UDC 669.14.018.27-426.2:62-272 September 1990

Round steel wire for springs

Oil quenched and tempered carbon and alloy steel wire
Technical delivery conditions

DIN 17 223 Part 2

Runder Federstahldraht; ölschlußvergüteter Federstahldraht aus unlegierten und legierten Stählen; technische Lieferbedingungen

Supersedes March 1964 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

The clauses and subclauses marked ● give specifications which are to be agreed upon at the time of ordering, and those marked ●● give specifications which are optional and may be agreed upon at the time of ordering.

1 Field of application

1.1 This standard specifies requirements for oil quenched and tempered round wire, made of carbon or alloy steel, suitable for the manufacture of springs that are mainly stressed in torsion (e.g. compression or extension springs) and, in some cases, also in bending (e.g. leg springs designed for operation in the fatigue limit or finite life range) (cf. appendix A). Normally, carbon steel wire is used for applications at ambient temperature and alloy steel wire for those at elevated temperature.

Note. It has been reported that orders are being placed for spring steel wire with non-circular cross section or for straight lengths cut from oil quenched and tempered spring steel wire to be supplied to this standard. It should, however, be noted that, in such cases, the specifications for mechanical and technological properties, dimensional tolerances and surface condition as given in this standard do not always apply to wire of other cross-sectional shape. The supply of such wire should therefore be subject to separate agreement.

1.2 This standard does not cover patented drawn spring steel wire (cf. DIN 17 223 Part 1) and stainless steel spring wire (cf. DIN 17 224).

2 Concept

Oil quenched and tempered spring steel wire is defined as wire that is subjected in a continuous process to heat treatment in the form of quenching in oil from its austenite formation temperature and subsequent tempering.

3 Wire types and grades

This standard covers oil quenched and tempered carbon and alloy steel wire for valve springs (type VD) in diameters from 0,5 to 10 mm and oil quenched and tempered carbon and alloy wire for springs (type FD) in diameters from 0,5 to 17 mm.

For wire grades, see table 1.

For all wire grades, specifications have been given for the chemical composition, mechanical and technological properties, and surface condition (depth of defects and decarburization). For type VD wire, the content of nonmetallic inclusions has been specified; for FD wire, corresponding specifications may be agreed.

Table A.1 provides information on the service conditions (temperature and type of loading) for which the different wire grades are suitable.

4 Designation

4.1 The standard designation of products as covered in this standard shall give the name of product (wire), the number of this standard, the symbol denoting the wire grade (cf. table 1) and the required nominal diameter (to be selected from DIN 2076) as shown in the example below.

Example:

Standard designation of steel wire for valve springs (VD) with a nominal diameter of 2,5 mm:

Wire DIN 17 223 – VD – 2,5

4.2 In addition to the standard designation, the order shall give the quantity to be supplied and details of any agreements that have been made with respect to the clauses or subclauses marked ● or ●●.

Example:

Designation of 1000 kg of steel wire for valve springs (VD) with a nominal diameter of 2,0 mm:

1000 kg wire DIN 17 223 – VD – 2,0

Table 1. **Symbols denoting wire grades**

Type of wire	Carbon steel	Alloy steel	
Valve spring steel wire	VD	VD CrV	VD SiCr
Spring steel wire	FD	FD CrV	FD SiCr

5 Requirements

5.1 ●● Form supplied

Wire shall normally be supplied in coil which shall consist of one continuous length of wire. Supply in the form of straight lengths or other forms may be agreed at the time of ordering (cf. subclause 5.5.1).

5.2 As delivered condition

5.2.1 Wire shall be supplied in the oil quenched and tempered condition (cf. clause 2).

5.2.2 ●● Wire shall, assuming normal handling conditions, be suitably protected against corrosion and mechanical damage, the type of corrosion protection being subject to agreement.

Continued on pages 2 to 9

Table 2. **Chemical composition as determined by ladle analysis**

Wire grade	Percentage by mass							
	C	Si	Mn	P max.	S max.	Cu max.	Cr	V
VD	0,63 to 0,73	0,10 to 0,30	0,50 to 1,00	0,020	0,020	0,06		
VD CrV	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
VD SiCr	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	
FD	0,60 to 0,75	0,10 to 0,30	≥ 0,50	0,030	0,025	0,12		
FD CrV	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
FD SiCr	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	

Table 3. **Permitted deviations in product analysis from ladle analysis** (cf. table 2)

Element	Wire grade	Permitted deviations in product analysis from ladle analysis[1] as percentages by mass
C	VD SiCr, FD SiCr	±0,03
	VD, VD CrV FD, FD CrV	±0,04
Si	VD SiCr, FD SiCr	±0,05
	VD, VD CrV FD, FD CrV	±0,03
Mn	All grades	±0,04
P and S	All grades	+0,005
Cu	All grades	+0,02
Cr	All grades	±0,05
V	All grades	±0,02

[1] The limit deviations specified for carbon refer to the carbon content as shown in the test report, manufacturer's test certificate or inspection certificate. For the remaining elements, the deviations shown by one element within one cast shall lie either only above the upper limit or below the lower limit of the range specified for the ladle analysis, but not both at the same time for one cast. If a maximum value has been specified, a positive deviation only is permitted.

5.2.3 The coils or packages shall be secured against accidental loosening of the waps. The beginning of the coil shall be marked, a protective cap being fitted on each end.

5.3 Chemical composition

The chemical composition of wire as determined by ladle analysis shall comply with the specifications of tables 2 and 3 (the latter giving the amounts by which the chemical composition determined in the product analysis may deviate from the values specified in table 2). The limit deviations for carbon are based on the values of ladle analysis as shown in the materials testing certificate, the limit deviations for the remaining elements being based on the values given in table 2.

5.4 Content of nonmetallic inclusions

When examining type VD wire for nonmetallic inclusions as described in DIN 50602, method M, the maximum-size rating values shall be as specified in table 4.

●● In the case of type FD wire, requirements regarding the content of such inclusions may be agreed at the time of ordering.

Table 4. **Maximum-size rating of nonmetallic inclusions for type VD wire**

Location of inclusions	Maximum-size rating as in DIN 50602
Zone between surface and three-quarter radius	0.1 – 9.1
Zone between axis and three-quarter radius	0.2 – 9.2

5.5 Mechanical properties

5.5.1 The mechanical properties of wire shall be as specified in tables 5 and 6, the values given referring to the actual wire cross section and applying only for round wire supplied in coil form.

● Requirements for straightened length of wire or wire of other cross-sectional shape are subject to agreement at the time of ordering.

5.5.2 The range of tensile strength values within one coil of type VD wire shall be not greater than 50 N/mm^2, that of type FD wire not exceeding 70 N/mm^2.

5.5.3 The modulus of elasticity of wires may be assumed to be about 206 kN/mm^2, and the modulus of rigidity, to be about 79,5 kN/mm^2.

5.6 Technological properties

5.6.1 Type VD wire larger than 0,7 up to 7 mm in diameter shall, on being twisted in accordance with subclause 6.4.3, withstand at least the number of twists specified in table 5. The primary fracture shall be perpendicular to the wire axis, the fracture face shall be smooth, not stepped, and the wire shall not have cracked along its axis.

5.6.2 ●● When type FD wire larger than 0,7 up to 7 mm in diameter is twisted in one direction until fracture, as described in subclause 6.4.3 (the number of twists being subject to agreement at the time of ordering), the primary fracture shall be perpendicular to the wire axis, the fracture face shall be smooth, not stepped, and the wire shall not have cracked along its axis.

5.6.3 When wire up to 0,70 mm is tested as described in subclause 6.4.4 (wrapping test), the wire surface shall show no visible defects and the coil formed shall have a uniform pitch.

5.7 Decarburization

The depth of partial decarburization (including isolated ferritic inclusions) of wire in its as delivered condition shall be as specified in tables 5 and 6.

5.8 Surface condition

Wire shall have a smooth surface.

When wire is inspected as described in subclause 6.4.5, the radial depth of surface defects shall be as specified in tables 5 and 6. The permissible percentages of internal defects detected in the course of receiving inspection or further processing may be agreed, taking the specifications of tables 5 and 6 as the basis.

5.9 Limit deviations, ovality and mass

5.9.1 The limit deviations of the wire diameter shall be as specified in tables 5 (type VD) and 6 (type FD).

5.9.2 Ovality (i.e. the difference between the minimum and maximum wire diameter measured in the same plane) shall not exceed 50 % of the range given by the limit deviations in tables 5 and 6.

5.9.3 Calculation of the mass of wire covered in this standard shall be based on a density of steel of 7,85 kg/dm^3.

6 Testing

6.1 •• Materials testing certificates

6.1.1 For each consignment, the issue of one of the certificates as specified in DIN 50 049 may be agreed at the time of ordering.

6.1.2 If a test report is to be issued, this report shall specify the results of the ladle analysis for all the elements listed in table 2.

6.1.3 Issue of an inspection certificate shall be based on testing as described in subclauses 6.2 to 6.6.

The details of sampling specified in column 8 of table 7 and on the test procedure described in subclause 6.4, except for testing for partial decarburization and surface condition, shall also apply for retesting in the case of complaints.

6.2 Scope of testing for acceptance inspection

The specifications given in columns 1 to 7 of table 7 shall apply for the scope of testing.

6.3 Sampling

See column 8 of table 7 for details of sampling.

6.4 Test procedure

6.4.1 Chemical composition

The chemical composition shall be determined using the methods described in the *Handbuch für das Eisenhüttenlaboratorium* (Handbook for the ferrous metallurgy laboratory).

6.4.2 Tensile strength

Tensile testing of wire of diameter less than 6 mm shall be performed as described in DIN 51 210 Part 1, and of wire of diameter 6 mm or more, as described in DIN 50 145, using test pieces with unreduced cross section.

For wire of diameter above 1 mm up to and including 14 mm, the reduction in cross-sectional area after fracture shall be determined in addition to the tensile strength. Calculation of both tensile strength and reduction in area shall be based on the actual cross section.

6.4.3 Torsional strength

Torsion testing shall be performed on the lines of DIN 51 212 until failure, the gauge length being 300 mm for each diameter. Type VD wire shall be subjected to alternating torsion, at a rate of 30 twists per minute, type FD wire being twisted in one direction only.

6.4.4 Bending strength

Bend testing shall be performed on the lines of DIN 51 215, using the following procedure (wrapping test).

A test piece about 500 mm in length shall be closely coiled around a mandrel having a diameter equal to about 3 d (d being the wire diameter), with a minimum of 1 mm. The test piece shall then be extended and released until its length in the released condition is equal to at least twice but not more than four times the coiled length. In this condition, the test piece shall be inspected for surface defects and for uniformity of coiling.

6.4.5 Freedom from surface defects

6.4.5.1 Test pieces taken from both coil ends shall be checked for surface defects, either after deep etching or, microscopically, using polished metallographic sections.

For the deep etch test, the section under test shall be degreased followed by etching using a solution of 50 % of hydrochloric acid and 50 % of 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 established, their depth shall be determined using, for example, polished sections, or by the stylus method. Cases of dispute shall be settled on the basis of the radial depth measured at a magnification of × 200.

6.4.5.2 • In addition, type VD wire from 2,5 to 6,5 mm in diameter shall be subjected to continuous non-destructive testing over its whole length. All surface defects having a depth of 40 µm or more shall be identified and their whole extent clearly and durably marked.

• For wire of diameter smaller than 2,5 mm and greater than 6,5 mm, the maximum depth of cracks to be marked is subject to agreement.

The permissible percentage of defects and the number of marked defects per batch shall be subject to agreement.

6.4.6 Decarburization

The depth of partial decarburization shall be determined on sharp-edged metallographic sections of test pieces taken from both coil ends, using the method described in DIN 50 192. The test pieces shall have been quenched and tempered and the sections, etched in alcoholic solution of nitric acid, examined at a magnification of × 200.

For type VD wire, the depth of partial decarburization shall be the maximum value measured and for type FD wire, the mean from four measurements taken across the diameter in two planes at right angles to each other.

6.4.7 Diameter

GO and NOT GO gap gauges or micrometers shall be used for diameter measurement.

6.5 Retests

If the results of acceptance inspection do not comply with the requirements, the inspector shall decide on what action is to be taken.

6.6 •• Resubmission

Unless otherwise agreed at the time of ordering, the manufacturer shall have the right, without prejudice or charge to the customer, either before or after retesting, to make good defects (e.g. by discarding defective wire), and resubmit the products as a new test unit for acceptance purposes.

7 Marking

Coils shall be provided with a label giving the following information:

a) manufacturer;

b) wire grade;

c) nominal wire diameter;

d) cast number.

8 Complaints

8.1 Under current law, warranty claims may only be raised against defective products is the defects impair their processing and use to a more than negligible extent. This shall apply unless otherwise agreed at the time of ordering.

8.2 It is normal and practical for the purchaser to give the supplier the opportunity to judge whether the complaints are justified, by submitting the product objected to and samples of the products supplied, wherever possible.

Table 5. **Mechanical and technological properties and quality requirements to be met by type VD wire**

1	2	3	4	5	6	7	8	9		10		11		12	13
Nominal wire diameter, in mm	Limit deviations, in mm	Tensile strength, R_m, in N/mm², for wire grade			Minimum reduction in area after fracture, Z, as a percentage, for wire grade			Minimum number of twists for wire grade						Permissible depth of surface defects when testing coil ends	Permissible depth of partial decarburization [1]
		VD	VD CrV	VD SiCr	VD	VD CrV	VD SiCr	VD		VD CrV		VD SiCr			
								Forward	Backward	Forward	Backward	Forward	Backward		
0,5	±0,010	1850 to 2000	1910 to 2060	2080 to 2230	–	–	–	6	24	6	12	6	0	–	–
Over 0,5 up to 0,6		1850 to 2000	1910 to 2060	2080 to 2230											
Over 0,6 up to 0,8		1850 to 2000	1910 to 2060	2080 to 2230											
Over 0,8 up to 1	±0,015	1850 to 1950	1910 to 2060	2080 to 2230											
Over 1 up to 1,3		1750 to 1850	1860 to 2010	2080 to 2230	50	50	50	6	16	6	8	5	0	Grades VD: not exceeding 0,5 % of wire diameter; VD CrV: not exceeding 0,7 % of wire diameter; VD SiCr: not exceeding 1,0 % of wire diameter.	Grades VD: not exceeding 0,5 % of wire diameter; VD CrV: not exceeding 0,7 % of wire diameter; VD SiCr: not exceeding 1,0 % of wire diameter.
Over 1,3 up to 1,4		1700 to 1800	1820 to 1970	2060 to 2210											
Over 1,4 up to 1,6	±0,020	1700 to 1800	1820 to 1970	2060 to 2210											
Over 1,6 up to 2		1670 to 1770	1770 to 1920	2010 to 2160				6	12	6	4	4	0		
Over 2 up to 2,5		1630 to 1730	1720 to 1860	1960 to 2060											
Over 2,5 up to 2,7		1600 to 1700	1670 to 1810	1910 to 2010											
Over 2,7 up to 3		1600 to 1700	1670 to 1810	1910 to 2010											
Over 3 up to 3,2		1570 to 1670	1670 to 1770	1910 to 2010	45	45	45	6	10						
Over 3,2 up to 3,5	±0,025	1570 to 1670	1670 to 1770	1910 to 2010											
Over 3,5 up to 4		1550 to 1650	1620 to 1720	1860 to 1960				6	8						
Over 4 up to 4,2		1550 to 1650	1570 to 1670	1860 to 1960											
Over 4,2 up to 4,5		1550 to 1650	1570 to 1670	1860 to 1960											
Over 4,5 up to 4,7		1540 to 1640	1570 to 1670	1810 to 1910				6	6			3	0		
Over 4,7 up to 5		1540 to 1640	1570 to 1670	1810 to 1910											
Over 5 up to 5,6		1520 to 1620	1520 to 1620	1810 to 1910	40	40	40								
Over 5,6 up to 6	±0,035	1520 to 1620	1520 to 1620	1760 to 1860				6	4						
Over 6 up to 6,5		1470 to 1570	1470 to 1570	1760 to 1860											
Over 6,5 up to 7		1470 to 1570	1470 to 1570	1710 to 1810											
Over 7 up to 8		1420 to 1520	1420 to 1520	1710 to 1810											
Over 8 up to 8,5		1390 to 1490	1390 to 1490	1670 to 1770	38		35	–		–		–			
Over 8,5 up to 10	±0,050	1390 to 1490	1390 to 1490	1670 to 1770											

[1]) Smaller values may be agreed if the semi-finished product has been machined before the wire has been manufactured.

Table 6. **Mechanical and technological properties and quality requirements to be met by type FD wire**

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal wire diameter, in mm	Limit deviations in mm	Tensile strength, R_m, in N/mm², for wire grade			Minimum reduction in area after fracture, Z, as a percentage, for wire grade			Minimum number of twists for wire grade			Permissible depth of surface defects when testing coil ends	Permissible depth of partial decarburization [1]
		FD	FD CrV	FD SiCr	FD	FD CrV	FD SiCr	FD	FD CrV	FD SiCr		
0,5	±0,020	1900 to 2100	2000 to 2200	2100 to 2300	–	–	–	–	–	–	–	–
Over 0,5 up to 0,6		1900 to 2100	2000 to 2200	2100 to 2300								
Over 0,6 up to 0,8		1900 to 2100	2000 to 2200	2100 to 2300				●● Subject to agreement.	●● Subject to agreement.	●● Subject to agreement.		
Over 0,8 up to 1	±0,025	1860 to 2060	1960 to 2160	2100 to 2300								
Over 1 up to 1,3		1810 to 2010	1900 to 2100	2070 to 2260	45	45	45				Wire grades FD and FD CrV: not exceeding 1,0% of wire diameter; FD SiCr: not exceeding 1,5% or wire diameter.	Wire grades FD and FD CrV: not exceeding 1,0% of wire diameter; FD SiCr: not exceeding 1,5% or wire diameter.
Over 1,3 up to 1,4		1790 to 1970	1870 to 2070	2060 to 2250								
Over 1,4 up to 1,6	±0,035	1760 to 1940	1840 to 2030	2040 to 2220								
Over 1,6 up to 2		1720 to 1890	1790 to 1970	2000 to 2180								
Over 2 up to 2,5		1670 to 1820	1750 to 1900	1970 to 2140								
Over 2,5 up to 2,7		1640 to 1790	1720 to 1870	1950 to 2120								
Over 2,7 up to 3		1620 to 1770	1700 to 1850	1930 to 2100								
Over 3 up to 3,2		1600 to 1750	1680 to 1830	1910 to 2080								
Over 3,2 up to 3,5	±0,045	1580 to 1730	1660 to 1810	1900 to 2060	42	42	42					
Over 3,5 up to 4		1550 to 1700	1620 to 1770	1870 to 2030								
Over 4 up to 4,2		1540 to 1690	1610 to 1760	1860 to 2020	40	40	40					
Over 4,2 up to 4,5		1520 to 1670	1590 to 1740	1850 to 2000								
Over 4,5 up to 4,7		1510 to 1660	1580 to 1730	1840 to 1990								
Over 4,7 up to 5		1500 to 1650	1560 to 1710	1830 to 1980								
Over 5 up to 5,6		1470 to 1620	1540 to 1690	1800 to 1950	38	38	38					
Over 5,6 up to 6	±0,060	1460 to 1610	1520 to 1670	1780 to 1930								
Over 6 up to 6,5		1440 to 1590	1510 to 1660	1760 to 1910	35	35	35					
Over 6,5 up to 7		1430 to 1580	1500 to 1650	1740 to 1890								
Over 7 up to 8		1400 to 1550	1480 to 1630	1710 to 1860								
Over 8 up to 8,5		1380 to 1530	1470 to 1620	1700 to 1850	32	32	32					
Over 8,5 up to 10	±0,070	1360 to 1510	1450 to 1600	1660 to 1810								
Over 10 up to 12	±0,090	1320 to 1470	1430 to 1580	1620 to 1770	30	30	30					
Over 12 up to 14		1280 to 1430	1420 to 1570	1580 to 1730								
Over 14 up to 15		1270 to 1420	1410 to 1560	1570 to 1720	–	–	–					
Over 15 up to 17	±0,12	1250 to 1400	1400 to 1550	1550 to 1700								

Table 7. **Scope of testing and sampling for acceptance inspection and synopsis of details of test procedure and associated requirements**

	1	2	3	4	5	6	7	8	9	10
Item No.	Test method	Wire type to be tested	Testing [1]	Test unit	Number of test pieces per test unit	Number of samples per coil	Number of specimens per sample	Samples to be taken	Testing to be performed as in	Requirements as in subclause (or table)
1	Product analysis		x [2]	Quantity of wire originating from one cast	1	1	1	as in SEP 1805 [7]	6.4.1	(3)
2	Tensile test	VD	o	Quantity of wire supplied per production batch [3]	100 %	2	1	From both coil ends.	6.4.2	5.5.2 (5)
		FD			10 % [4]					(6)
3	Torsion test [5]	VD			100 %	2	1		6.4.3	5.6.1 (5)
		FD			10 % [4]					5.6.2 (6)
4	Wrapping test [6]	VD			100 %	2	1		6.4.4	5.6.3
		FD			10 % [4]					
5	Check for surface defects	VD			100 %	2	1		6.4.5	5.8 (5)
		FD			10 % [4]					(6)
6	Check for decarburization	VD			10 %	2	1		6.4.7	5.7 (5)
		FD			10 % [4]					(6)
7	Dimensional check	VD			100 %	2	1		6.4.8	5.9 (5)
		FD			10 % [4]					(6)

[1] o = testing shall be mandatory if the issue of an inspection certificate or inspection report has been agreed. x = testing to be carried out only subject to particular agreement, even where the issue of an inspection certificate or inspection report has been agreed.

[2] If an acceptance inspection has been agreed, the purchaser shall be informed of the result of the ladle analysis for the relevant wire grades listed in table 2.

[3] A production batch is understood to be that quantity of wire manufactured from the same cast, subjected to the same heat treatment, exhibiting the same reduction in area and having the same surface finish.

[4] 10 % of the coils of a production batch, with a minimum of 2 and a maximum of 10.

[5] Only for wire of diameter over 0,7 up to 7 mm.

[6] Only for wire of diameter up to 0,7 mm.

[7] See footnote 2 on page 9.

Appendix A
Recommended service conditions

A.1 Table A.1 gives recommended service conditions for types VD and FD wire.

A.2 VD wire is suitable for springs subjected to fatigue loading. In the following, guideline values of fatigue strength (for 10^7 load cycles), τ_{KH}, of unpeened helical springs (with D_m/d equal to 6 to 8 and i_f equal to 5,5) in the cold set, released condition (assuming the most unfavourable combination of permissible defects) are given as a function of the wire diameter:

VD:	up to 4 mm:	$\tau_{KH} = 480\ N/mm^2$,
	over 4 up to 6 mm:	$\tau_{KH} = 440\ N/mm^2$ [1];
VD CrV:	up to 4 mm:	$\tau_{KH} = 600\ N/mm^2$,
	over 4 up to 6 mm:	$\tau_{KH} = 480\ N/mm^2$ [1];
VD SiCr:	up to 4 mm:	$\tau_{KH} = 540\ N/mm^2$,
	over 4 up to 6 mm:	$\tau_{KH} = 460\ N/mm^2$ [1].

In the design of springs, correction factors are to be allowed for (cf. DIN 2089 Part 1).

A.3 Spring steel wire is used for springs operating in the finite life range or subject to moderate fatigue loading (cf. DIN 2088 and DIN 2089 Part 1).

Table A.1 **Recommended service conditions**

Wire grade	Application
VD	High dynamic duty, torsion, ambient temperature [1]
VD CrV	Very high dynamic duty, torsion, service temperatures up to 80 °C [1]
VD SiCr	Very high dynamic duty, torsion, service temperatures up to 100 °C [1]
FD	Static duty
FD CrV	
FD SiCr	

[1] This relates to wire that has not undergone warm setting. Warm setting may, however, increase the service temperature range considerably.

Standards and other documents referred to

DIN 2076	Round spring wire; dimensions, permissible deviations and mass
DIN 2088	Helical compression springs made from round wire or rod; calculation and design of torsion springs (leg springs)
DIN 2089 Part 1	Helical compression springs made from round wire or rod; design
DIN 17 223 Part 1	Round steel wire for springs; patented cold drawn carbon steel wire; technical delivery conditions
DIN 17 224	Stainless steel wire and strip for springs; technical delivery conditions
DIN 50 049	Materials testing certificates
DIN 50 145	Testing of metallic materials; tensile test
DIN 50 192	Determination of depth of decarburization
DIN 50 602	Metallographic examination; microscopic examination of special steel using standard diagrams to assess the content of non-metallic inclusions
DIN 51 210 Part 1	Testing of metallic materials; tensile test on wire without using an extensometer
DIN 51 212	Testing of metallic materials; torsion test on wire
DIN 51 215	Testing of metallic materials; wrapping test on wire; general information

Stahl-Eisen-Prüfblatt (Iron and steel test sheet) 1805 [2] *Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen* (Sampling and sample preparation for the product analysis of steel)

Handbuch für das Eisenhüttenlaboratorium [2] (Loose-leaf collection)

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[1] No reliable values of fatigue strength are available for wire exceeding 6 mm in diameter. In fatigue tests, an average fatigue strength of 400 to 500 N/mm² has been established.

[2] Obtainable from *Verlag Stahleisen mbH*, Postfach 82 29, D-4000 Düsseldorf 1.

Previous editions

DIN 17 223: 04.55; DIN 17 223 Part 2: 03.64.

Amendments

The following amendments have been made to the March 1964 edition.

a) CrV and SiCr steel wire grades have been included for the first time.

b) The wire diameter range has been extended to cover wire grades FD and VD.

c) Limit deviations for the nominal wire diameter have been included for the first time (the values complying with those specified in 2076).

d) Only letter symbols have been specified for the designation of wire grades, material numbers having been dropped.

e) Specifications for the chemical composition as determined by ladle analysis have been amended and a table specifying the permissible deviations in product analysis from the ladle analysis has been included for the first time.

f) Maximum size rating values of non-metallic inclusions have been specified for type VD wire.

g) The specifications regarding mechanical and technological properties have been revised.

h) For type VD wire, the values of permissible partial decarburization have been amended, those for tape FD wire have been included for the first time.

i) The maximum permissible radial depth of defects has been specified and provisions have been made for continuous non-destructive testing of valve spring steel wire.

j) A wrapping test has been included for wire with a nominal diameter up to 0,7 mm.

k) Details of testing as part of acceptance inspection have been specified. More detailed specifications have been given for the sampling procedure.

l) The notes on recommended service conditions have been revised.

m) The standard has been editorially revised.

Explanatory notes

Work on this standard was prolonged, one reason for this being the necessity of coordinating it with international work in ISO/TC 17 where a corresponding standard is being prepared (document ISO/DP 8458/3) and another being the need to avoid making specifications conflicting with those of a national standard on wire rod being prepared concurrently. Particularly sensitive in this respect were specifications regarding the permissible depth of surface defects and of partial decarburization, and the content of non-metallic inclusions.

The specification of permissible depth of partial decarburization is based on comparative tests on wire rod, drawn wire and quenched and tempered wire, carried out by various steel and wire manufacturers. In these tests it was found that the depth of decarburization of wire rod did not differ from that of drawn wire, whereas decarburization of quenched and tempered wire was lower by as much as 30 % or non-existent. These results were deemed to indicate that it is quite possible to make different specifications for wire rod and for wire covered here. The standard on wire rod specifies testing of the material in its as rolled condition whereas testing of products in accordance with this standard, in their quenched and tempered condition.

The steel manufacturers requested that the requirements for the content of non-metallic inclusions be limited to the content of oxidic inclusions, since specifying requirements regarding sulfidic inclusions would require a special treatment of the steel to reduce the sulfur content to a maximum of 0,010 %. The wire and spring manufacturers, however, continued to maintain that the specifications given in table 4 are essential and realistic. In the light of this, the steel manufacturers agreed to pay increased attention not only, as hitherto, to the oxidic inclusions but also to the sulfidic inclusions.

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