BRITISH STANDARD

BS 3592 :
Part 2 : 1992

Steel wire for hose reinforcement

Part 2. Specification for metallic coated steel wire for the bonded reinforcement of hydraulic hoses

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 Ltd.
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

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

BEAMA Ltd.
British Industrial Fasteners Federation
Fencing Industry Association
Wire Products Association

This British Standard, having been prepared under the direction of the Iron and Steel Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 28 February 1992

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To Members of:

Technical Committee
ISM/26
Steel Wire

Sub Committee
ISM/26/1
Low Carbon Steel Wire

Panel Committee
ISM/26/2
Steel Wire for Fastener

Dear Member

BS 3592:Part 2:1992

British Standard steel wire for hose reinforcement Part 2. Specification for metallic coated steel wire for the bonded reinforcement of hydraulic hoses.

Gr 5

The above publication is now available and we enclose a copy with our compliments. We are very grateful for the help and co-operation of the committees concerned with its preparation and would like to thank you for your part in this work.

A copy has also been sent to interested technical and trade associations with the request that they bring it to the notice of their members. We shall be glad of any help you can give in making this and other BSI publications widely known.

Yours sincerely

M S T Langton

Mrs M S T Langton
Director, Standards Technical

Amendment No. 1
published and effective from 15 October 1992
to BS 3592 : Part 1 : 1986

Steel wire for hose reinforcement
Part 1. Specification for coated round and flat steel wire for rubber hose reinforcement

Revised text

AMD 7283
October 1992

Clause 4.2 Tensile strength

In the first sentence delete 'nominal' and substitute 'actual'.

Delete the note.

AMD 7283
October 1992

Table 3. Tensile strength grades

For steel type low carbon steel (mild steel) wire forms round and flat, in the column headed 'Tensile strength grade' delete '350 to 550' and '650 to 850' and substitute '350 to 600' and '>600 to 850', respectively.

AMD 7283
October 1992

Table 4. Ductility wrap test

In the column headed 'Tensile strength grade' delete '350 to 550' and '650 to 850' and substitute '350 to 600' and '>600 to 850', respectively.

AMD 7283
October 1992

Table 5. Reverse bend test

In the column headed 'Tensile strength grade' delete '350 to 550' and '650 to 850' and substitute '350 to 600' and '>600 to 850', respectively.

Contents

Foreword

This Part of BS 3592 has been prepared under the direction of the Iron and Steel Standards Policy Committee and is a revision of BS 3592 : Part 2 : 1986 which is superseded and withdrawn.

In this revision the dimensions and mechanical properties specified have been updated in line with current practice. Appendix A is included for mill wire cast measurement.

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

Specification

1 Scope

This Part of BS 3592 specifies metallic coated patented cold drawn carbon steel wire used for the bonded reinforcement of hydraulic hoses.

Wire diameters are specified between 0.20 mm and 0.80 mm in tensile strengths appropriate to hose design requirements.

NOTE 1. For the purposes of this standard the term 'reel' is synonymous with the terms 'spool' and 'bobbin'.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Manufacture

2.1 Steel rod

The rod used for the manufacture of the wire shall be produced from fully killed steel made by any process other than the air or air oxygen bottom blown processes.

The rod quality shall be of a grade suitable for the manufacture of small diameter wires for high duty dynamic applications in hydraulic hoses.

NOTE. Typically, pipe and complete decarburization should be absent. The segregation rating should be low. The radial depth of partial decarburization and surface defects should be not more than 2 % of the rod diameter.

2.2 Steel composition

The ladle analysis of the steel shall comply with the limits specified in table 1.

Table 1. Ladle analysis limits

Ladle analysis limits			Ladle analysis limits	
Element	Min.	Max.	Element	Max.
	%	%		%
C	0.45	0.90	Cr	0.10
Si	—	0.30	Mo	0.05
Mn	0.40	0.80	Ni	0.10
P	—	0.030	Cu	0.10
S	—	0.030	Sn	0.05

2.3 Wire

After the final patenting heat treatment the wire shall be coated with brass or zinc. The coated wire shall then be drawn to the specified diameter.

The brass plating conditions shall yield a coating complying with the composition and final coating mass specified in **4.3**.

2.4 Welds

2.4.1 If welds are made in the finished wire they shall comply with the conditions specified in **2.4.2** to **2.4.4**.

NOTE. Welds should only be included by agreement between the purchaser and the manufacturer at the time of the enquiry and order.

2.4.2 Not more than 10 % of the reels of wire in any one consignment shall contain final welds, with a maximum of three welds in any one reel of wire.

2.4.3 The tensile strength of test welds shall be not less than 40 % of the tensile strength of adjacent weld-free wire for wire diameters of 0.30 mm and larger and not less than 35 % of the tensile strength of adjacent weld-free wire for wire diameters smaller than 0.30 mm.

2.4.4 After removal of surplus weld metal, the diameter of the wire in the weld zone shall not exceed the adjacent wire diameter by more than 20 %, when measured in accordance with **6.1**.

3 Condition of finished wire

3.1 Surface

The surface of the drawn coated wire shall be clean and free from tarnish or rust and shall not be oiled.

3.2 Waviness, crimp or twist

A length of wire shall not show any waviness, crimp or twist.

3.3 Wire cast

Details of wire cast measurement are given in appendix A.

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.

Wire from a coil shall take up a circular cast of diameter not less than that of the original diameter and not more than 1.5 times the original coil diameter.

3.4 Helix

A complete wap of wire shall be removed without tension and when tested in accordance with **A.3** the helical displacement measured by the deviation of one cut end from the horizontal plane shall not exceed 50 mm.

4 Properties

4.1 Dimensions and mechanical properties

4.1.1 *General*

The dimensions and mechanical properties shall be as specified in table 2. The tensile strength shall be calculated on the actual diameter of the wire.

4.1.2 *Dimensional tolerances*

The tolerance on diameter shall be ± 0.010 mm on all sizes of wire (see **6.1**).

Table 2. Dimensions and mechanical properties

Nominal diameter *d*	Tensile strength		Minimum elongation at fracture	Number of minimum torsions (100 × *d*)	Number of reverse bends 2.5 mm radius
	Minimum	Maximum			
mm	MN/m^2	MN/m^2	%		
0.20	2150	2450	1.8 for all wire sizes	35	125
	2450	2750		35	125
	2750	3050		35	125
0.25	2150	2450		40	125
	2450	2750		40	125
	2750	3050		35	105
	3050	3350		30	75
0.30	2150	2450		35	105
	2450	2750		35	95
	2750	3050		30	85
	3050	3350		25	60
0.33	2450	2750		35	75
0.34	2450	2750		35	75
	2750	3050		30	65
0.38	2150	2450		35	60
	2450	2750		35	60
	2750	3050		30	55
	3050	3350		20	50
0.40	2450	2750		35	55
	2750	3050		30	50
0.46	2150	2450		30	45
	2450	2750		30	45
0.50	2150	2450		30	40
	2450	2750		30	35
	2750	3050		25	30
0.56	2150	2450		25	35
	2450	2750		25	30
	2750	3050		20	25
0.60	2150	2450		30	30
	2450	2750		25	25
0.65	2450	2750		25	20
0.71	2150	2450		25	20
	2450	2750		25	20
0.80	2150	2450		20	15

4.1.3 *Maximum ovality*

Maximum ovality shall be 0.010 mm in all sizes of wire (see **6.1**).

4.1.4 *Tensile ranges*

Four tensile ranges are given in table 2 for some nominal diameters and shall be designated as follows:

(a) 2150 MN/m^2 to 2450 MN/m^2 lower tensile to be designated LT;

(b) 2450 MN/m^2 to 2750 MN/m^2 standard tensile to be designated ST;

(c) 2750 MN/m^2 to 3050 MN/m^2 high tensile to be designated HT;

(d) 3050 MN/m^2 to 3350 MN/m^2 super high tensile to be designated SHT.

4.2 Knot tensile strength

The knot tensile strength shall be not less than 50 % of the tensile strength of the adjacent normal tensile test piece (see **6.2**).

4.3 Coating

4.3.1 *Brass coating*

The coating shall consist of copper and zinc only, with a copper content of 68 ± 4 % (*m/m*) (see **6.3**).

The mass of brass coating shall be not less than that specified in table 3, expressed as g/kg of uncoated steel wire.

4.3.2 *Zinc coating*

The mass of zinc shall not be less than that specified in table 4, expressed as grams per metre squared of the steel surface (see **6.4**).

Table 3. Brass coating mass

Nominal plated wire diameter	Minimum coating mass
mm	g/kg
< 0.35	3.0
≥ 0.35	2.0

Table 4. Zinc coating mass

Nominal zinc coated wire diameter		Minimum coating mass
Equal to and over	Up to but excluding	
mm	mm	g/m^2
0.20	0.25	20
0.25	0.40	30
0.40	0.50	40
0.50	0.60	50
0.60	0.80	60

5 Selection of test pieces

A length of wire sufficient for all the mechanical tests shall be taken from the outside end of each reel of wire. For the coating determination, test pieces shall be taken from 10 % of the reels of wire.

6 Test methods

6.1 Diameter and ovality

The method for measurements shall be capable of reading to intervals of not less than 0.002 mm. Pairs of measurements shall be made at right angles to each other at three places along a length of not less than 250 mm.

The reported diameter of the wire shall be the average of the six measurements. The reported ovality shall be the difference between any one pair of measurements at right angles to each other.

6.2 Mechanical tests

Mechanical tests shall be carried out in accordance with BS 4545 with the following qualifications.

(a) *Elongation.* The elongation shall be measured up to the moment of fracture, on an initial gauge length of 250 mm, by means of a suitable extensometer or recorder, and at a strain rate of between 50 mm·min^{-1} and 100 mm·min^{-1}.

(b) *Knot tensile test.* A simple loop knot shall be formed in the middle zone of the test piece. The knot tensile test piece shall be taken adjacent to the tensile test piece.

(c) *Torsion test.* Torsion test shall be in accordance with ISO 7800 except as follows.

(1) Requirements for wire diameters below 0.3 mm are specified in this standard;

(2) The free length between grips shall be $100 \times d$;

(3) The speed of test shall be 1 s^{-1}.

(d) *Reverse bend test.* Reverse bend test shall be in accordance with ISO 7801.

NOTE. If specified the torsion and reverse bend test may be carried out after ageing for 1 h at 100 °C minimum.

6.3 Brass coating

6.3.1 *Composition*

The composition of the coating shall be determined by either the atomic absorption spectrophotometer or X-ray fluorescence method to an accuracy of ± 0.5 % on the copper content.

6.3.2 *Mass*

The mass of the coating shall be determined during the course of the composition determination.

The mass of the brass coating shall be expressed as grams per kilogram of uncoated steel wire.

NOTE. The relationship between the coating mass, steel surface and the steel mass is given by:

$$1\ g/m^2 = \frac{0.5096}{d}\ g/kg$$

where

d is the steel wire diameter (in mm).

6.4 Zinc coating

The mass of zinc coating shall be determined in accordance with section two of BS 443.

NOTE. For brass or zinc coated wire to be built into hose using purchaser's particular compounds and process, the purchaser may wish to ensure that when the hose is tested in accordance with BS 5173 : Section 103.1, a minimum adhesion requirement will be met.

7 Retests

7.1 If any test piece fails any test, two additional test pieces shall be taken from the same reel of wire and subjected to the test or tests which the original test piece failed. If both additional test pieces pass the test or tests, the reel shall have complied with this Part of BS 3592, but if either of them fails, the reel shall have failed to comply.

7.2 If 10 % or more of the reels in a lot fail to comply, the whole lot shall have failed to comply with this Part of BS 3592.

7.3 Where only a proportion of the reels are tested initially for coating mass, if any of the selected reels fail to comply after retest then all reels in the lot shall be tested. Any further retests shall be subject to the requirements of **7.1** and the lot shall be assessed in accordance with **7.2**.

8 Documentation, identification and packing

8.1 Documentation

The manufacturer shall provide for each consignment either one of the following:

(a) a certificate of compliance with this Part of BS 3592 based on the results of his tests;

(b) a test certificate giving the results of all tests identified to each reel number.

NOTE. It should be agreed between the purchaser and the manufacturer at the time of the enquiry and order whether a type (a) or (b) certificate is to be supplied.

8.2 Identification

Each reel shall be identified with the following information:

(a) the manufacturer's name;

(b) the number and date of this British Standard, i.e. BS 3592 : Part 2 : 1992[1];

(c) the specified wire diameter and strength;

(d) the individual reel number;

(e) the actual strength and wire diameter;

(f) where appropriate, the number of welds in the wire.

8.3 Packing

The leading end of the wire shall be secured on each reel and be readily identified. The outer surface of the wire on the reel shall be protected by wrapping circumferentially with a suitable material for not less than the width of the traverse between the flanges.

The wrapping, e.g. paper coated with a vapour phase inhibitor, shall not cause a chemical reaction with the metallic coating.

Wrapped reels shall be grouped in a convenient size and form of waterproof pack, which shall be in accordance with BS 1133.

Desiccant bags shall be enclosed in each waterproof pack.

[1] Marking BS 3592 : Part 2 : 1992 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.

Appendix

Appendix A. Wire cast measurement

A.1 General

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).

The following tests are carried out if specified to determine the degree of circular, helix and spiral cast.

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

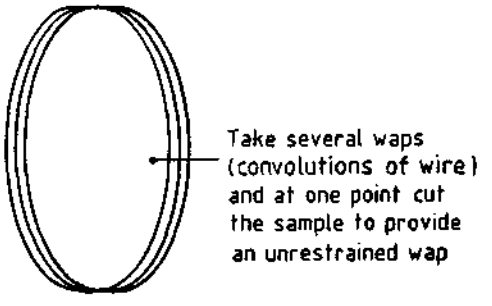


Figure 1. Sampling of wire

A.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 closed and open circular cast.)

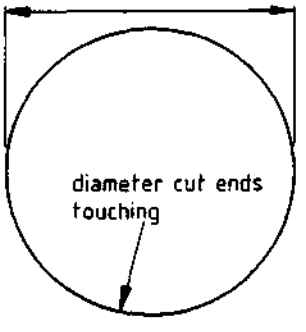


Figure 2. Closed circular cast

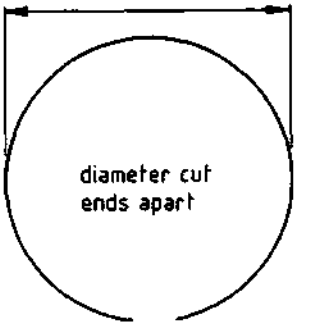
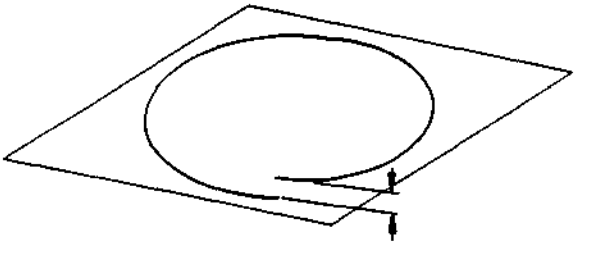


Figure 3. Open circular cast

A.3 Helix cast

To measure the displacement of the cut ends at right angles to the wap place the wap on a horizontal surface, measure and record the vertical distance between the ends of the wap (see figure 4).

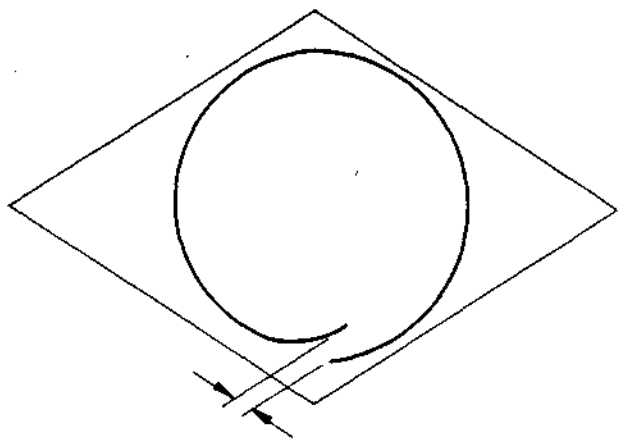


NOTE. The wap is laid on a flat surface and vertical displacement of the cut ends (open cast or closed cast) is measured.

Figure 4. Helix: horizontal placement

A.4 Spiral cast

To measure spiral cast place the wap on a flat horizontal surface and measure the horizontal distance between the ends of the wap (see figure 5).



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

Figure 5. Spiral cast

Publication(s) referred to

BS 443	Specification for testing zinc coatings on steel wire and for quality requirements
BS 1133	Packaging code
BS 4545	Methods for mechanical testing of steel wire
BS 5173	Methods of test for rubber and plastics hoses and hose assemblies Section 103.1 Determination of adhesion between components
ISO 7800	Metallic materials — Wire — Simple torsion test
ISO 7801	Metallic materials — Wire — Reverse bend test

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