Specification for

Patented cold drawn steel wire for mechanical springs

BSI STANDARDS

Committees responsible for this British Standard

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

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

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to BS 5216 : 1991

Specification for patented cold drawn steel wire for mechanical springs

Correction

Table 2 Chemical composition

Delete the final column headed '**N maximum**'.

Contents

Foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Policy Committee and is a revision of BS 5216 : 1975 which is withdrawn.

In this revision the definition of patenting is identified, a comparison with the wire grades in the former BS 1408 is included in appendix E and tensile strength values are specified for grade 1 (NS, HS) for nominal diameters 0.200 mm to 1.90 mm together with minor changes to the chemical composition and the introduction of decarburization and surface defect levels to reflect current technology.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Specification

1 Scope

This British Standard specifies the requirements for patented cold drawn plain carbon steel round wire, supplied in coils, reels or cut lengths, suitable for the manufacture of mechanical springs.

Wire sizes are listed in various tensile strength grades, with restrictions on the available combination of size and strength according to the application.

In addition to the definitive requirements, this standard also requires the items detailed in clause 3 to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be satisfied.

NOTE 1. The titles of the publications referred to in this standard are listed on the inside back cover.

NOTE 2. For the purposes of this standard the term 'reel' is synonymous with the terms 'spool' and 'bobbin'.

2 Definitions

For the purposes of this British Standard the definition of patenting given in BS 6562 : Part 1 applies together with the following.

2.1 static duty

Applications where springs are subjected to static stresses or infrequent dynamic loading, or a combination of both. Where the stresses are high, the term high duty static is applicable and for lower levels of stress the term normal duty static is appropriate.

2.2 bright

A surface finish obtained on a cold drawn wire where the only coating is that necessary for the wiredrawing process.

3 Information and requirements to be agreed and to be documented

3.1 Information to be supplied by the purchaser

The following information to be supplied by the purchaser shall be fully documented.

Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard can be made and verified:

(a) the number of this British Standard, i.e. BS 5216;

(b) the wire code reference (see table 1);

(c) the tensile strength grade (see **9.1**);

(d) the diameter of the wire;

(e) whether the steel wire is to be supplied as coil or reel or cut lengths.

Example 2.80 mm normal duty dynamic spring wire, bright, in tensile grade 2 coil. Ordered as: BS 5216, ND 2, 2.80 mm bright coil.

3.2 Options

If the purchaser wishes to take up any of the optional requirements given in this standard such requirements shall be specified at the time of the enquiry and/or order. In the absence of such information, the manufacturer shall supply in accordance with the following.

(a) *General*

(1) For wire grade M the maximum level of silicon is as given in table 2 (see **5.2**).

(2) The wire is supplied in bright condition (see clause **6**).

(b) *Testing*

(1) Surface defects are assessed using the deep etch test (see **7.2**, and appendix B).

(2) Tensile strength is calculated on the actual diameter of the wire (see **9.1**).

Table 1. Production range, codes and grades

Wire application	Code	Tensile strength grade	Size range available	Product forms
			mm	
Normal duty static	NS	1	0.200 to 9.00	Coil or reel or cut lengths
		2	0.200 to 13.20	
High duty static	HS	2 and 3	0.200 to 13.20	Coil or reel or cut lengths
Normal duty dynamic	ND	2 and 3	0.200 to 13.20	Coil or reel or cut lengths
High duty dynamic	HD	2 and 3	1.600 to 13.20	Coil or reel or cut lengths
High duty static and dynamic (music)	M	4	0.100 to 4.00	Coil or reel
		5	0.100 to 3.00	Coil or reel

NOTE. Wire may be supplied coiled onto spools or formers.

Table 2. Chemical composition

Code	C	Si maximum	Mn	S maximum	P maximum	N maximum
	%	%	%	%	%	%
NS, HS	0.35 to 0.85	0.35	0.40 to 1.00	0.050	0.050	0.008
ND, HD	0.45 to 0.85	0.35	0.30 to 1.00	0.030	0.030	0.008
M	0.60 to 1.00	0.35[1)]	0.25 to 0.75	0.030	0.030	0.008

[1)] See 5.2.

4 Production range, codes, and grades

The wire sizes and tensile strength grades for the various wire applications shall be as given in table 1.

5 Manufacture

5.1 Steelmaking process

The steel shall be made by any process except that air and mixed air-oxygen bottom blown basic converter processes shall not be used.

5.2 Chemical composition

The chemical compositions of the steels shall be as given in table 2 based on cast analysis except that for wire grade M other levels of silicon may be specified. Cast analysis shall be supplied by the manufacturer.

Any subsequent analytical checks shall take into consideration the heterogeneity normal to the steel and shall be in accordance with appendix A.

5.3 Freedom from defects

5.3.1 The ingots, blooms or billets shall be so prepared as to remove surface imperfections which might produce defects in the wire made from them.

5.3.2 The rod from which the wire is drawn shall be free from harmful surface defects, pipe and other flaws (see also clause 6 for finished wire).

6 Condition of finished wire

6.1 All wire shall be supplied either bright or with one of a number of other surface finishes or coatings specified by the purchaser, and shall be free from harmful surface defects.

NOTE. If coatings are specified by the purchaser details should be agreed between the purchaser and the manufacturer.

6.2 If it is necessary to grind the wire to meet the specified decarburization or surface defect limits given in tables 3 and 4, the grinding shall be done after the final patenting heat treatment and before final drawing.

Table 3. Decarburization for wire (code references HS, ND, HD, M unground and M ground)

Code	Maximum percentage of wire diameter	
	Complete decarburization	Partial decarburization
	%	%
HS	0	3
ND M unground	0	1.5
HD M ground	0	0

Table 4. Surface defect limits for wire (code references HS, ND, HD, M unground and M ground)

Code	Defect limit as percentage of wire diameter
	%
HS	3
ND M unground	1.5
HD M ground	0

7 Decarburization and surface defects

7.1 Decarburization

When examined in accordance with the microscopic method of BS 6617 : Part 1 decarburization of the wire shall be not greater than the values given in table 3.

Decarburization shall be measured on a sample of wire in the final supply condition.

7.2 Surface defects

When examined in accordance with **B.1** and/or **B.2** the percentage of seams or other surface defects shall not be greater than those given in table 4.

8 Sampling for mechanical tests

8.1 General

All tests shall be carried out on the material in the condition in which it will be supplied to the purchaser. Apart from any straightening of the test lengths prior to testing, they shall not be treated in any way which may make them unrepresentative of the bulk of which they are a sample. Sampling shall be in accordance with **8.2** or **8.3** as appropriate.

8.2 Coils or reels

A test piece shall be taken from one end of every coil or reel. If small coils or reels are split from parent coils or reels, samples tested from either end of the parent coil or reel shall be considered representative providing the coils or reels can be identified to the parent coil or reel.

8.3 Cut lengths

Wire supplied in cut lengths shall be grouped in such a manner as to be clearly identified with the coil or coils from which the lengths have been cut. Two test pieces selected at random from the lengths shall then be considered to be representative of that coil or coils of wire.

9 Mechanical properties

NOTE. For retests see clause 12.

9.1 Tensile strength

When tested in accordance with BS 4545 the tensile strength, calculated on either the actual diameter of the wire or the nominal diameter of the wire, shall be in accordance with the range appropriate to the grade and wire size given in tables 5 and 6.

For intermediate sizes the tensile strength shall be that applicable to the next larger nominal diameter.

Table 5. Nominal sizes and tensile strength grades (code references NS, HS, ND and HD)

Nominal diameter	Tensile strength		
	Grade 1	Grade 2	Grade 3
mm	N/mm^2	N/mm^2	N/mm^2
0.200	2040 to 2340	2340 to 2640	2640 to 2940
0.224	2020 to 2320	2320 to 2620	2620 to 2920
0.250	2000 to 2300	2300 to 2600	2600 to 2900
0.280	1970 to 2270	2270 to 2570	2570 to 2870
0.300	1960 to 2250	2250 to 2550	2550 to 2850
0.315	1960 to 2240	2240 to 2520	2520 to 2800
0.335	1950 to 2230	2230 to 2510	2510 to 2790
0.355	1930 to 2210	2210 to 2490	2490 to 2770
0.375	1900 to 2180	2180 to 2460	2460 to 2740
0.40	1870 to 2150	2150 to 2430	2430 to 2710
0.42	1860 to 2120	2120 to 2380	2380 to 2640
0.45	1840 to 2100	2100 to 2360	2360 to 2620
0.48	1820 to 2080	2080 to 2340	2340 to 2600
0.50	1800 to 2060	2060 to 2320	2320 to 2580
0.53	1780 to 2040	2040 to 2300	2300 to 2560
0.56	1760 to 2020	2020 to 2280	2280 to 2540
0.60	1750 to 1990	1990 to 2230	2230 to 2470
0.63	1730 to 1970	1970 to 2210	2210 to 2450
0.67	1720 to 1960	1960 to 2200	2200 to 2440
0.71	1680 to 1920	1920 to 2160	2160 to 2400
0.75	1660 to 1900	1900 to 2140	2140 to 2380
0.80	1650 to 1880	1880 to 2110	2110 to 2340
0.85	1620 to 1850	1850 to 2080	2080 to 2310
0.90	1600 to 1830	1830 to 2060	2060 to 2290
0.95	1580 to 1810	1810 to 2040	2040 to 2270
1.00	1570 to 1790	1790 to 2010	2010 to 2230

Table 5. Nominal sizes and tensile strength grades (code references NS, HS, ND and HD) *(continued)*

Nominal diameter	Tensile strength		
	Grade 1	Grade 2	Grade 3
mm	N/mm^2	N/mm^2	N/mm^2
1.06	1550 to 1770	1770 to 1990	1990 to 2210
1.12	1530 to 1750	1750 to 1970	1970 to 2190
1.18	1530 to 1740	1740 to 1950	1950 to 2160
1.25	1510 to 1720	1720 to 1930	1930 to 2140
1.32	1500 to 1700	1700 to 1910	1910 to 2120
1.40	1490 to 1690	1690 to 1890	1890 to 2090
1.50	1460 to 1660	1660 to 1860	1860 to 2060
1.60	1440 to 1640	1640 to 1840	1840 to 2040
1.70	1420 to 1620	1620 to 1820	1820 to 2020
1.80	1400 to 1600	1600 to 1800	1800 to 2000
1.90	1390 to 1590	1590 to 1790	1790 to 1990
2.00	1370 to 1570	1570 to 1770	1770 to 1970
2.12	1350 to 1550	1550 to 1750	1750 to 1950
2.24	1330 to 1530	1530 to 1730	1730 to 1930
2.36	1320 to 1520	1520 to 1720	1720 to 1920
2.50	1300 to 1500	1500 to 1700	1700 to 1900
2.65	1290 to 1490	1490 to 1690	1690 to 1890
2.80	1270 to 1470	1470 to 1670	1670 to 1870
3.00	1250 to 1450	1450 to 1650	1650 to 1850
3.15	1240 to 1440	1440 to 1640	1640 to 1840
3.35	1220 to 1420	1420 to 1620	1620 to 1820
3.55	1200 to 1400	1400 to 1600	1600 to 1800
3.75	1190 to 1390	1390 to 1590	1590 to 1790
4.00	1170 to 1370	1370 to 1570	1570 to 1770
4.25	1150 to 1350	1350 to 1550	1550 to 1750
4.50	1130 to 1330	1330 to 1530	1530 to 1730
4.75	1120 to 1320	1320 to 1520	1520 to 1720
5.00	1110 to 1310	1310 to 1510	1510 to 1710
5.30	1090 to 1290	1290 to 1490	1490 to 1690
5.60	1070 to 1270	1270 to 1470	1470 to 1670
6.00	1050 to 1250	1250 to 1450	1450 to 1650
6.30	1040 to 1240	1240 to 1440	1440 to 1640
6.70	1030 to 1230	1230 to 1430	1430 to 1630
7.10	1010 to 1210	1210 to 1410	1410 to 1610
7.50	1000 to 1200	1200 to 1400	1400 to 1600
8.00	970 to 1170	1170 to 1370	1370 to 1570
8.50	960 to 1160	1160 to 1360	1360 to 1560
9.00	940 to 1140	1140 to 1340	1340 to 1540

Table 5. Nominal sizes and tensile strength grades (code references NS, HS, ND and HD) *(concluded)*

Nominal diameter	Tensile strength		
	Grade 1	Grade 2	Grade 3
mm	N/mm^2	N/mm^2	N/mm^2
9.50	—	1130 to 1330	1330 to 1530
10.00	—	1120 to 1320	1320 to 1520
10.60	—	1100 to 1300	1300 to 1500
11.20	—	1090 to 1290	1290 to 1490
11.80	—	1070 to 1270	1270 to 1470
12.50	—	1060 to 1260	1260 to 1460
13.20	—	1040 to 1240	1240 to 1440

NOTE 1. Preferred sizes are shown in bold type.
NOTE 2. For available tensile strength grades see table 1.

Table 6. Nominal sizes and tensile strength grades (code reference M)

Nominal diameter	Tensile strength	
	Grade 4	Grade 5
mm	N/mm^2	N/mm^2
0.100	3020 to 3400	3400 to 3780
0.125	2960 to 3320	3320 to 3680
0.150	2900 to 3250	3250 to 3600
0.180	2820 to 3160	3160 to 3500
0.200	2760 to 3090	3090 to 3420
0.224	2720 to 3030	3030 to 3340
0.250	2680 to 2980	2980 to 3280
0.280	2650 to 2940	2940 to 3230
0.300	2640 to 2920	2920 to 3200
0.315	2620 to 2890	2890 to 3160
0.335	2600 to 2860	2860 to 3120
0.355	2570 to 2830	2830 to 3090
0.375	2550 to 2800	2800 to 3050
0.40	2520 to 2770	2770 to 3020
0.42	2510 to 2750	2750 to 2990
0.45	2480 to 2720	2720 to 2960
0.48	2460 to 2690	2690 to 2920
0.50	2440 to 2670	2670 to 2900
0.53	2430 to 2650	2650 to 2870
0.56	2420 to 2630	2630 to 2840
0.60	2410 to 2610	2610 to 2810
0.63	2400 to 2590	2590 to 2780
0.67	2380 to 2570	2570 to 2760
0.71	2370 to 2550	2550 to 2730
0.75	2350 to 2530	2530 to 2710

Table 6. Nominal sizes and tensile strength grades (code reference M) *(concluded)*

Nominal diameter	Tensile strength	
	Grade 4	Grade 5
mm	N/mm^2	N/mm^2
0.80	2320 to 2490	2490 to 2660
0.85	2290 to 2460	2460 to 2630
0.90	2280 to 2440	2440 to 2600
0.95	2260 to 2420	2420 to 2580
1.00	2240 to 2390	2390 to 2540
1.06	2210 to 2360	2360 to 2510
1.12	2190 to 2340	2340 to 2490
1.18	2160 to 2310	2310 to 2460
1.25	2140 to 2290	2290 to 2440
1.32	2120 to 2270	2270 to 2420
1.40	2090 to 2240	2240 to 2390
1.50	2060 to 2210	2210 to 2360
1.60	2040 to 2190	2190 to 2340
1.70	2020 to 2170	2170 to 2320
1.80	2000 to 2150	2150 to 2300
1.90	1990 to 2140	2140 to 2290
2.00	1970 to 2120	2120 to 2270
2.12	1950 to 2100	2100 to 2250
2.24	1930 to 2080	2080 to 2230
2.36	1920 to 2070	2070 to 2220
2.50	1900 to 2050	2050 to 2200
2.65	1890 to 2040	2040 to 2190
2.80	1870 to 2020	2020 to 2170
3.00	1850 to 2000	2000 to 2150
3.15	1840 to 1990	—
3.35	1820 to 1970	—
3.55	1800 to 1950	—
3.75	1790 to 1940	—
4.00	1770 to 1920	—

NOTE. Preferred sizes are shown in boid type.

9.2 Torsion

9.2.1 The torsion test shall be applied to wire between 0.40 mm and 10.00 mm diameter in accordance with BS 4545.

9.2.2 For wires over 0.40 mm up to and including 2.00 mm, the test piece shall withstand being twisted, without failure, 20 twists in a gauge length equivalent to 100 wire diameters. For wires over 2.00 mm up to and including 6.00 mm the number of twists shall be 15. For wires over 6.00 mm up to and including 10.00 mm the number of twists shall be 12. If the gauge length is greater or less than 100 wire diameters, the number of twists shall be adjusted in proportion to the gauge length.

The test shall be continued until fracture occurs, when the primary fracture shall be perpendicular to the axis of the wire and the surface shall not be split. During fly-back of the wire, secondary fractures may occur and these shall be ignored.

9.3 Wrapping test

The wrapping test shall be applied to wire smaller than 3.00 mm diameter in accordance with BS 4545.

The wire shall not show sign of failure when close coiled eight complete turns around a mandrel of diameter equal to that of the wire.

9.4 Flexibility

A single U bend test shall be applied to wire of 3.00 mm and larger diameters. When tested in accordance with BS 4545 and appendix C the wire shall not shown sign of failure. To avoid the need for holding an excessive number of mandrel sizes, the wire shall be deemed to have met the requirements of this standard if it is bent around a mandrel smaller than that specified.

9.5 Wire cast

NOTE. Details of wire cast measurement are given in appendix D.

9.5.1 ***Circular cast***

When measured in accordance with **D.1** and **D.2** wire from a reel shall take up a circular cast of diameter not less than the barrel diameter of the reel and not more than 2.5 times the barrel diameter.

When measured in accordance with **D.1** and **D.2** wire from a coil shall take up a circular cast of diameter not less than that of the original coil diameter and not more than 1.5 times the original coil diameter.

NOTE. Requirements for straightness of wire in cut lengths should be agreed between the purchaser and the manufacturer.

9.5.2 ***Helix test***

When tested in accordance with **D.1** and **D.3** the helix of the wap of wire, measured by the deviation of one cut end from the horizontal plane, shall not exceed 50 mm.

9.5.3 ***Spiral cast***

When tested in accordance with **D.1** and **D.4** the wap of wire shall not show spiral cast.

10 Tolerances on diameter and ovality

The minimum and maximum diameters shall be measured at the same section on a straight piece of wire, selected in accordance with clause **8**. Each measurement shall be within the tolerance given in table 7 for the appropriate diameter of wire, except that, for coils of 300 kg or less, the values within the tolerance shall be not more than half the total given in table 7 and the restricted variation for individual coils shall lie anywhere within the total tolerance given in table 7.

Table 7. Tolerances on diameter and ovality (code references NS, HS, ND, HD and M)

Nominal wire diameter	Tolerance on diameter		Maximum ovality	
	Wire in coil	Wire in straight lengths	Wire in coil	Wire in straight lengths
mm	mm	mm	mm	mm
> 0.100 ≤ 0.40	± 0.004	—	0.004	—
> 0.40 ≤ 0.80	± 0.010	—	0.010	—
> 0.80 ≤ 1.90	± 0.014	± 0.022	0.014	0.022
> 1.90 ≤ 3.15	± 0.020	± 0.030	0.020	0.030
> 3.15 ≤ 5.60	± 0.030	± 0.044	0.030	0.044
> 5.60 ≤ 8.50	± 0.040	± 0.060	0.040	0.060
> 8.50 ≤ 10.00	± 0.050	± 0.070	0.050	0.070
> 10.00 ≤ 13.20	± 0.060	± 0.080	0.060	0.080

ovality at any one measured section shall not exceed the maximum shown in table 7.

NOTE. Ovality is defined as the difference between the maximum and minimum axes of the wire, measured at any one cross section.

11 Straight length tolerances

When supplied in straight lengths, the lengths shall be not less than those given in the order and shall be within the tolerances given in table 8.

Table 8. Tolerances on length of straight wire (code references NS, HS, ND and HD)

Length of cut wire	Tolerance
mm	mm
≤ 160	—
> 160 ≤ 315	+ 2
> 315 ≤ 500	+ 3
> 500 ≤ 800	+ 4
> 800 ≤ 1250	+ 5
> 1250 ≤ 2000	+ 7
> 2000	+ 13

NOTE. Tolerances on lengths up to and including 160 mm should be agreed at the time of the enquiry and order.

12 Retests

12.1 General

If any test piece fails any of the tests, additional pieces for retest shall be taken from the appropriate coil, reel or bundle of straight lengths representing the product of the coil in accordance with **12.2** or **12.3** and retested.

12.2 Coils or reels

For wire in coil or reel, two additional test pieces shall be taken from the end of the same coil or reel.

NOTE. Part of the coil or reel may be discarded before taking the new test pieces.

12.3 Straight lengths

For wire supplied in lengths, four additional test pieces shall be taken at random from the same bundles representing the product of the coil.

12.4 Results

If the additional test pieces pass all the tests, the appropriate coil, reel or bundles representing the product of the coil shall be deemed to comply with this standard. If any of them fail, the coil, reel or corresponding bundles shall be deemed not to comply with this standard.

13 Packing and marking

Consignments of wire shall be suitably protected against mechanical damage and corrosion during transport.

NOTE. If special protection is required this should be agreed at the time of enquiry and order.

Wire in coil, reel or bundles of lengths shall be securely tied and shall carry a suitable label or labels on which the following shall be clearly shown:

(a) the number and date of this British Standard, i.e. BS 5216 : 1991[1)];

(b) the wire code reference (see table 1);

(c) the tensile strength grade (see tables 5 and 6);

(d) the diameter of the wire;

(e) coil or reel or cut lengths;

(f) any other information agreed between the manufacturer and purchaser.

[1)] Marking BS 5216 : 1991 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Appendices

Appendix A. Product analysis and permitted variations

A.1 Analysis of the product may vary from the cast analysis due to heterogeneity arising during the casting and solidification of the ingot. Table 9 shows the permitted variations in product analysis.

The variations may occur either above or below the individual element range but shall not be applied above and below the specified range for any one element in any one cast of steel.

NOTE. The specified range is that specified by the purchaser and is a restricted range within the chemical composition ranges given in table 2.

Table 9. Permitted variations of product analysis from specified ranges

Element	Range in which maximum of specified element falls	Variation on specified range	
		Carbon steels	
		Over maximum	Under minimum
	%	%	%
C	> 0.25 ≤ 0.50	0.03	0.03
	> 0.50	0.04	0.04
Si	≤ 0.35	0.03	0.03
Mn	0.25 ≤ 1.0	0.04	0.04
S	≤ 0.040	0.006	—
	> 0.040 ≤ 0.050	0.008	
P	≤ 0.040	0.006	—
	> 0.040 ≤ 0.050	0.008	

A.2 If the chemical analysis of any wire falls outside the limits of acceptable variation from the specified composition range for an element, that wire shall be deemed not to comply with the requirements of this British Standard.

A.3 In the event of the results of the analysis of a single sample falling outside the permitted variations on the product analysis further samples shall be selected for check analysis from the remainder of the consignment, as follows.

(a) At least two samples from the same cast for delivered masses up to and including 5 t.

(b) At least five samples from the same cast for delivered masses over 5 t up to and including 20 t.

(c) At least eight samples from the same cast for delivered masses over 20 t.

The results of the analysis of these samples shall fall within the limits of permissible variation. If any of these further samples are proved to be outside the limits of permissible variation for any element, the consignment shall be deemed not to comply with the requirements of this standard.

A.4 Samples for product analysis shall be taken in accordance with the requirements of BS 1837 and, in the event of dispute, analyzed in accordance with the appropriate methods of BS 6200.

Appendix B. Examination of defects

B.1 Deep etch test for detection of surface defects

Give the test pieces a stress relieving treatment for a minimum of 10 min at a temperature of 400 °C to 500 °C. Immerse the cold test pieces in a boiling solution of 50 % by volume of concentrated hydrochloric acid and 50 % water for a period of time equivalent to 1 s for every 0.025 mm of wire diameter to a maximum of 5 min, after which examine the wire at a magnification of x5 to x12 and assess the surface defects as a percentage of the wire diameter.

B.2 Non-destructive testing for surface defects

By agreement between the purchaser and the manufacturer, wire intended for use in dynamic duty springs may be continuously inspected by eddy current or ultrasonic methods of agreed sensitivity. If non-destructive testing is used the maximum depth of defect should be agreed between the purchaser and the manufacturer.

Appendix C. Bend test

C.1 In carrying out the test, the wire shall be free to move longitudinally in the forming device.

C.2 Bend the wire through 180° to form a U around a mandrel of diameter equal to twice the wire diameter for wire diameters from 3.00 mm to 6.00 mm and equal to three times the wire diameter for wire diameters over 6.00 mm.

Appendix D. Wire cast measurement

D.1 General

D.1.1 The cast of wire is characterized by the diameter of the free laying unrestrained wap of wire taken from coil or reel. For coil, ends can be together (closed cast) or apart (open cast).

D.1.2 Sufficient wire from a coil or reel is cut off to produce a full free wap (single convolution of wire) ensuring that it is not bent or damaged (see figure 1).

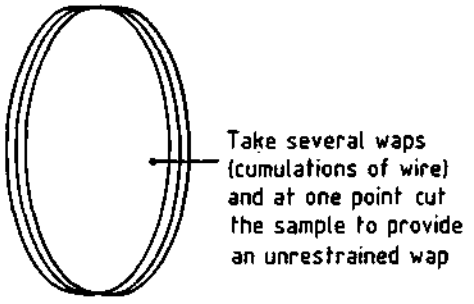


Figure 1. Sampling of wire

D.2 Circular ring cast

To measure circular cast, being the inside diameter of the wap, place the wap on a flat horizontal surface and measure the average diameter. (See figures 2 and 3, which also show the definition of closed and open circular cast.)

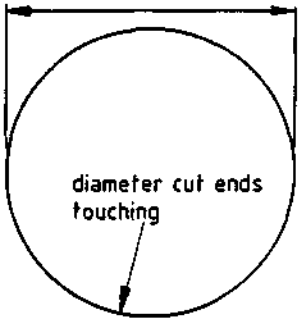


Figure 2. Closed circular cast

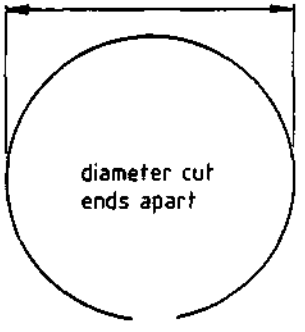
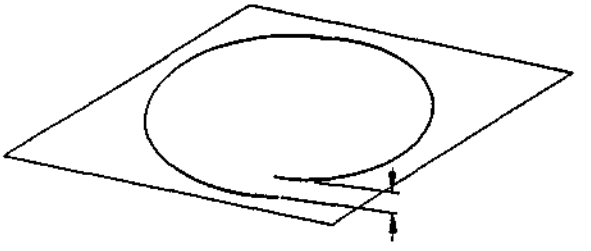


Figure 3. Open circular cast

D.3 Helix cast

Place the wap on a flat horizontal surface and measure and record the vertical distance between the ends of the wap. (See figure 4.)



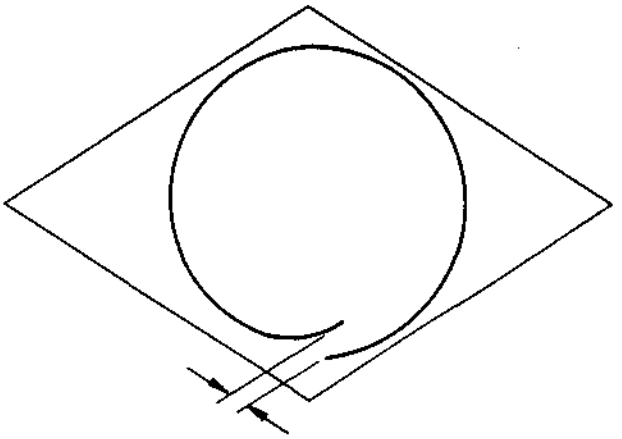
NOTE. The wap is laid on a flat surface and the vertical displacement of cut ends (cast open or closed) is measured.

Figure 4. Helix

D.4 Spiral cast

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

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



NOTE. The wap is laid on a flat surface and any horizontal displacement of cut ends is assessed.

Figure 5. Spiral cast

Appendix E. Comparison with the withdrawn BS 1408 grades

The nearest equivalent grades to the withdrawn BS 1408 grades are given in table 10.

Table 10. Nearest equivalent grades to withdrawn BS 1408 grades

BS 5216 grade	Nearest equivalent to withdrawn BS 1408 grade
NS	BS 1408B
HS	BS 1408B
ND	BS 1408C
HD	BS 1408D
M	BS 1408M