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Specification for

Non-circular steel wire for mechanical springs

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Committees responsible for this British Standard

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Aluminium Federation
Bicycle Association of GB
British Cable Makers' Confederation
British Rubber Manufacturers' Association Ltd.
British Steel Industry
Federation of Wire Rope Manufacturers of Great Britain
Forestry Commission
Health and Safety Executive
National Centre of Tribology
Sheffield Stainless Steel Manufacturers' Association
Society of Chain Link Fencing Manufacturers
Society of Motor Manufacturers and Traders Ltd.
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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Summary of pages

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Foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Policy Committee.

The use of non-circular wire for mechanical springs is increasing and the Technical Committee ISM/26 considered there was a need to prepare a British Standard.

This standard specifies the requirements for non-circular wire up to 12.0 mm characteristic dimension in carbon, alloy and stainless steels.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Specification

1 Scope

This British Standard specifies the requirements for steel wires of non-circular section supplied in coils or straight lengths, suitable for the manufacture of mechanical springs. It covers flattened, rectangular, square and trapezoidal (also termed keystone or tapered) section wires with square or rounded edges, and special cross section wires, up to a maximum characteristic dimension of 12.0 mm. The standard covers grades of carbon steel in the annealed, prehardened and tempered, cold drawn or cold rolled conditions including music wire, grades of alloy steel in the annealed and prehardened and tempered conditions, and grades of cold drawn or rolled stainless steel.

In addition to the definitive requirements, this standard also requires the items detailed in clause **4** to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be satisfied.

NOTE. The grades of steel wire specified in this standard have been selected from those specified in BS 1429, BS 2056, BS 2803, and BS 5216.

2 References

2.1 Normative references

This British Standard incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this British Standard only when incorporated in it by updating or revision.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard the following definitions apply.

3.1 flattened wire

A wire having a cross section with two parallel sides (see figure 1a) which are much longer than the other rounded sides.

3.2 rectangular section wire

A special case of flattened wire, having a cross section with two sets of parallel sides at right angles to each other, but with one set longer than the other (see figure 1b).

3.3 square section wire

A wire having a cross section with two sets of parallel sides of equal length at right angles to each other (see figure 1c).

3.4 trapezoidal section wire

A wire having a cross section with two parallel sides, one shorter than the other, and with the other two sides of equal length (see figure 1d). The special feature of this wire is that, when coiled into a spring such that the shorter minor characteristic dimension is located on the inside of the coil, the cross section of the material takes on either an approximately square or rectangular cross section.

3.5 characteristic dimension

The dimensions of a wire which best identify the shape, e.g. for rectangular wire the major characteristic dimension is the width and the minor characteristic dimension the thickness, for trapezoidal wire the height is the major characteristic dimension and the two parallel faces are minor characteristic dimensions.

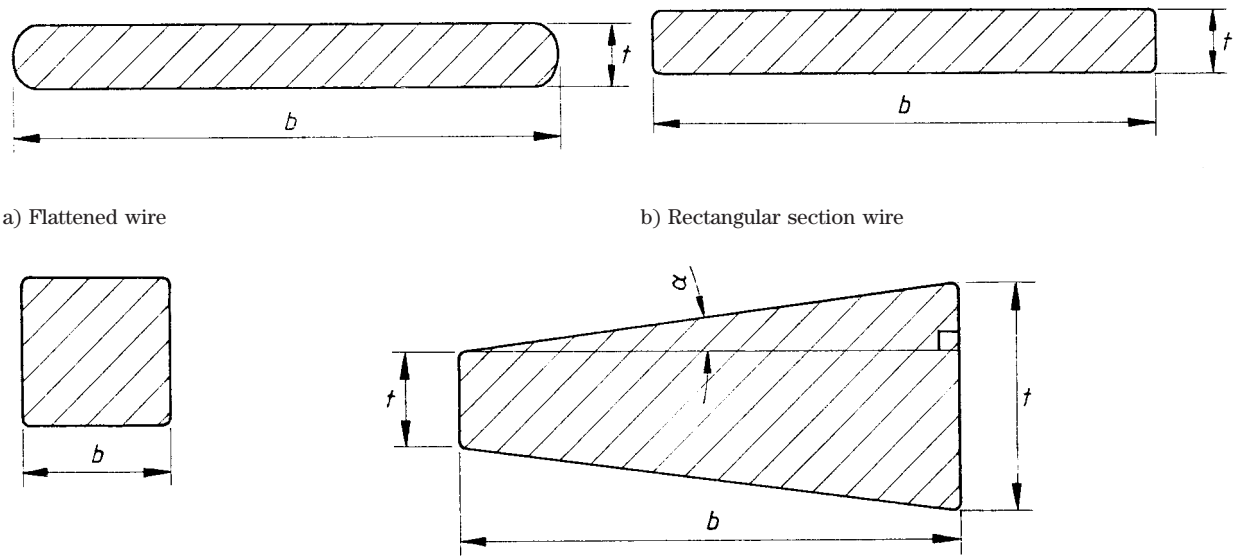
3.6 cast

The cast of wire characterized by the diameter of the free laying unrestrained wap of wire taken from a coil or reel.

NOTE 1. For the purposes of this standard, the term ‘reel’ is synonymous with the term ‘spool’.

NOTE 2. For coil, ends can be together (closed cast), or apart (open cast).

NOTE 3. See also BS 2056 and/or BS 5216.



a) Flattened wire

b) Rectangular section wire

c) Square section wire

d) Trapezoidal section wire

Key

b = major characteristic dimension

t = minor characteristic dimension

α = angle of taper

Figure 1. Cross sections of typical non-circular wire shapes indicating characteristic dimensions

3.7 carbon gradient

The difference between the total depth of decarburization and the depth of functional decarburization.

3.8 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 (see table 1).

3.9 dynamic duty

Applications where springs are subjected to frequent dynamic loading of a regular or irregular frequency and amplitude. Where the stresses are high, the term high duty dynamic is applicable, and for lower levels of stress the term normal duty dynamic is appropriate (see table 1).

3.10 music wire

A cold drawn wire, uniform in strength and hardness, intended especially for the manufacture of springs (see table 1).

Table 1. Quality codes and wire applications

Wire applications	Quality codes
Music wire	M
Normal duty static	NS
High duty static	HS
Normal duty dynamic	ND
High duty dynamic	HD

4 Information and requirements to be agreed and to be documented

4.1 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 this British 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 7612;

b) the steel grade and quality code (see **3.8**, to **3.10** and tables 1 and 2)

c) the wire condition, i.e. patented cold drawn, or cold rolled, cold drawn or cold rolled, annealed or prehardened and tempered;

d) the wire shape and nominal characteristic dimensions; for trapezoidal wires, the angle of taper;

e) the tensile strength (see **10.3**);

f) the form of supply, i.e. coils or straight lengths;

g) any applicable requirements from the appropriate clauses for: edge conditions (see **5.4.6**), hardness testing (see **10.6**), packing and identification (see clause **13**);

h) any other special requirements.

Example: 4.0 mm × 2.0 mm natural edges cold rolled wire, normal duty dynamic, to grade 735A50, tensile strength 800 N/mm^2 max., annealed, in coil. Ordered as: BS 7612 ND 4.0 mm × 2.0 mm — 735A50 — 800 N/mm^2 max. — annealed coil — natural edges.

4.2 Items for agreement

The following items to be agreed between the contracting parties, which are specified in the clauses referred to, shall be fully documented. Both the definitive requirements specified throughout this British Standard and the following documented items shall be satisfied before a claim of compliance with the standard can be made and verified.

a) If a cast analysis other than that specified in table 2 shall be used, it shall be agreed at the time of enquiry and/or order (see **5.2.1**).

b) If corner radius other than that specified shall be used, it shall be agreed at the time of enquiry and/or order (see **5.4.6**).

c) If tolerances other than those specified in table 6 are stipulated they shall be agreed at the time of enquiry and/or order (see **6.1**)

d) If the tensile strength shall be calculated using other than the actual cross-sectional area of the wire, the method shall be agreed at the time of enquiry and/or order (see **10.3**).

e) If the bend test shall be over other than the major dimension, it shall be agreed at the time of enquiry and/or order (see **10.5.2**).

f) If wire for use in dynamic duty springs shall be inspected by eddy current or ultrasonic methods of non-destructive testing, the methods shall be agreed at the time of enquiry and/or order (see note to **11.3**).

5 Manufacture

5.1 Steelmaking process

5.1.1 *Carbon and alloy steels*

The steel may be made by any process except that air and mixed air-oxygen bottom blown basic converter processes shall not be used. In the case of the oxygen process, the nitrogen content of the steel shall not exceed 0.008 %.

5.1.2 *Stainless steel*

The steel shall be made by an electric furnace process.

5.2 Chemical composition

5.2.1 The cast analysis shall conform to the composition ranges given in table 2 for the appropriate steel grade unless otherwise agreed by the manufacturer and purchaser at the time of enquiry and/or order. (See **4.2**a.)

NOTE 1. On request, the wire manufacturer should supply the cast analysis for the specified elements.

NOTE 2. Suitability for purpose is the governing factor for acceptance of the wires and in certain cases in order to meet this the manufacturer may wish to deviate from the cast analysis given in table 2.

5.2.2 Any subsequent analytical checks on the product shall take into consideration the heterogeneity normal to the steel (see also annex A).

5.3 Freedom from defects in input material

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

5.3.2 The rod from which the wire is processed shall be free from harmful surface defects, such as pipe and other flaws.

5.3.3 Should it be necessary to grind the round or input wire to meet the specified defect and decarburization limits (see tables 8 and 9, the grinding shall be at a stage during the manufacture such that all residual grinding marks are completely eliminated by subsequent processing.

Table 2. Chemical compositions and ranges (cast analysis)

Steel grade	Quality codes	C % (*m/m*)		Si % (*m/m*)		Mn % (*m/m*)		S % (*m/m*)	P % (*m/m*)	Cr % (*m/m*)		Ni % (*m/m*)		Others % (*m/m*)
		min.	max.	min.	max.	min.	max.	max.	max.	min.	max.	min.	max.	
Carbon steels, cold worked														
	NS, HS,	0.35	0.85	—	0.35	0.40	1.00	0.05	0.05	—	—	—	—	—
	ND, HD,	0.45	0.85	—	0.35	0.30	1.00	0.03	0.03	—	—	—	—	—
	M	0.60	1.00	—	0.35	0.25	0.75	0.03	0.03	—	—	—	—	—
Annealed carbon and low alloy steels														
090A65	NS, ND, HD	0.55	0.75	—	0.30	0.60	1.20	See note.	See note.	—	—	—	—	—
070A72	NS, ND, HD	0.70	0.75	0.10	0.35	0.60	0.80			—	—	—	—	—
060A96	NS, ND, HD	0.93	1.00	0.10	0.35	0.50	0.70			—	—	—	—	—
735A50	NS, ND, HD	0.46	0.54	0.10	0.35	0.60	0.90			0.80	1.10	—	—	V 0.15 min.
685A55	NS, ND, HD	0.50	0.60	1.20	1.60	0.50	0.80			0.50	0.80	—	—	—
Prehardened and tempered carbon and low alloy steels														
095A65	NS	0.55	0.75	—	0.30	0.60	1.20	0.05	0.05	—	—	—	—	—
094A65	HS, ND	0.55	0.75	—	0.30	0.60	1.20	0.04	0.04	—	—	—	—	—
093A65	HD	0.55	0.75	—	0.30	0.60	1.20	0.03	0.03	—	—	—	—	—
735A50	HS, ND, HD	0.46	0.54	0.10	0.35	0.60	0.90	0.035	0.035	0.80	1.10	—	—	V 0.15 min.
730A65	HS, ND, HD	0.57	0.72	0.15	0.30	0.50	0.90	0.025	0.03	0.35	0.60	—	—	V 0.10 to 0.3
685A55	HS, ND, HD	0.50	0.60	1.20	1.60	0.50	0.80	0.025	0.03	0.50	0.80	—	—	—
Stainless steels														
301S26	—	—	0.15	—	1.00	—	2.00	0.03	0.045	16.0	18.0	6.0	8.0	—
302S26	—	—	0.12	—	1.00	—	2.00	0.03	0.045	17.0	19.0	7.5	10.0	—
316S33	—	—	0.07	—	1.00	—	2.00	0.03	0.045	16.5	18.5	11.0	14.0	Mo 2.5 to 3.0
316S42	—	—	0.07	—	1.00	—	2.00	0.03	0.045	16.0	18.5	9.5	13.5	Mo 2.0 to 2.5

NOTE. S and P contents depend on wire quality code.
NS 0.05 % max. for both elements.
ND 0.04 % max. for both elements.
HD 0.03 % max. for both elements.

5.4 Condition of finished wire

5.4.1 *General*

The wire shall be supplied in the appropriate condition and quality code as given in table 3.

Table 3. Condition of finished wire

Steel grade	Condition	Quality codes
	Patented cold drawn or cold rolled	NS, HS ND, HD M
090A65 070A72 060A96 735A50 685A55	***Annealed or lightly drawn or cold rolled***	NS, ND, HD NS, ND, HD NS, ND, HD NS, ND, HD NS, ND, HD
095A65 094A65 093A65 735A50 730A65 685A55	***Prehardened and tempered***	NS HS, ND HD HS, ND, HD HS, ND, HD HS, ND, HD
310S26 302S26 316S33 316S42	***Stainless steels, cold drawn or rolled***	— — — —

5.4.2 *Annealed wire*

Annealed wires supplied in coil or spools shall lie dead and be free from helix set.

5.4.3 *Prehardened and tempered wire*

Prehardened and tempered wire supplied in coil or on spools shall run out straight from the coil.

NOTE. Attention is drawn to the need for precautions when releasing the binders.

5.4.4 *Cast for hard drawn or rolled carbon steel and stainless steel wire*

Hard drawn or rolled carbon steel and stainless steel wires supplied in coil or on spools shall be supplied either 'cast to the coil or spool' or dressed to fly approximately straight from the coil or spool when released, as follows.

a) When tested in accordance with **10.4.2**, wire supplied 'cast to coil' shall take up a circular cast of diameter not less than the original internal coil diameter and not more than 1.5 times the original internal coil diameter.

b) When tested in accordance with **10.4.2**, wire supplied on a spool or reel shall have a cast diameter of not more than 2.5 times the original internal spool or reel diameter.

NOTE 1. Wires dressed to fly straight should be approximately straight when released from the coil diameter.

NOTE 2. The degree of straightness of wire in cut lengths should be agreed between the manufacturer and the purchaser.

5.4.5 *Helix set*

When tested in accordance with **10.4.3**, the helix set of cast materials shall not exceed the values given in table 4.

Table 4. Helix set test

Dimensions in millimetres

Characteristic dimension		Offset (max.)
Over	Up to and including	
—	0.40	60
0.40	1.00	80
1.00	1.75	90
1.75	12.00	100

5.4.6 *Edge profiles*

Corner radius shall be agreed between supplier and purchaser at the time of enquiry and/or order. In the case of flattened wire it shall be supplied with rounded edges (see figure 2a) unless otherwise agreed and specified (see figure 2b), in which case the corner radius (r) shall be agreed between supplier and purchaser at the time of enquiry and/or order (see **4.2**b).

5.4.7 *Coil curvature*

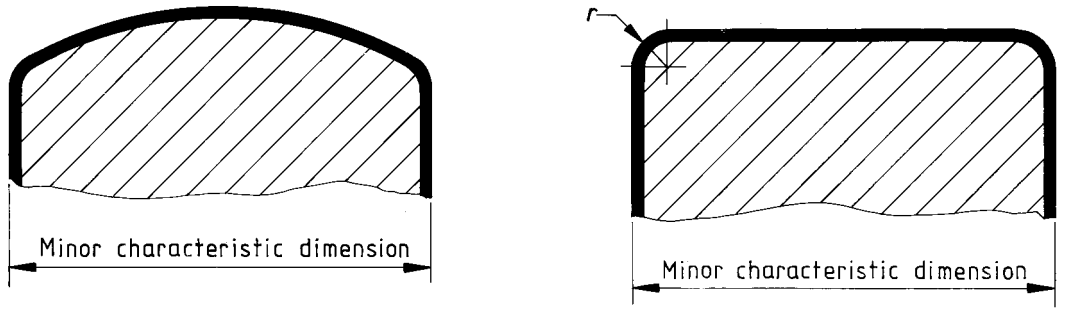
Prehardened and tempered coiled flat wire shall have a maximum curvature or coil set of 10 mm in any 1 m length when a 1 m length is laid on a flat surface with the minor dimensions parallel to that flat surface. The maximum deflection (normally at mid position) shall be measured from the datum straight edge. (See figure 3.)

5.4.8 *Edge bow*

NOTE 1. Edge bow is a measure of, product straightness and is the deviation of a side edge of flat wire from a straight edge.

The degree of edge bow shall not exceed the class tolerances specified by the purchaser in table 5 when measured by laying the wire section on a flat surface with the major dimension parallel to that surface and placing a straight edge of specified length on the concave side and measuring the greatest distance (normally at mid position) between the wire edge and the datum straight edge. (See figure 4.)

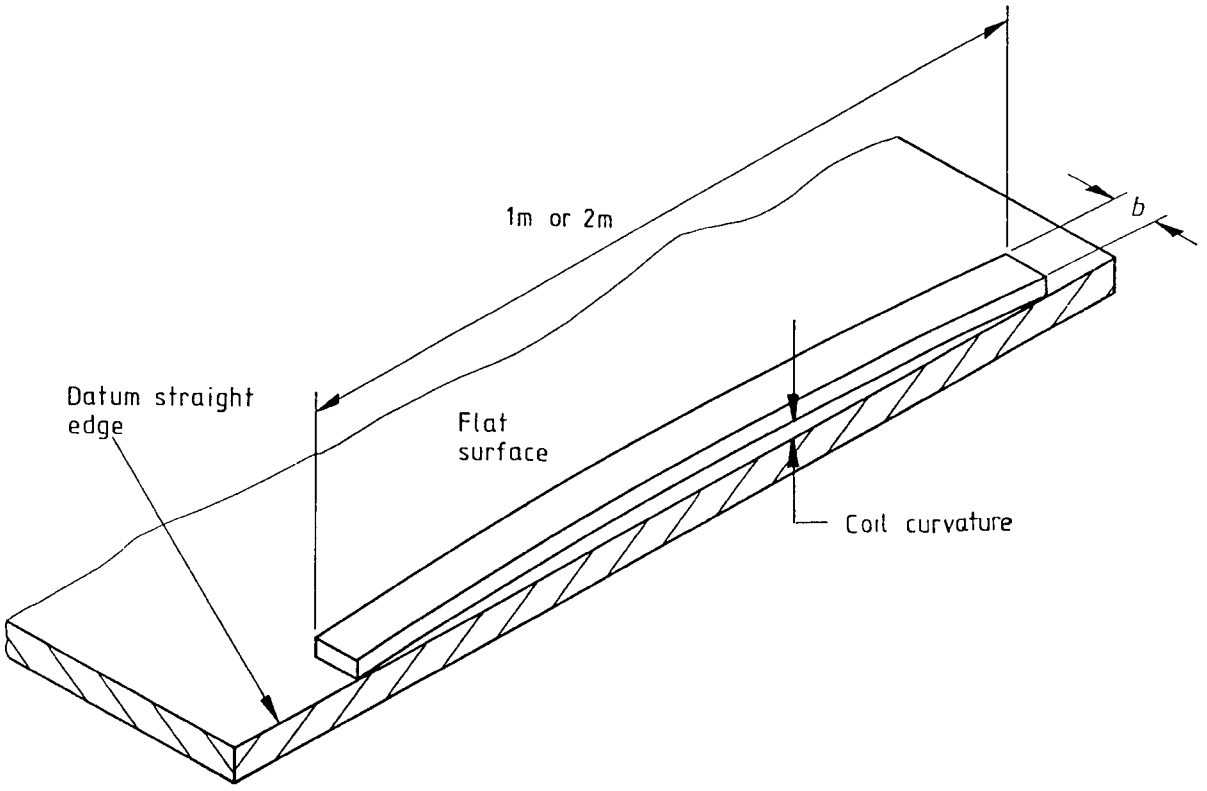
NOTE 2. For products which are not oil hardened and tempered or straight cast, it is usual to manually remove coil curvature set, prior to the measurement of edge bow.



a) Natural round edge

b) Squared edge

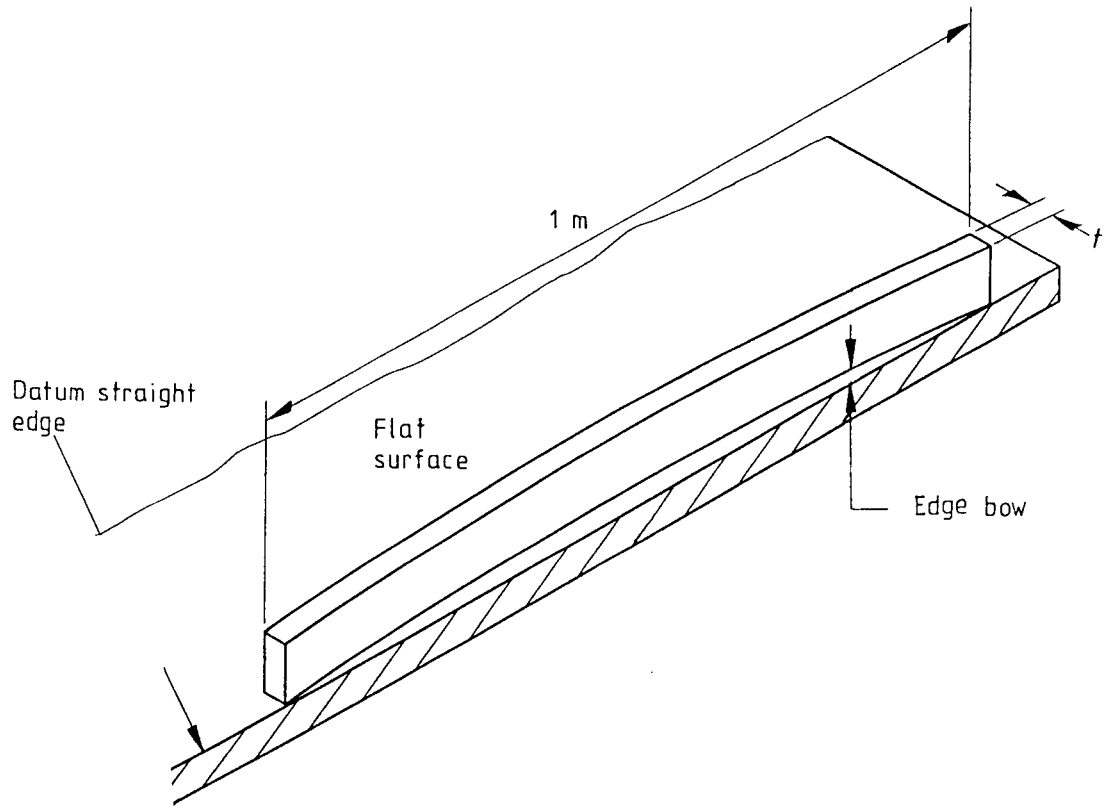
Figure 2. Edge profiles



Key

b = major characteristic dimension

Figure 3. Coil curvature



Key

t = minor characteristic dimension

Figure 4. Edge bow

Table 5. Edge bow tolerances

Class	**Tolerance on 1 m length (max.)** mm	**Tolerance on 2 m length (max.)** mm
1	12.5	50
2	6.0	25
3	2.5	10

NOTE 1. For lengths other than 1 m and 2 m, the tolerance on edge bow shall be calculated in accordance with the following formula with the result rounded to the next highest 0.5 mm:

$$\text{tolerance} = \frac{(\text{non-standard length})^2}{(\text{standard length})} \times \text{tolerance given in this table}$$

NOTE 2. Class 3 is applicable to wire in the prehardened and tempered condition.

5.4.9 *Cut lengths*

Cut lengths shall be square cut at 90° to the major axis of the wire and free from burrs.

NOTE. All types of wire should be free from spiral twist, dog legs, kinks, ripples of short amplitude and snaking involving longer amplitude.

6 Dimensions and tolerances

NOTE. For wires with special sections, the size and shape should be agreed between the supplier and the purchaser.

6.1 Size tolerances

The tolerance on characteristic dimensions shall be in accordance with table 6 unless otherwise agreed by the manufacturer and purchaser at the time of enquiry and/or order. (See **4.2** c.)

NOTE. No tolerances are specified for radius of round cornered sections which should be agreed between supplier and purchaser.

Table 6. Tolerances on characteristic dimensions

Dimensions in millimetres

Nominal dimension		Square, rectangular and trapezoidal sections	Flattened wire	
Over	Up to and including		Tolerances on width	Tolerances on thickness
—	1.0	±0.03	±0.07	±0.020
1.0	2.0	±0.04	±0.08	±0.025
2.0	3.0	±0.05	±0.09	±0.030
3.0	4.0	±0.06	±0.10	±0.040
4.0	5.0	±0.07	±0.11	±0.050
5.0	6.0	±0.08	±0.12	±0.060
6.0	8.0	±0.09	±0.13	±0.070
8.0	10.0	±0.10	±0.14	±0.090
10.0	12.0	±0.11	±0.15	±0.090
12.0	—	±0.12	±0.16	±0.100

6.2 Straight length tolerances

When supplied in straight lengths, the lengths shall be not less than those given in the order and shall not exceed the positive tolerances given in table 7.

Table 7. Tolerances on length of straight lengths

Dimensions in millimetres

Lengths		Positive tolerance
Over	Up to and including	
—	160	—
160	315	2
315	500	3
500	800	4
800	1250	5
1250	2000	7
2000	—	13

7 Bend requirements

When tested in accordance with **10.5**, all grades of wire tested shall show no signs of failure.

8 Hardness requirements

When tested in accordance with **10.6**, minimum surface hardness requirements for annealed wires of characteristic dimensions 3.0 mm and over shall be in accordance with table 11.

9 Freedom from defects in finished wire

9.1 When all qualities (with the exception of NS grades of wire) are examined in accordance with **11.1**, surface defect limits shall be in accordance with table 8.

Table 8. Surface defect limits

Wire application	Quality code	Percentage of minor characteristic dimension
High duty static	HS	2 % or 0.15 mm, whichever is smaller
Normal duty dynamic	ND or M	1 % or 0.1 mm, whichever is smaller
High duty dynamic	HD or M	Nil

9.2 When all qualities of carbon and low alloy steel grades are examined in accordance with **11.2**, decarburization limits shall be in accordance with table 9.

Table 9. Decarburization limits for carbon and low alloy steel grades				
Quality code	**Percentage of minor characteristic dimension**			
	Total depth of decarburization	**Complete decarburization**	**Partial decarburization**	**Carbon gradient**
HS	3 % or 0.20 mm, whichever is smaller	Nil	0.7 % or 0.05 mm, whichever is smaller	Remainder
ND or M	1.5 % or 0.12 mm, whichever is smaller	Nil	0.37 % or 0.03 mm, whichever is smaller	Remainder
HD or M	0.5 % or 0.01 mm, whichever is smaller	Nil	Nil	0.5 % or 0.01 mm, whichever is smaller

10 Mechanical testing

10.1 Procedures

The procedures and apparatus for mechanical testing shall be in accordance with BS EN 10218-1.

10.2 Selection of test pieces

10.2.1 All tests shall be made on test pieces taken from the wire in the condition in which it is to be supplied to the purchaser. Apart from any necessary straightening of the test pieces prior to testing, they shall not be treated in any way that may make them unrepresentative of the batch of which they are a sample.

10.2.2 The test pieces for mechanical, surface defect, and decarburization tests (see clause **11**) shall be taken from one end of each coil as specified in BS EN 10002-1 : 1990. Wire supplied in straight lengths shall be grouped in such a manner as to be clearly identified with the coil 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 of wire.

10.3 Tensile test

In routine testing with fixed gear type tensile testing machines, the straining rate shall be preset to give a rate of separation of the grips not greater than 40 % of the test length per minute.

The tensile strength shall be calculated using the actual cross-sectional area of the wire unless otherwise agreed by the purchaser and supplier at the time of enquiry and/or order (see note 2). The cross-sectional area shall be determined from the mass of a known length of wire and its density as given in table 10. The mass shall be measured to an accuracy of $\pm$ 1%.

NOTE 1. In removal of samples for mass determination it is important to minimize burr formation.

NOTE 2. The level of tensile strength should be agreed between the manufacturer and the purchaser. The tensile strengths of round wire of equivalent cross-sectional area as specified in BS 1429, BS 2056, BS 2803 and BS 5216 may be used as a general guide to appropriate strength levels. (See **4.2**d.)

Table 10. Material densities	
Steel grade	**Density** kg/mm^3
All NS, HS, ND, HD and M grades 090A65, 070A72, 060A96, 735A50, 685A55, 095A65, 094A65, 093A65 and 730A65	7.83×10^{-6}
301S26, 302S26, 316S33 and 316S42	7.97×10^{-6}

10.4 Cast and helix set tests

10.4.1 *General*

These tests shall apply only to patented cold drawn or cold rolled carbon steel and stainless steel grades.

10.4.2 *Cast test*

A complete wap of wire shall be removed from each coil and placed on a smooth horizontal surface free from any restraint. The diameter of the free turn shall be measured.

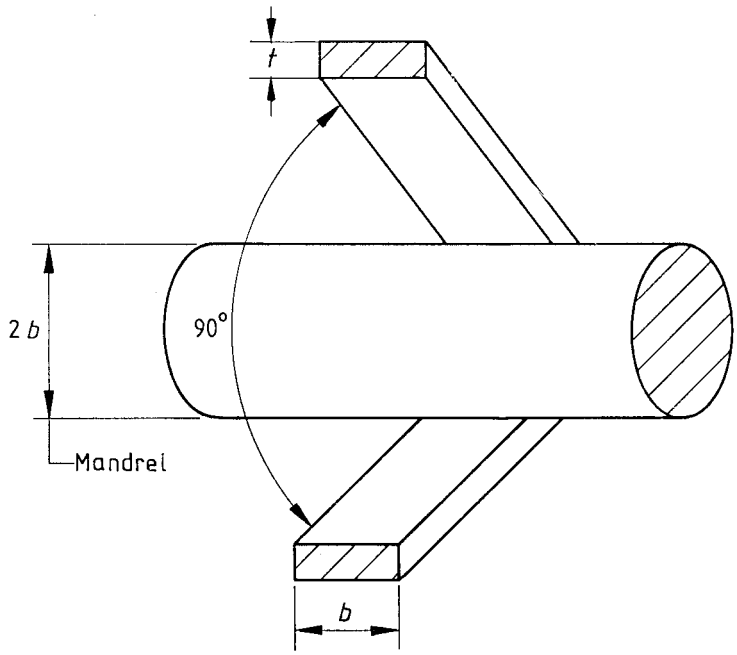
10.4.3 *Helix set test*

A complete wap of wire shall be taken and suspended from its mid-point such that the two ends hang free diametrically below the point of suspension. The helix set shall be measured as the offset between the two ends of the wire.

10.5 Bend test

10.5.1 The bend test shall be applied to wire with a characteristic major dimension of 3.00 mm and above.

10.5.2 The bend test shall be over the major dimension unless otherwise agreed by the manufacturer and the purchaser at the time of enquiry and/or order. (See **4.2**e and figure 5.)



Key

b = major characteristic dimension

t = minor characteristic dimension

Figure 5. Bend test

10.5.3 For all grades with the exception of the annealed grade the wire shall be bent through 90° around a mandrel of diameter equal to twice the major characteristic dimension for wires from 3.00 mm to 6.00 mm and equal to three times the major characteristic dimension for wires above 6.00 mm. To avoid the need for an excessive number of mandrel sizes, the wire shall be deemed to have conformed to this standard if it is bent around a mandrel smaller than that specified.

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

10.5.4 For annealed steel grades, the bend test shall be carried out as follows.

a) *Wires with a major characteristic dimension of* 6.5 mm *and under*

The test piece shall be bent cold, by steadily applied pressure or by a succession of blows and flattened closed until it assumes the position indicated in figure 6, without showing signs of failure.

NOTE 1. The axis of bend should be at 90° to the major characteristic dimension of the wire.

b) *Wires with a major characteristic dimension over* 6.5 mm

The test pieces shall be bent cold through 180 °, by steadily applied pressure or by a succession of blows, over a former of diameter equal to the major characteristic dimension of the wire without showing signs of failure.

NOTE 2. The axis of bend should be at 90 ° to the major characteristic dimension of the wire.

10.6 Hardening test

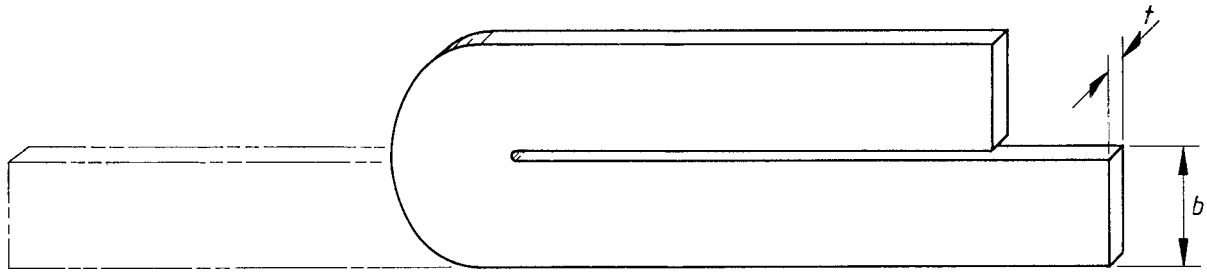
The hardening test shall be applied to annealed wires only of characteristic dimensions 3.0 mm and over. The test piece shall be hardened by quenching in oil from the appropriate temperature shown in table 11. For the purpose of the test a flat shall be ground on the surface of the hardened test piece, removing at least 0.2 mm.

Vickers hardness tests in accordance with BS EN ISO 6507-1 shall be carried out on this flat. The minimum hardness values to be obtained shall be as given in table 11.

NOTE. The preferred method for testing hardness is the Vickers test. Where a purchaser states a preference, however, a Rockwell test may be carried out in accordance with BS 891 and this should be indicated at the time of ordering and an appropriate minimum Rockwell hardness value agreed.

Table 11. Minimum surface hardness requirements

Steel grade	**Oil quenched from temperature of** °C	**Minimum hardness** HV
090A65	820 to 850	720
070A72	820 to 850	720
060A96	800 to 830	750
735A50	850 to 880	680
685A55	900 to 930	680



Key

b = major characteristic dimension

t = minor characteristic dimension

Figure 6. Final position of wire after the bend test where $b > t$

11 Examination for defects

11.1 Deep etch test

The deep etch test for examination of surface defects shall apply to all qualities other than stainless steel grades.

A test piece of 250 mm length shall be taken and prior to pickling shall be stress relieved for a minimum of 10 min at a temperature of 400 °C to 500 °C. The cold test piece shall then be immersed in a boiling solution of 50 % (*V/V*) of concentrated hydrochloric acid and 50 % of water, for a period of time equivalent to 1 s for every 0.025 mm of diameter determined for a round wire of identical cross-sectional area to that of the non-circular wire under test, up to a maximum of 2.5 min. After this the wire shall be washed, dried and examined at a magnification of ×5 to ×12. Any surface defects indicated by this test shall be further examined on adjacent untested samples by taking transverse metallographic sections through the surface defects revealed by the deep etch test and measuring their depth.

11.2 Decarburization test

This test shall apply to carbon and low alloy steel grades only. All qualities of wire shall be examined for decarburization using the microscopic method specified in BS 6617 : Part 1 : 1985.

11.3 Internal defects

A metallographic test for internal defects shall apply to high duty dynamic quality wire only. Representative samples of wire in both longitudinal and transverse section shall be polished and very lightly etched and examined for internal defects at a magnification of ×175 to ×225.

NOTE. By agreement between the purchaser and the supplier wire intended for use in dynamic duty springs may be continuously inspected by eddy current or ultrasonic methods of non-destructive testing of suitable sensitivity. The maximum depth of defect, the marking and the allowable number of such defects in any one coil, should be agreed between the purchaser and the supplier. (See **4.2**f.)

12 Retests

12.1 General

Should any test piece fail any of the tests, additional test pieces shall be taken from the appropriate coil and retested. For wire in coils, two additional test pieces shall be taken from the same end of the same coil as the original test.

NOTE. It is permissible to discard part of the coil before taking the new test pieces.

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

12.2 Acceptance

If all the additional test pieces pass all the tests, the coil or the bundles representing the product of the coil shall be deemed to conform to this British Standard. Should any of them fail, the coil or the corresponding bundles shall be deemed not to conform to this British Standard.

13 Packing and identification

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

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

Wire in coil or bundles of lengths shall be securely tied. In the interests of safety, coils dressed to run out straight shall carry a warning label pointing out the need for care when releasing binders.

All consignments shall carry a suitable label or labels on which shall be shown:

a) the number and date of this British Standard i.e. BS 7612 : 1993[1)];

b) the steel grade;

c) the wire quality code;

d) whether annealed, cold drawn, cold rolled or prehardened and tempered;

e) the nominal dimensions of the wire, in mm;

f) the nominal tensile strength, in N/mm^2;

g) the manufacturer's name;

h) any other information agreed between manufacturer and purchaser.

[1)] Marking BS 7612 : 1993 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 solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Annex

Annex A (normative)

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 A.1 shows the permitted variations in product analysis. The variations may occur either above or below the individual element ranges but shall not be applied both above and below the specified range for any one element in any one cast of steel.

A.2 If the product analysis of any wire falls outside the limits of permissible variation from the specified composition range for a significant element, that wire shall be deemed not to conform to this 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 mass up to and including 5 t;

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

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

A.4 Samples for product analysis shall be taken in accordance with BS 1837 : 1970 and, in the event of dispute, analysed in accordance with the appropriate methods of British Standard Handbook 19 : 1970 or BS 6200.

Table A.1. Permitted variation of product analysis from specified range

All values are in % (*m/m*)

Element	Range in which maximum of specified element falls	Variation on specified range					
		Carbon steel		Alloy steels		Stainless steels	
		Over max.	Under min.	Over max.	Under min.	Over max.	Under min.
Carbon	> 0.03 ≤ 0.25	—	—	—	—	0.01	0.01
	> 0.25 ≤ 0.50	0.03	0.03	0.03	0.03	0.02	0.02
	> 0.50 ≤ 1.05	0.04	0.04	0.03	0.03	—	—
Silicon	> 0.10 ≤ 0.35	0.03	0.03	0.03	0.03	—	—
	> 0.35 ≤ 1.0	—	—	—	—	0.05	0.05
	> 1.0 ≤ 2.0	0.07	0.07	0.07	0.07	—	—
Manganese	≤ 1.0	0.04	0.04	0.04	0.04	0.03	0.03
	> 1.10 ≤ 2.0	0.08	0.08	0.05	0.05	0.04	0.04
Phosphorus	≤ 0.030	0.005	—	0.003	—	0.003	—
	> 0.030 ≤ 0.050	0.008	—	0.004	—	0.004	—
Sulfur	≤ 0.030	0.005	—	0.003	—	0.003	—
	> 0.030 ≤ 0.050	0.008	—	0.004	—	0.004	—
Chromium	≤ 0.60	—	—	0.03	0.03	—	—
	> 0.60 ≤ 1.25	—	—	0.04	0.04	—	—
	> 10.0 ≤ 15.0	—	—	—	—	0.15	0.15
	> 15.0	—	—	—	—	0.20	0.20
Molybdenum	> 2.0 ≤ 3.0	—	—	—	—	0.08	0.08
Nickel	> 5.0 ≤ 10.0	—	—	—	—	0.10	0.10
	> 10.0 ≤ 20.0	—	—	—	—	0.15	0.15
Vanadium	≤ 0.30	—	—	—	0.03	—	—

List of references (see clause **2**)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 1837 : 1970	*Methods for the sampling of iron, steel, permanent magnet alloys and ferro-alloys*
BS 6200 :	*Sampling and analysis of iron, steel and other ferrous metals*
BS 6200 : Part 3	*Methods of analysis*
BS 6617 :	*Determination of decarburization in steel*
BS 6617 : Part 1 : 1985	*Methods for determining decarburization by microscopic and micro-hardness techniques*
BS Handbook 19 : 1970	*Methods for the sampling and analysis of iron, steel and and other ferrous metals*
BS EN ISO 6507	*Metallic marterials — Vickers hardness test*
BS EN ISO 6507 : Part 1 : 1998	*Test method*
BS EN 10218	*Steel wire and wire products — General*
BS EN 10218 : Part 1 : 1994	*Test methods*

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 891 : 1989	*Methods for hardness test (Rockwell method) and for verification of hardness testing machines (Rockwell method)*
BS 1429 : 1980	*Specification for annealed round steel wire for general engineering springs*
BS 2056 : 1991	*Specification for stainless steel wire for mechanical springs*
BS 2803 : 1980	*Specification for pre-hardened and tempered carbon and low alloy round steel wire for springs for general engineering purposes*
BS 5216 : 1991	*Specification for patented cold drawn carbon steel wire for mechanical springs*
BS EN 10002-1 :	*Tensile testing of metallic materials*
BS EN 10002-1 : Part 1 : 1990	*Method of test at ambient temperature*

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