N: 0,10 to 0,22

[a] Alternative compositions may be used by agreement.

[b] "Name" and "Number" are derived in accordance with EN 10027-1 and -2 respectively.

[c] Steel 1.4436 may be used to provide increased corrosion resistance compared with 1.4401, with the specification of this part of EN 10270 applicable for steel 1.4401.

[d] For better cold formability the upper limit of nickel content may be increased up to 8,30 %.

[e] Duplex grades.

4.5 Mechanical properties

4.5.1 For the tensile strength in the as drawn condition the data of Table 2 shall apply.

Table 2 — Tensile strength in the drawn condition

Nominal diameter mm [g]	Tensile strength (MPa) [a b c d e f] for the following steel grades																	
	1.4310				1.4401		1.4568		1.4301			1.4539		1.4462				
	Normal tensile strength (NS) -		High tensile strength (HS) -						Normal tensile strength (NS)	High tensile strength (HS)				Normal tensile strength (NS) -		High tensile strength (HS) -		
	min.	max.	min.	max.	min.	max.	min.	max.	min.	min.	max.	min.	max.	min.	max.	min.	max.	
$d \leq 0{,}20$	2 200	2 530	2 350	2 710	1 725	1 990	1 975	2 280	2 000	2150	2 300	1 600	1 840	2 150	2 480	2 370	2 730	
$0{,}20 < d \leq 0{,}30$	2 150	2 480	2 300	2 650	1 700	1 960	1 950	2 250	1 975	2050	2 280	1 550	1 790	2 100	2 420	2 370	2 730	
$0{,}30 < d \leq 0{,}40$	2 100	2 420	2 250	2 590	1 675	1 930	1 925	2 220	1 925	2050	2 220	1 550	1 790	2 000	2 300	2 370	2 730	
$0{,}40 < d \leq 0{,}50$	2 050	2 360	2 200	2 530	1 650	1 900	1 900	2 190	1 900	1950	2 190	1 500	1 750	2 000	2 300	2 370	2 730	
$0{,}50 < d \leq 0{,}65$	2 000	2 300	2 150	2 480	1 625	1 870	1 850	2 130	1 850	1950	2 130	1 450	1 670	1 900	2 190	2 370	2 730	
$0{,}65 < d \leq 0{,}80$	1 950	2 250	2 100	2 420	1 600	1 840	1 825	2 100	1 800	1850	2 070	1 450	1 670	1 900	2 190	2 230	2 570	
$0{,}80 < d \leq 1{,}00$	1 900	2 190	2 050	2 360	1 575	1 820	1 800	2 070	1 775	1850	2 050	1 400	1 610	1 800	2 070	2 140	2 470	
$1{,}00 < d \leq 1{,}25$	1 850	2 130	2 000	2 300	1 550	1 790	1 750	2 020	1 725	1750	1 990	1 350	1 560	1 800	2 070	2 090	2 410	
$1{,}25 < d \leq 1{,}50$	1 800	2 070	1 950	2 250	1 500	1 730	1 700	1 960	1 675	1750	1 930	1 350	1 560	1 700	1 960	2 090	2 410	
$1{,}50 < d \leq 1{,}75$	1 750	2 020	1 900	2 190	1 450	1 670	1 650	1 900	1 625	1650	1 870	1 300	1 500	1 700	1 960	2 000	2 300	
$1{,}75 < d \leq 2{,}00$	1 700	1 960	1 850	2 130	1 400	1 610	1 600	1 840	1 575	1650	1 820	1 300	1 500	1 700	1 960	2 000	2 300	
$2{,}00 < d \leq 2{,}50$	1 650	1 900	1 750	2 020	1 350	1 560	1 550	1 790	1 525	1550	1 760	1 300	1 500	1 550	1 790	1 900	2 190	
$2{,}50 < d \leq 3{,}00$	1 600	1 840	1 700	1 960	1 300	1 500	1 500	1 730	1 475	1550	1 700	1 300	1 500	1 550	1 790	1 860	2 140	
$3{,}00 < d \leq 3{,}50$	1 550	1 790	1 650	1 900	1 250	1 440	1 450	1 670	1 425	1450	1 640	1 300	1 500	1 550	1 790	–	–	
$3{,}50 < d \leq 4{,}25$	1 500	1 730	1 600	1 840	1 225	1 410	1 400	1 610	1 400	1450	1 610	1 250	1 440	1 450	1 670	–	–	
$4{,}25 < d \leq 5{,}00$	1 450	1 670	1 550	1 790	1 200	1 380	1 350	1 560	1 350	1350	1 560	1 250	1 440	1 450	1 670	–	–	
$5{,}00 < d \leq 6{,}00$	1 400	1 610	1 500	1 730	1 150	1 330	1 300	1 500	1 300	1350	1 500	1 250	1 440	1 350	1 560	–	–	
$6{,}00 < d \leq 7{,}00$	1 350	1 560	1 450	1 670	1 125	1 300	1 250	1 440	1 250	1300	1 440	1 200	1 380	1 350	1 560	–	–	
$7{,}00 < d \leq 8{,}50$	1 300	1 500	1 400	1 610	1 075	1 240	1 250	1 440	1 200	1300	1 380	1 150	1 330	–	–	–	–	
$8{,}50 < d \leq 10{,}00$	1 250	1 440	1 350	1 560	1 050	1 210	1 250	1 440	1 175	1250	1 360	–	–	–	–	–	–	

a Tensile strength calculated on actual diameter.

b The range of tensile strength values within a production batch of the same heat shall be a maximum of 9 % of the minimum values in this table.

c After straightening, it is recognized that the tensile strength may reduce by up to 10 % but the minimum values of this Table have to be fulfilled.

d When better formability is required, lower tensile strength values may be agreed upon.

e The wire is supplied in the cold drawn condition. The tensile strength in the finished spring may be substantially influenced by a heat treatment; particularly precipitation hardening of grade 1.4568 results in substantially higher tensile strength (see A.5.2 and Table A.3).

f 1 MPa = 1 N/mm^2.

g Larger diameters may be specified in which case the parties shall agree the tensile strength at the time of enquiry and order.

NOTE 1 Grade 1.4310 and 1.4462 can be delivered in normal tensile strength (NS) or high tensile strength (HS).

NOTE 2 For steel 1.4568 the characteristics of the springs are not only determined by the characteristics of the drawn wire but also by the heat-treatment of the spring (see A.2). Therefore the steel should be of such quality so that by the heat treatment after drawing the mechanical properties are met.

4.5.2 In addition to the requirements of Table 2 the maximum tensile strength range within one unit package (individual coil, spool or reel,..) shall satisfy Table 3.

For straightened and cut lengths the values of Table 3 apply for the individual bundles.

Table 3 — Tensile strength range within an individual unit package (coil/spool/bundle)

Wire diameter d (mm)	**Max. range** (MPa)
$d \leq 1{,}50$	100
$1{,}50 < d \leq 10{,}00$	70

4.6 Technological properties

4.6.1 Coiling test

For evaluation of uniformity of coiling and surface condition the coiling test may be applied to wire with a diameter of 0,50 mm to 1,50 mm. The spring coiled in accordance with 5.4.3 shall show a defect free surface condition without splits or fracture; the coil shall have uniform pitch of the turns and a fair dimensional regularity of its diameter.

NOTE Although the usefulness of the coiling test is not generally recognized, it has been retained since it offers the possibility of revealing internal stresses. If doubtful test results are obtained the wire concerned should not be rejected immediately but efforts should be made by the parties concerned to elucidate the cause.

4.6.2 Wrapping test

The wrapping test may be applied to wire with a diameter of 0,30 mm to 3,00 mm. The wire shall not show any sign of cracks or surface imperfections when closely wrapped eight turns around a mandrel of a diameter equal to the wire size (see also 5.4.4).

4.6.3 Simple bend test

Where requested, the bend test may be applied for wire with a diameter over 3,00 mm. The wire shall withstand the test without any sign of failure.

NOTE In some applications the material is severely deformed by bending. Such is the case for extension springs with tight hooks, springs with bends on legs, spring wire forms, etc. In such cases the bend test provides for a wire test very close to actual use.

4.7 Supply conditions of wire on coils/reels and spools

4.7.1 General

The wire of each coil shall consist of one single length of wire originating from only one heat. It shall be wound so that there are no kinks.

Where wire is delivered on spools, spoolless cores or carriers up to 10 % of those may consist of a maximum of two wire lengths. The joints shall be properly made, suitably marked and labelled.

4.7.2 Coil size

The internal diameter of unit packages (coil/reels or spools) shall reach at least the values given in Table 4, unless otherwise agreed.

Table 4 — Wire diameter and associated minimum coil internal diameter

Wire diameter (d) (mm)	**Minimum internal diameter** (mm)
$0,18 \leq d \leq 0,28$	100
$0,28 < d \leq 0,50$	150
$0,50 < d \leq 0,70$	180
$0,70 < d \leq 1,60$	250
$1,60 < d \leq 4,50$	400
$4,50 < d$	500

4.7.3 Circular wire cast

The wire shall be uniformly cast and take a circular cast. Unless otherwise specified the wap diameter of the wire supplied in coils/reels may expand when the binding wires are removed, but should usually not retract to less than the unit internal diameter, other than by agreement between supplier and purchaser. The expansion shall be approximately even within a single unit package and within all the units in a production batch.

4.7.4 Helix cast of wire

The wire shall be dead cast, free from helix cast. The requirement shall be considered fulfilled in the case of wire below 5,00 mm if the following condition is satisfied.

An individual wap taken from a unit package and freely hung on a hook may show an axial displacement ' f_a' at the ends of the wap (see Figure 1); the displacement f_a shall not exceed a value given by the following equation:

$$f_a \leq \frac{0,2W}{\sqrt[4]{d}}$$

where

f_a the axial displacement in mm;

W the diameter of the free wap in mm;

d the diameter of the wire in mm.

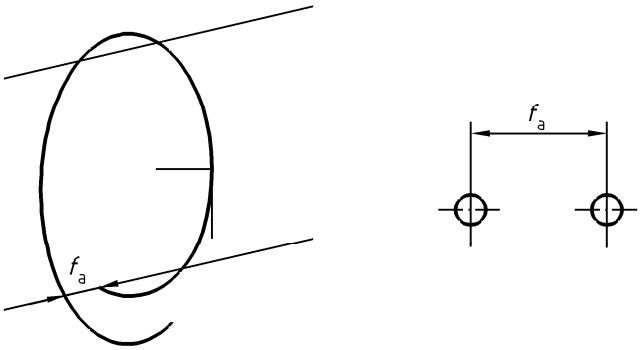


Figure 1 — Helix cast of wire

4.8 Surface quality

4.8.1 The surface of the wire shall be as far as practically possible free from grooves, pits and other surface defects, which could impair proper use of the wire. One method to reveal surface discontinuities is the reverse torsion test (see 5.4.6).

4.8.2 In cases where the wire is intended for high-duty springs, the purchaser and the supplier may agree at the time of order about special surface requirements and tests.

4.9 Inner soundness

The wire shall be sound and free from any inhomogenity or defect which significantly limits its use.

Tests appropriate for an assessment of the inner soundness of the wire, such as the wrapping test, may be agreed upon at the time of ordering.

4.10 Dimensions and dimensional tolerances

4.10.1 Tolerances on diameter

The tolerances on diameter are given in Table 5:

Table 5 — Diameter tolerances

Nominal diameter (d) (mm)	**Diameter tolerance** (mm)				
	Spools or coils				Cut lengths
	T12	T13	T14	T15	T14
$d \leq 0{,}20$	± 0,010	± 0,008	± 0,005	± 0,004	+ 0,009 - 0,005
$0{,}20 < d \leq 0{,}25$	± 0,010	± 0,008	± 0,005	± 0,004	+ 0,009 - 0,005
$0{,}25 < d \leq 0{,}40$	± 0,015	± 0,010	± 0,008	± 0,005	+ 0,018 - 0,008
$0{,}40 < d \leq 0{,}64$	± 0,015	± 0,010	± 0,008	± 0,005	+ 0,018 - 0,008
$0{,}64 < d \leq 0{,}80$	± 0,020	± 0,015	± 0,010	± 0,008	+ 0,025 - 0,010
$0{,}80 < d \leq 1{,}00$	± 0,020	± 0,015	± 0,010	± 0,008	+ 0,025 - 0,010
$1{,}00 < d \leq 1{,}60$	± 0,025	± 0,020	± 0,015	± 0,010	+ 0,040 - 0,015
$1{,}60 < d \leq 2{,}25$	± 0,025	± 0,020	± 0,015	± 0,010	+ 0,050 - 0,015
$2{,}25 < d \leq 3{,}19$	± 0,030	± 0,025	± 0,020	± 0,015	+ 0,070 - 0,020
$3{,}19 < d \leq 4{,}00$	± 0,030	± 0,025	± 0,020	± 0,015	+ 0,080 - 0,020
$4{,}00 < d \leq 4{,}50$	± 0,035	± 0,030	± 0,025	± 0,020	+ 0,100 - 0,025
$4{,}50 < d \leq 6{,}00$	± 0,035	± 0,030	± 0,025	± 0,020	+ 0,120 - 0,025
$6{,}00 < d \leq 6{,}25$	± 0,035	± 0,030	± 0,025	± 0,020	+ 0,120 - 0,025
$6{,}25 < d \leq 7{,}00$	± 0,040	± 0,035	± 0,030	± 0,025	+ 0,135 - 0,030
$7{,}00 < d \leq 9{,}00$	± 0,040	± 0,035	± 0,030	± 0,025	+ 0,160 - 0,030
$9{,}00 < d \leq 10{,}00$	± 0,045	± 0,040	± 0,035	± 0,030	+ 0,185 - 0,035

4.10.2 Out of roundness

The out of roundness, i.e. the difference between the maximum and minimum diameter of the wire in the same cross section of the wire, shall not be more than 50 % of the total permissible deviation for wire in coils, specified in Table 5. For special applications tighter tolerances may be agreed at the time of enquiry and order.

4.10.3 Tolerance on the length of straightened and cut lengths

The requirements for length tolerance and straightness are as in EN 10218-2. The tolerance on the length shall only be on the positive keeping the same tolerance range (see Table 6).

Table 6 — Tolerance on the length of straightened and cut wire

Nominal length (l) (mm)	Length tolerance		
	Class 1	Class 2	Class 3
$l \leq 300$	$^{+1,00}_{0}$ mm	$^{+1}_{0}$ %	$^{+2}_{0}$ %
$300 < l \leq 1\,000$	$^{+2,00}_{0}$ mm		
$1\,000 < l$	$^{+0,2}_{0}$ %		

5 Testing and inspection

5.1 Inspection and inspection documents

Products conforming with this standard shall be delivered with specific testing (see EN 10021) and the relevant inspection document (see EN 10204) agreed at the time of enquiry and order.

The inspection document shall include the following information:

— the document number;

— the date of issue;

— the customer's order number and name;

— the confirmation that the material complies with the requirements of the order;

— the tests, the results and where appropriate presented in a statistical manner;

— the identification by production lot number and heat number;

— the heat analysis;

— results of optional tests agreed.

5.2 Extent of testing for specific testing

The extent of testing shall be in accordance with Table 7.

Table 7 — Extent of testing and sampling for specific testing and summary of the information on test procedure and requirements

	1	2	3	4	5	6	7	8	9	10
	Test method	Applies to wire diameters and wire grades	Mandatory / optional [a]	Test unit	Number of products per test unit	Number of samples per product	Number of test pieces per sample	Sampling	Test procedure acc. to	Requirements See …..
1	Product analysis	All	O [b]	Quantity supplied per heat	1	1	1	As per EN ISO 14284	5.4.1	4.4
2	Tensile test	All	m	Quantity supplied per production batch [d]	10 % [c]	1	1	Test pieces taken from the ends of the coils	5.4.2	4.5
3	Coiling test	0,5 mm ≤ d ≤ 1,5 mm	o		The scope of testing shall be agreed on ordering.				5.4.3	4.6.1
4	Wrapping test	0,3 mm ≤ d ≤ 3 mm	o						5.4.4	4.6.2
5	Bend test	d > 3 mm	o						5.4.5	4.6.3
6	Wire cast characteristics	All	m		10 % [c]	1	1		5.4.7	4.7.3 4.7.4
7	Testing for surface quality	All	o		To be agreed at the order				5.4.6	4.8
8	Check on dimensions	All	m		100 %	1	1		EN 10218-2	4.10

[a] m (= mandatory): the test is to be carried out in each case / o (= optional): the test is carried out only if so agreed at the time of ordering.

[b] The results of the cast analysis for the elements listed in Table 1 for the grade concerned shall be notified to the customer in all cases.

[c] 10 % of the wire units in the production batch, at least 2 but no more than 10 coils/reels or spools.

[d] A production batch is defined as a quantity of production originating from the same cast, which has been subjected to the same conditions of heat treatment, and with the same reduction in cross-section and with the same surface finish.

5.3 Sampling

Sampling and testing preparation shall be in accordance with EN ISO 377 and EN ISO 14284.

Samples shall be taken at the end of the coils, reels or spools or at random for wire in the form of straightened and cut lengths. Table 7/column 8 gives further details.

5.4 Test methods

5.4.1 Chemical composition

Unless otherwise agreed at the time of ordering the choice of a suitable physical or chemical method of analysis for the determination of product analysis shall be at the discretion of the supplier.

In cases of dispute the analysis shall be carried out by a laboratory approved by the two parties. The method of analysis to be applied shall be agreed upon, where possible in accordance with CEN/TR 10261.

5.4.2 Tensile test

The tensile test shall be carried out according to EN ISO 6892-1, on samples with the full cross-section of the wire. For the calculation of the tensile strength the actual cross-section based on the actual wire diameter is applied.

5.4.3 Coiling test

The coiling test shall be carried out in the following manner: A test piece - approximately 500 mm in length - shall be closely wound, under slight but reasonably uniform tension on a mandrel three to three and a half times the nominal diameter. The mandrel diameter shall however be at least 1,00 mm. The close coil shall be stretched so that after releasing the stress it sets to approx. three times its original length.

The surface condition of the wire and the regularity of the spring pitch and individual windings shall be inspected with the test piece in this condition.

5.4.4 Wrapping test

The wrapping test for ductility shall be carried out according to EN 10218-1. The wire shall be wrapped 8 turns around a mandrel with a diameter equal to the wire diameter.

5.4.5 Simple bend test

For the bend test a wire sample of sufficient length shall be bent in U form around a mandrel with a diameter equal to twice the wire diameter for sizes above 3,00 mm to 6,50 mm and equal to three times the wire diameter for sizes above 6,50 mm. For practical reasons the wire shall be deemed to have met the requirements of this standard if it withstands bending around a mandrel smaller than the one specified.

In carrying out the test the wire shall be free to move longitudinally in the forming device.

5.4.6 Reverse torsion test

The torsion test shall be carried out according to EN 10218-1 with the specific requirement that the wire is twisted first 2 complete turns in one direction and then 2 turns back in the other direction without revealing surface cracks visible to the naked eye.

The distance between the clamps shall be 100 d with a maximum of 300 mm.

5.4.7 The wire cast

The circular and helix cast as defined in EN 10218-1 shall be tested on a sufficiently long piece of wire so as to form a full free wap (single convolution of wire) ensuring that it is not bent or mechanically damaged.

5.5 Retests

Retests shall be carried out according to EN 10021.

6 Marking and packaging

Each unit shall be properly marked and identified so as to permit identification, traceability and reference to the inspection documents. The labels shall withstand normal handling and show the information according to Table 8. Other information shall be subject of an agreement between the parties.

Wire shipments shall be suitably protected against mechanical damage and/or contamination during transport.

Table 8 — information on the labels [a]

Designation	+
Manufacturer	+
Nominal diameter	+
Steel grade	+
Tensile strength grade	+ [b]
Surface finish	(+)
Cast number	(+)
Identification number	+ [b]
Coating	+ [b]
[a] The symbols in the table mean: + The information shall be mentioned on the labels (+) The information shall be mentioned on the labels if so agreed. [b] Only where applicable.	

Annex A
(informative)

Additional information

A.1 Indications for classification of steel grades

Depending on stress, the maximum temperature of use of the steel grade number 1.4310 is up to 250 °C.

If greatest resistance to corrosion is required for one of the steels covered by this part of EN 10270, the austenitic grade number 1.4401 may be used, also depending on stress for a maximum temperature of use up to 250 °C.

The maximum for the precipitation-hardenable austenitic-martensitic steel grade number 1.4568 is up to 300 °C depending on stress. This steel has a high fatigue strength and an increased strength at elevated temperatures, but a reduced resistance to corrosion.

The various grades of steel have slightly different values for the modulus of elasticity, determined on longitudinal test pieces, and for the shear modulus (see Table A.1). It should be taken into account that with increasing temperature the values of the modulus of elasticity and shear modulus decrease.

Table A.1 — Reference data for the modulus of elasticity and shear modulus (mean values) [a] [b] [c]

Steel grade		Modulus of elasticity [a]		Shear modulus [b]	
Name	Number	Delivery condition GPa [d]	Condition HT [e] GPa [d]	Delivery condition GPa [d]	Condition HT [e] GPa [d]
X10CrNi18-8	1.4310	180	185	70	73
X5CrNiMo17-12-2	1.4401	175	180	68	71
X7CrNiAl17-7	1.4568	190	200	73	78
X5CrNi18-10	1.4301	185	190	65	68
X2CrNiMoN22-5-3	1.4462	200	205	77	79
X1NiCrMoCu25-20-5	1,4539	180	185	69	71

[a] The reference data for the modulus of elasticity (E) are calculated from the shear modulus (G) by means of the formula $G = E/2(1+\nu)$ where ν (Poisson's constant) is set to 0,3. The data are applicable for a mean tensile strength of 1 800 MPa. For a mean tensile strength of 1 300 MPa, the values are 6 GPa lower. Intermediate values may be interpolated.

[b] The reference data for the shear modulus (G) are applicable to wires with a diameter ≤ 2,8 mm for measurements by means of a torsion pendulum, for a mean tensile strength of 1 800 MPa. For a mean tensile strength of 1 300 MPa, the values are 2 GPa lower. Intermediate values may be interpolated. Values ascertained by means of an Elastomat are not always comparable with values ascertained by means of a torsion pendulum.

[c] For the finished spring, lower values may be ascertained. Therefore, standards for calculation of springs may specify values different from those given here on the basis of measurement of wire.

[d] 1 MPa = 1 N/mm^2, 1 GPa = 1 kN/mm^2.

[e] HT treated: See A.5 and Table A.2.

A.2 Alteration of tensile strength by heat treatment

The heat treatment of stress-relieving (tempering) or in the case of steel grade 1.4568 precipitation hardening will increase tensile strength and yield strength values as compared with the cold drawn condition (+C). Heat treatments of this kind will also reduce the internal stresses in the wire produced by drawing and spring forming.

The increase in the tensile strength of grade 1.4568 caused by the precipitation hardening is greater than that caused by the stress relieving of other grades in this standard. Where the wire has been straightened before the heat treatment, the loss in tensile strength caused by the straightening can be almost compensated for.

Consequently, final stress-relieving or precipitation hardening of the finished springs is a basic recommendation. Reference data for the heat treatment are given in A.5.2 and Table A.2.

Data on the increase in tensile strength by this heat treatment are given in Figure A.1, Table A.3 for 1.4568+P, Table A.4 for 1.4462 and Table A.5 for 1.4538.

The heat treatment can cause out of straightness and also some discolouration.

A.3 Physical properties

Reference data for the modulus of elasticity and shear modulus are given in Table A.1. Further physical properties (e.g. density,...) are given in EN 10088-1.

A.4 Magnetic properties

It should be noted that, depending upon chemical composition and degree of cold deformation condition, these steels show some degree of magnetic permeability. (See EN 10088-1.)

A.5 Guidelines for processing and heat treatment

A.5.1 Spring forming

Forming is carried out by cold deformation. Therefore, account has to be taken of the fact that the deformability of cold-worked, cold-drawn wire is limited. Depending on the forming requirements, a lower tensile strength may be agreed upon when ordering (see Footnote d to Table 2).

Table A.2 — Reference data for heat treatment of springs made of wire [a] [b] [c] (see also A.5.2)

Steel grade		Temperature	Duration	Means of cooling
Name	Number	(°C)		
X10CrNi18-8	1.4310 [d]	250 to 425	30 min to 4 h	air
X5CrNiMo17-12-2	1.4401 [d]	250 to 425	30 min to 4 h	air
X7CrNiAl17-7	1.4568	450 to 480	30 min to 1 h	air
X5CrNi18-10	1.4301 [d]	250 to 425	30 min to 4 h	air
X2CrNiMoN22-5-3	1.4462 [d]	250 to 450	1h to 3h	air
X1NiCrMoCu25-20-5	1.4539 [d]	250 to 425	30 min to 4 h	air

NOTE Generally, tension springs and torsion springs with initial tension are not to be treated at the same high temperature as above mentioned springs. If moderate loss of initial tension can be accepted, heat treatment temperatures of max. 200 °C for grades number 1,4301, 1.4310, 1.4401 and 300 °C for grade number 1.4568 are recommended.

[a] See classification of the tensile strength data in Table 2 and Figure A.1.

[b] The optimum heat treatment conditions may be very different. The spring manufacturer shall choose those conditions answering the purpose - see also A.5.2.1.

[c] The heat treatment data refer to compression springs, torsion and tension (springs without initial tension).

[d] The lower temperature is recommended for extension springs with prestress.

A.5.2 Heat treatment

A.5.2.1 Table A.2 contains reference data on heat treatment to be carried out on finished springs in order to achieve suitable strength and elastic properties. In special cases, modified heat treatments, to be determined by practical trials, will be necessary to meet specific requirements.

A.5.2.2 If the colours produced by heat treatment are not permissible for visual or corrosion-resistance reasons, the springs may be suitable cleaned before the heat treatment or the heat treatment may be carried out in a protective atmosphere.

Table A.3 — Expected minimum tensile strength for precipitation hardened 1.4568

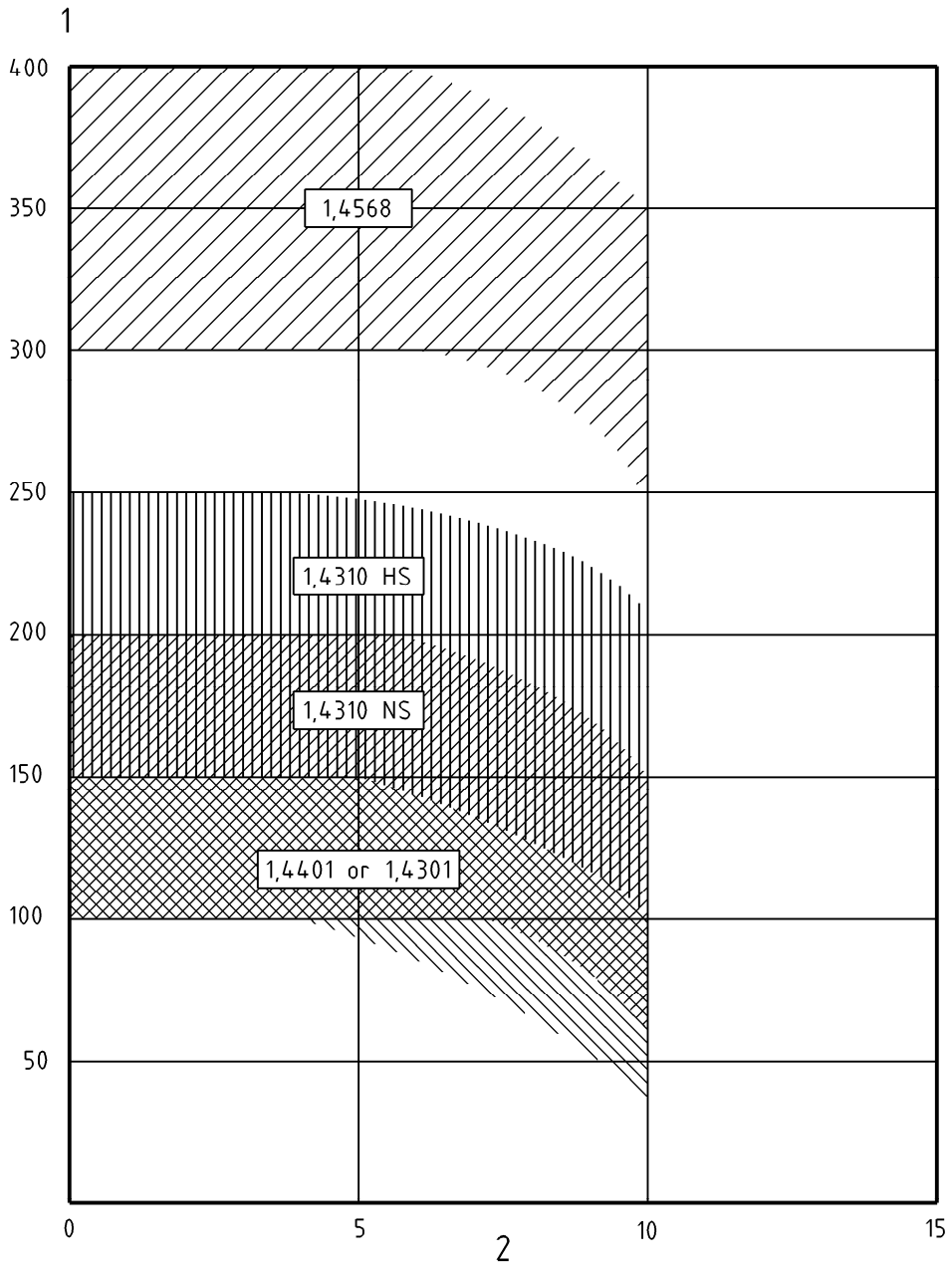
Nominal diameter (mm)	Tensile strength (MPa)
$d \leq 0{,}20$	2 275
$0{,}20 < d \leq 0{,}30$	2 250
$0{,}30 < d \leq 0{,}40$	2 225
$0{,}40 < d \leq 0{,}50$	2 200
$0{,}50 < d \leq 0{,}65$	2 150
$0{,}65 < d \leq 0{,}80$	2 125
$0{,}80 < d \leq 1{,}00$	2 100
$1{,}00 < d \leq 1{,}25$	2 050
$1{,}25 < d \leq 1{,}50$	2 000
$1{,}50 < d \leq 1{,}75$	1 950
$1{,}75 < d \leq 2{,}00$	1 900
$2{,}00 < d \leq 2{,}50$	1 850
$2{,}50 < d \leq 3{,}00$	1 800
$3{,}00 < d \leq 3{,}50$	1 750
$3{,}50 < d \leq 4{,}25$	1 700
$4{,}25 < d \leq 5{,}00$	1 650
$5{,}00 < d \leq 6{,}00$	1 550
$6{,}00 < d \leq 7{,}00$	1 500
$7{,}00 < d \leq 8{,}50$	1 500
$8{,}50 < d \leq 10{,}00$	1 500

Table A.4 — Expected minimum tensile strength increase for 1.4462

Nominal diameter (mm)	Tensile strength (MPa)
$0{,}20 \leq d \leq 1{,}00$	300 to 450
$1{,}00 < d \leq 8{,}5$	200 to 400

Table A.5 — Expected minimum tensile strength increase for 1.4539

Nominal diameter (mm)	Tensile strength (MPa)
$0{,}15 \leq d \leq 8{,}5$	50 to 100



Key

1 Increase in tensile strength, MPa
2 Wire diameter, mm

Figure A.1 — Reference data for the increase in tensile strength of cold drawn wire by heat treatment (see Table A.2)

Annex B
(informative)

Cross reference of steel grade designations

Table B.1 — Cross reference of steel grade designations

Designation in EN 10270-3		Corresponding former designation					ISO-designation
According to EN 10027-1:2005	According to EN 10027-2:1992	DIN 17224:1982		AFNOR	BS 2056:1991	MMS 900	ISO 6931-1:1994
X10CrNi18-8	1.4310	X 12 CrNi 17-7	1.4310	Z 12 CN 18-09	302S26	SS-steel 2331	Number 1 X 9 CrNi 18-8
X5CrNiMo17-12-2	1.4401	X 5 CrNiMo 18-10	1.4401	Z 7 CND 17-11-02	316S42	SS-steel 2347	Number 2 X 5 CrNiMo 17-12-2
X7CrNiAl17-7	1.4568	X 7 CrNiAl 17-7	1.4568	Z 9 CNA 17-07	301S81	SS-steel 2388	Number 3 X 7 CrNiAl 17-7
X5CrNi18-10	1.4301	X 5 CrNi 18-10	1.4301	Z 7 CN 18-09	304S17	—	—

Bibliography

[1] EN 10088-1, *Stainless steels — Part 1: List of stainless steels*

[2] ISO 6931-1:1994, *Stainless steels for springs — Part 1: Wire*

[3] BS 2056:1991, *Specification for stainless steel wire for mechanical springs*

[4] DIN 17224:1982, *Federdraht und Federband aus nichtrostenden Stählen; Technische Lieferbedingungen*

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