BS EN 10270-2:2011

BSI Standards Publication

Steel wire for mechanical springs

Part 2: Oil hardened and tempered spring steel wire

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National foreword

This British Standard is the UK implementation of EN 10270-2:2011. It supersedes BS EN 10270-2:2001 which is withdrawn.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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This European Standard was approved by CEN on 10 September 2011.

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Foreword

This document (EN 10270-2:2011) 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of an identical text or by endorsement, at the latest by April 2012, and conflicting national standards shall be withdrawn at the latest by April 2012.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 10270-2:2001.

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 oil hardened and tempered spring steel wire made from unalloyed or alloyed steels. They are primarily subject to torsional stresses such as in coil springs for compression and extension and in special cases also for applications where the spring wire is subject to bending stresses such as lever springs.

As a rule unalloyed steels are used for applications at room temperature whereas alloyed steels are generally used at a temperature above room temperature. Alloyed steels may also be chosen for above average tensile strengths.

1.2 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 10204:2004, *Metallic products — Types of inspection documents*

EN 10218-1:2011, *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*

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

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)*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
oil hardened and tempered spring steel wire
wire that is heat treated in line in the following way: it is first transformed into austenite, quenched in oil or similar quenching medium, followed immediately by tempering by heating to the appropriate temperature

4 Classification

This standard deals with all types of hardened and tempered spring steel wire. The grade for normal applications made from unalloyed or alloyed steel has the abbreviation FD and is intended for static applications.

Spring steel wire for medium fatigue levels, such as required for some clutch springs from unalloyed or alloyed steel, has the abbreviation TD.

Spring steel wire from unalloyed steel or alloyed steel intended for use under severe dynamic duty such as for valve springs or other springs with similar requirements has the abbreviation VD.

The diameter ranges for the various wire grades are shown in Table 1.

Table 1 — Spring wire grades and diameter range

Tensile strength	Static	Medium fatigue	High fatique
Low tensile strength	FDC	TDC	VDC
Medium tensile strength	FDCrV	TDCrV	VDCrV
High tensile strength	FDSiCr	TDSiCr	VDSiCr
Very high tensile strength	FDSiCrV	TDSiCrV	VDSiCrV
Diameter range (mm)	0,50 to 17,00	0,50 to 10,00	0,50 to 10,00

Medium and high fatigue grades TD and VD are characterized by high steel cleanliness, specific chemical, mechanical and technological parameters and a well defined surface condition in relation to the allowable depth of surface defects and decarburization.

The static grade FD is characterized by its chemical, mechanical and technological characteristics as well as by a specified surface condition concerning surface defects and decarburization.

5 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 10270-2;

d) the steel grade (see Tables 1 and 2);

e) the nominal wire diameter selected from Tables 4 or 5 and for cut length the length and the length tolerance class (see Table 9);

f) the form of delivery and unit mass (see 6.1);

g) the type of inspection document;

h) any particular agreement.

EXAMPLE 5 t oil hardened and tempered spring steel wire according to this standard, grade VDC, nominal diameter 2,50 mm in coils of about 300 kg; inspection document 3.1 according to EN 10204:2004:

5 t spring steel wire EN 10270-2 – VDC-2,50 in coils of about 300 kg; EN 10204:2004 – 3.1

6 Requirements

6.1 Form of delivery

6.1.1 Oil hardened and tempered wire shall be supplied in coils, on spools or in cut lengths. The wire in coils or on spools shall form one continuous length. Wire in coil may also be supplied on carriers containing one or more coils.

For "VD" and "TD" grades no welds are permitted after the heat treatments preceding the final drawing operation; for "FD" grades no welds shall be made at finished size unless agreed otherwise between the parties.

6.1.2 The supplied wire units shall be tightly bound to ensure that wire spiral waps do not spring out unexpectedly. The starting end shall be marked and at the coil ends the wire shall be covered with a protective cap.

6.2 Surface finish

The wire shall be protected against corrosion and mechanical damage. Unless otherwise specified the wire shall be delivered in slightly oiled condition.

6.3 Chemical composition

The steel is characterized by the heat analysis which shall be in accordance with the values of Table 2. The permissible deviation of the product analysis from the limiting values of heat analysis shall be in accordance with Table 3.

6.4 Non metallic inclusions

The "VD" grades shall be checked for maximum size of inclusion according to EN 10247. The allowable level of inclusions shall be agreed between the parties at the enquiry and order.

6.5 Mechanical properties

For tensile strength R_m and reduction in area after fracture (Z) the wire grades shall satisfy the values listed in Tables 4 and 5. Reduction of area is measured only for size 1,00 mm and above (see Tables 4, 5 and 11).

The range of the tensile strength values within a coil/reel shall not exceed 50 MPa for the grades "VD", 60 MPa for the grades "TD" and 70 MPa for the grades "FD".

Table 2 — Chemical composition, % by mass

Grade	C	Si	Mn [a]	P max.	S max.	Cu max.	Cr	V
VDC	0,60 to 0,75	0,15 to 0,30	0,50 to 1,00	0,020	0,020	0,06	- [b]	-
VDCrV	0,62 to 0,72	0,15 to 0,30	0,50 to 0,90	0,025	0,020	0,06	0,40 to 0,60	0,15 to 0,25
VDSiCr	0,50 to 0,60	1,20 to 1,60	0,50 to 0,90	0,025	0,020	0,06	0,50 to 0,80	-
VDSiCrV	0,50 to 0,70	1,20 to 1,65	0,40 to 0,90	0,020	0,020	0,06	0,50 to 1,00	0,10 to 0,25 [C]
TDC	0,60 to 0,75	0,10 to 0,35	0,50 to 1,20	0,020	0,020	0,10	- [b]	-
TDCrV	0,62 to 0,72	0,15 to 0,30	0,50 to 0,90	0,025	0,020	0,10	0,40 to 0,60	0,15 to 0,25
TDSiCr	0,50 to 0,60	1,20 to 1,60	0,50 to 0,90	0,025	0,020	0,10	0,50 to 0,80	-
TDSiCrV	0,50 to 0,70	1,20 to 1,65	0,40 to 0,90	0,020	0,020	0,10	0,50 to 1,00	0,10 to 0,25 [C]
FDC	0,60 to 0,75	0,10 to 0,35	0,50 to 1,20	0,030	0,025	0,12	- [b]	-
FDCrV	0,62 to 0,72	0,15 to 0,30	0,50 to 0,90	0,030	0,025	0,12	0,40 to 0,60	0,15 to 0,25
FDSiCr	0,50 to 0,60	1,20 to 1,60	0,50 to 0,90	0,030	0,025	0,12	0,50 to 0,80	-
FDSiCrV	0,50 to 0,70	1,20 to 1,65	0,40 to 0,90	0,030	0,025	0,12	0,50 to 1,00	0,10 to 0,25

a Manganese may be ordered with restricted range, but with a minimum range of 0,20 %.

b For heavy wire diameter (above 8,5 mm) chromium may be added up to 0,30 % for proper through hardening.

c For medium and high fatigue grades the range of vanadium content can be limited to 0,05 % to 0,15 %

Table 3 — Permissible deviation of the product analysis from the limiting values for the heat analysis

Chemical element	Wire grade	Permissible deviation % by mass
C	All	± 0,03
Si	SiCr, SiCrV	± 0,05
	other grades	± 0,03
Mn	All	± 0,04
P	All	+ 0,005
S	All	+ 0,005
Cu	All	+ 0,02
Cr	All	± 0,05
V	All	± 0,02

Table 4 — Mechanical and technological properties and quality requirements for wire grades FDC, FDCrV, FDSiCr and FDSiCrV

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Nominal wire diameter	Permissible deviations	Tensile strength R_m				Minimum reduction in area after fracture Z				Minimum number of twists in the torsion test N_t [a]			
		FDC [b]	FDCrV [b]	FDSiCr [b]	FDSiCrV [b]	FDC	FDCrV	FDSiCr	FDSiCrV	FDC	FDCrV	FDSiCr	FDSiCrV
mm	mm	MPa	MPa	MPa	MPa	%	%	%	%				
d = 0,50	± 0,010	1 900 to 2 100	2 000 to 2 200	2 100 to 2 300	2 280 to 2 430	–	–	–	–	–	–	–	–
0,50 < d ≤ 0,60		1 900 to 2 100	2 000 to 2 200	2 100 to 2 300	2 280 to 2 430								
0,60 < d ≤ 0,80		1 900 to 2 100	2 000 to 2 200	2 100 to 2 300	2 280 to 2 430								
0,80 < d ≤ 1,00	± 0,015	1 860 to 2 060	1 960 to 2 160	2 100 to 2 300	2 280 to 2 430								
1,00 < d ≤ 1,30		1 810 to 2 010	1 900 to 2 100	2 070 to 2 260	2 280 to 2 430								
1,30 < d ≤ 1,40	± 0,020	1 790 to 1 970	1 870 to 2 070	2 060 to 2 250	2 260 to 2 410								
1,40 < d ≤ 1,60		1 760 to 1 940	1 840 to 2 030	2 040 to 2 220	2 260 to 2 410								
1,60 < d ≤ 2,00		1 720 to 1 890	1 790 to 1 970	2 000 to 2 180	2 210 to 2 360					To be agreed	To be agreed	To be agreed	To be agreed
2,00 < d ≤ 2,50	± 0,025	1 670 to 1 820	1 750 to 1 900	1 970 to 2 140	2 160 to 2 310	45	45	45	45	upon	upon	upon	upon
2,50 < d ≤ 2,70		1 640 to 1 790	1 720 to 1 870	1 950 to 2 120	2 110 to 2 260								
2,70 < d ≤ 3,00		1 620 to 1 770	1 700 to 1 850	1 930 to 2 100	2 110 to 2 260								
3,00 < d ≤ 3,20	± 0,030	1 600 to 1 750	1 680 to 1 830	1 910 to 2 080	2 110 to 2 260								
3,20 < d ≤ 3,50		1 580 to 1 730	1 660 to 1 810	1 900 to 2 060	2 110 to 2 260	42	42	42	42				
3,50 < d ≤ 4,00		1 550 to 1 700	1 620 to 1 770	1 870 to 2 030	2 060 to 2 210								

"*to be continued*"

Table 4 (*concluded*)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Nominal wire diameter	Permissible deviations	Tensile strength R_m				Minimum reduction in area after fracture Z				Minimum number of twists in the torsion test N_t[a]			
		FDC[b]	FDCrV[b]	FDSiCr[b]	FDSiCrV[b]	FDC	FDCrV	FDSiCr	FDSiCrV	FDC	FDCrV	FDSiCr	FDSiCrV
mm	mm	MPa	MPa	MPa	MPa	%	%	%	%				
$4{,}00 < d \leq 4{,}20$	± 0,035	1 540 to 1 690	1 610 to 1 760	1 860 to 2 020	2 060 to 2 210	40	40	40	40	To be agreed upon	To be agreed upon	To be agreed upon	To be agreed upon
$4{,}20 < d \leq 4{,}50$		1 520 to 1 670	1 590 to 1 740	1 850 to 2 000	2 060 to 2 210								
$4{,}50 < d \leq 4{,}70$		1 510 to 1 660	1 580 to 1 730	1 840 to 1 990	2 010 to 2 160								
$4{,}70 < d \leq 5{,}00$		1 500 to 1 650	1 560 to 1 710	1 830 to 1 980	2 010 to 2 160								
$5{,}00 < d \leq 5{,}60$		1 470 to 1 620	1 540 to 1 690	1 800 to 1 950	2 010 to 2 160	38	38	38	38				
$5{,}60 < d \leq 6{,}00$	± 0,040	1 460 to 1 610	1 520 to 1 670	1 780 to 1 930	1 960 to 2 110								
$6{,}00 < d \leq 6{,}50$		1 440 to 1 590	1 510 to 1 660	1 760 to 1 910	1 960 to 2 110	35	35	35	35				
$6{,}50 < d \leq 7{,}00$		1 430 to 1 580	1 500 to 1 650	1 740 to 1 890	1 960 to 2 110								
$7{,}00 < d \leq 8{,}00$	± 0,045	1 400 to 1 550	1 480 to 1 630	1 710 to 1 860	1 910 to 2 050								
$8{,}00 < d \leq 8{,}50$		1 380 to 1 530	1 470 to 1 620	1 700 to 1 850	1 890 to 2 030	32	32	32	32				
$8{,}50 < d \leq 10{,}00$	± 0,050	1 360 to 1 510	1 450 to 1 600	1 660 to 1 810	1 870 to 2 010								
$10{,}00 < d \leq 12{,}00$	± 0,070	1 320 to 1 470	1 430 to 1 580	1 620 to 1 770	1 830 to 1 970	30	30	30	30				
$12{,}00 < d \leq 14{,}00$	± 0,080	1 280 to 1 430	1 420 to 1 570	1 580 to 1 730	1 790 to 1 930								
$14{,}00 < d \leq 15{,}00$		1 270 to 1 420	1 410 to 1 560	1 570 to 1 720	1 780 to 1 920	–	–	–	–				
$15{,}00 < d \leq 17{,}00$	± 0,090	1 250 to 1 400	1 400 to 1 550	1 550 to 1 700	1 760 to 1 900								

[a] Requirements for twists are for $d \geq 0{,}70$ mm.

[b] 1 MPa = 1 N/mm^2.

Table 5 — Mechanical and technological properties and quality requirements for wire grades TDC, TDCrV, TDSiCr, TDSiCrV, VDC, VDCrV, VDSiCr and VDSiCrV

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Nominal wire diameter	Permissible deviations	Tensile strength R_m for wire grades				Minimum reduction in area after fracture Z				Minimum number of twists in the torsion test N_t [a]					
		TDC VDC	TDCrV VDCrV	TDSiCr VDSiCr	TDSiCrV VDSiCrV	TDC VDC	TDCrV VDCrV	TDSiCr VDSiCr	TDSiCrV VDSiCrV	TDC VDC		TDCrV VDCrV		TDSiCr VDSiCr	TDSiCrV VDSiCrV
mm	mm	MPa[b]	MPa[b]	MPa[b]	MPa[b]	%	%	%	%	right	left	right	left	min.	
d = 0,50	± 0,010	1 850 to 2 000	1 910 to 2 060	2 080 to 2 230	2 230 to 2 380	–	–	–	–	–	–	–	–	–	–
0,50 < d ≤ 0,60		1 850 to 2 000	1 910 to 2 060	2 080 to 2 230	2 230 to 2 380										
0,60 < d ≤ 0,80		1 850 to 2 000	1 910 to 2 060	2 080 to 2 230	2 230 to 2 380					6	24	6	12	6	5
0,80 < d ≤ 1,00	± 0,015	1 850 to 1 950	1 910 to 2 060	2 080 to 2 230	2 230 to 2 380										
1,00 < d ≤ 1,30	± 0,020	1 750 to 1 850	1 860 to 2 010	2 080 to 2 230	2 230 to 2 380	50	50	50	50						
1,30 < d ≤ 1,40		1 700 to 1 800	1 820 to 1 970	2 060 to 2 210	2 210 to 2 360					6	16	6	8	5	5
1,40 < d ≤ 1,60		1 700 to 1 800	1 820 to 1 970	2 060 to 2 210	2 210 to 2 360										
1,60 < d ≤ 2,00	± 0,025	1 670 to 1 770	1 770 to 1 920	2 010 to 2 160	2 160 to 2 310										
2,00 < d ≤ 2,50		1 630 to 1 730	1 720 to 1 860	1 960 to 2 060	2 100 to 2 250					6	14				
2,50 < d ≤ 2,70		1 600 to 1 700	1 670 to 1 810	1 910 to 2 010	2 060 to 2 210						12				
2,70 < d ≤ 3,00	± 0,030	1 600 to 1 700	1 670 to 1 810	1 910 to 2 010	2 060 to 2 210										
3,00 < d ≤ 3,20		1 570 to 1 670	1 670 to 1 770	1 910 to 2 010	2 060 to 2 210							6	4	4	4
3,20 < d ≤ 3,50		1 570 to 1 670	1 670 to 1 770	1 910 to 2 010	2 010 to 2 160					6	10				
3,50 < d ≤ 4,00		1 550 to 1 650	1 620 t0 1 720	1 860 to 1 960	2 010 to 2 160										
4,00 < d ≤ 4,20	± 0,035	1 550 to 1 650	1 570 to 1 670	1 860 to 1 960	1 960 to 2 110	45	45	45	45	6	8				3
4,20 < d ≤ 4,50		1 550 to 1 650	1 570 to 1 670	1 860 to 1 960	1 960 to 2 110										

"*to be continued*"

Table 5 (*concluded*)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Nominal wire diameter	Permissible deviations	Tensile strength R_m for wire grades				Minimum reduction in area after fracture Z				Minimum number of twists in the torsion test N_t [a]					
		TDC VDC	TDCrV VDCrV	TDSiCr VDSiCr	TDSiCrV VDSiCrV	TDC VDC	TDCrV VDCrV	TDSiCr VDSiCr	TDSiCrV VDSiCrV	TDC VDC		TDCrV VDCrV		TDSiCr VDSiCr	TDSiCrV VDSiCrV
mm	mm	MPa[b]	MPa[b]	MPa[b]	MPa[b]	%	%	%	%	right	left	right	left	min.	
$4{,}50 < d \leq 4{,}70$	± 0,035	1 540 to 1 640	1 570 to 1 670	1 810 to 1 910	1 960 to 2 110	45	45	45	40	6	6	6	4	3	3
$4{,}70 < d \leq 5{,}00$		1 540 to 1 640	1 570 to 1 670	1 810 to 1 910	1 960 to 2 110										
$5{,}00 < d \leq 5{,}60$		1 520 to 1 620	1 520 to 1 620	1 810 to 1 910	1 910 to 2 060	40	40	40	35						
$5{,}60 < d \leq 6{,}00$	± 0,040	1 520 to 1 620	1 520 to 1 620	1 760 to 1 860	1 910 to 2 060					6	4				
$6{,}00 < d \leq 6{,}50$		1 470 to 1 570	1 470 to 1 570	1 760 to 1 860	1 910 to 2 060					-	-	-	-	-	_
$6{,}50 < d \leq 7{,}00$		1 470 to 1 570	1 470 to 1 570	1 710 to 1 810	1 860 to 2 010										
$7{,}00 < d \leq 8{,}00$	± 0,045	1 420 to 1 520	1 420 to 1 520	1 710 to 1 810	1 860 to 2 010										
$8{,}00 < d \leq 9{,}00$		1 390 to 1 490	1 390 to 1 490	1 670 to 1 770	1 810 to 1 960	38		35	35						
$9{,}00 < d \leq 10{,}0\ 0$	± 0,050	1 390 to 1 490	1 390 to 1 490	1 670 to 1 770	1 810 to 1 960										

[a] Requirements for twists are for $d \geq 0{,}70$ mm.

[b] 1 MPa = 1 N/mm^2.

6.6 Technological properties

6.6.1 Coiling test

In order to assess the uniformity of the wire in the coiling deformation and its surface condition the coiling test may be carried out on samples up to 0,70 mm diameter.

In the test as described further in 7.4.3 the test piece shall exhibit a defect-free surface without splits or fracture and a uniform pitch of the turns after coiling.

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.

6.6.2 Simple torsion test

The torsion test is carried out for assessing deformability, fracture behaviour and surface condition for sizes from 0,70 mm to 6,00 mm. The wires grades "VD" and "TD" shall satisfy the minimum requirements of Table 5.

The fracture of the torsion test piece shall be smooth and perpendicular to the wire axis. The fracture shall be Type 1a as per EN 10218-1:2011. The rupture shall show no longitudinal cracks.

For the grade "FD" wire the torsion test is applied for sizes from 0,70 mm to 6,00 mm. The test piece shall be twisted in one direction until fracture. The fracture shall show a flat surface Type 1a or 3a according to EN 10218-1:2011.

Minimum values for the numbers of torsions required for grade "FD" may be agreed at the time of order.

6.7 Surface quality

6.7.1 The surface of the wire shall be smooth and permissible depth of surface defects at the coil ends shall be in accordance with Table 6.

If needed for VD grade the wire can be shaved or ground.

By Eddy current testing of surface defects the areas of the coil with defects above the level of Table 7 shall be marked. This testing is not performed for FD-grades. The number of defective parts that can be tolerated may be agreed between the parties.

Table 6 — Permissible depth of surface defects (mm)

Wire grade	VD	TD	FD
C	0,005 d	0,008 d	0,010 d
CrV	0,007 d	0,008 d	0,010 d
SiCr, SiCrV	0,010 d	0,013 d	0,015 d

Table 7 — Permissible surface defects by Eddy current testing

Nominal diameter d mm	Max. depth of defect [a]	
	VD	TD
$2{,}50 \leq d \leq 4{,}99$	40 µm	60 µm
$4{,}99 < d \leq 5{,}99$	50 µm	60 µm
$5{,}99 < d \leq 8{,}00$	60 µm	0,01 d
[a] Other values may be agreed at the time of enquiry and order.		

6.7.2 Surface decarburization

The wire grades according to this standard shall be free from total decarburization. The maximum depths of the partially decarburized zone shall be checked at the end of the coils. The permissible depth is shown in Table 8.

If needed for VD and TD grades the wire can be shaved or ground.

Table 8 — Permissible depth of surface decarburization (mm)

Wire grade	VD	TD	FD
C	0,005 d	0,008 d	0,010 d
CrV	0,007 d	0,008 d	0,010 d
SiCr, SiCrV	0,010 d	0,013 d	0,015 d

6.8 Dimensions and dimensional tolerances

6.8.1 Dimensional tolerances

a) Wire in coils

The tolerances level for the wire diameter is based on EN 10218-2 level:

1) T5 for wire diameter up to and including 0,80 mm;

2) T4 for wire diameter above 0,80 mm up to 10,00 mm;

3) T3 for wire diameter above 10,00 mm;

b) Wire in cut lengths

The requirements for length tolerances and straightness are as in EN 10218-2. The tolerance on the nominal length shall only be in plus keeping the same tolerance range (Table 9).

Table 9 — Tolerances on the length of cut lengths

Nominal length L mm	Tolerance mm	
	Class 1	Class 2
$L \leq 300$	$^{+1,0}_{0}$ mm	$^{+1,0}_{0}$ %
$300 < L \leq 1\,000$	$^{+2,0}_{0}$ mm	
$1\,000 < L$	$^{+0,2}_{0}$ %	

6.8.2 Out of roundness

The out of roundness, i.e. the difference between the maximum and minimum diameter of the wire at the same cross section, shall not be more than 50 % of the total permissible deviation specified in Tables 4 and 5.

7 Testing and inspection

7.1 Inspection and inspection documents

Products according to 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:

— heat analysis;

— result of the tensile test (R_m and Z);

— result of the torsion test (N_t);

— actual wire diameter;

— results of optional tests agreed.

7.2 Extent of testing for specific inspection

The extent of testing shall be in accordance with Table 11.

7.3 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 units. Table 11/column 8 gives further details.

7.4 Test methods

7.4.1 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.

7.4.2 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.

7.4.3 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 approximately 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.

7.4.4 Simple torsion test

The torsion test shall be carried out according to ISO 7800.

For the grade "FD" the test is continued in one direction until fracture. For wire grades TDC, TDCrV, VDC and VDCrV the test piece is first twisted in one direction - the number of twists indicated in Table 5 - and is then twisted in the other direction until fracture.

7.4.5 Surface defects

Testing for surface defects shall be carried out on test pieces taken from both ends of the wire units either by deep etching or microscopically, using polished metallographic sections. It may be agreed for wire diameters below 2,00 mm at the time of enquiry and ordering that microscopic testing be carried out immediately after the last heat treatment.

The deep etch test shall be executed according to EN 10218-1 or alternatively by the following method:

The section of the wire to be tested shall be first suitably degreased, followed by etching using a solution of 50 volume % hydrochloric acid and 50 volume % water, heated to $(75\ ^{+5}_{0})$ °C, until the diameter has been reduced by about 1 % with a maximum of 0,03 mm. If surface defects are detected, their depth shall be determined using, for example polished section, or by the stylus method. Cases of dispute shall be settled on the basis of the radial depth measured at a magnification of x 200.

For the grades of the type "TD" and "VD" in the diameter range 2,50 mm to 8,00 mm the total length of the coil shall be tested in line by an appropriate non-destructive test. All the areas with defects above the allowable level as shown in Table 7 shall be clearly and permanently marked.

7.4.6 Decarburization

The depth of decarburization shall be inspected by metallographic means. The test pieces are taken at the ends of the wire unit. Evaluation shall be performed on the transverse section of test pieces etched with nital and at magnification of x 200 in accordance with EN ISO 3887.

7.4.7 Diameter

The diameter shall be measured using limit gauges, a micrometer or any suitable method. The out of roundness shall be determined as the difference between the maximum and minimum diameters at any one cross-section.

7.5 Retests

Retests shall be performed according to EN 10021.

8 Marking and packaging

Each unit shall be properly marked and identified so as to permit traceability and reference to the inspection documents.

The labels shall withstand normal handling and contact with oil; they shall show at least the information according to Table 10. Other information shall be subject to an arrangement between the parties.

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

Table 10 — Information on the labels[a]

Wire grade	VD	TD	FD
Designation	+	+	+
Manufacturer	+	+	+
Nominal diameter	+	+	+
Spring wire grade	+	+	+
Cast number	+	+	(+)
Identification number	+	+	(+)
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			

Table 11 — Extent of testing and sampling for specific inspection and summary of the information on test procedures 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	7.4.1	6.3 [b]
2	Tensile test R_m Z	All > 1 mm	m	Quantity coils supplied per production batch [d]	10 %[c]	1	1	Test pieces taken from the ends of the coils	7.4.2	6.5 [d]
3	Coiling test	All ≤ 0,70 mm	o		The scope of testing shall be agreed on ordering;				7.4.3	6.6.1
4	Torsion test [e]	VD, TD FD	m o						7.4.4	6.6.2
5	Non metallic inclusion	VD TD	m o						EN 10247	6.4
6	Testing for surface defects	FD TD, VD	o m						7.4.5	6.7.1
7	Testing for decarburization	FD TD, VD	o m						7.4.6	6.7.2
8	Check on dimensions	All	m		100 %	1	1		7.4.7	6.8

[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 heat analysis for the elements listed in Table 2 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 drawn with the same reduction in cross-section.

[e] Only for diameters over 0,70 and up to 6,00 mm.

Annex A
(informative)

Additional information

A.1 Modulus of elasticity and shear modulus at room temperature

The modulus of elasticity is assumed to be 206 GPa and the shear modulus 79,5 GPa.

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