INTERNATIONAL STANDARD

ISO 16650

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Bead wire

Fil d'acier pour tringle

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16650 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

Bead wire

1 Scope

This International Standard specifies the requirements and characteristics of round and flat wire used for strengthening the bead of all kinds of tyres.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 404:1992, *Steel and steel products — General technical delivery requirements*

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

ISO 7800:2003, *Metallic materials — Wire — Simple torsion test*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis*

ISO 10474:1991, *Steel and steel products — Inspection documents*

ISO 16120-1:2001, *Non-alloy steel wire rod for conversion to wire — Part 1: General requirements*

ISO 16120-2:2001, *Non-alloy steel wire rod for conversion to wire — Part 2: Specific requirements for general purpose wire rod*

ISO 16120-4:2001, *Non-alloy steel wire rod for conversion to wire — Part 4: Specific requirements for wire rod for special applications*

3 Terms and definitions

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

3.1
nominal diameter
d
that diameter by which the wire is designated and specified by the purchaser

NOTE This is the basis on which the values of all relevant characteristics are determined for the acceptance of the wire.

3.2
actual diameter
arithmetic mean of two measurements at right angles determined at same cross-section

3.3
out-of-roundness
arithmetic difference between the maximum and minimum diameter measured in the same transverse cross-section perpendicular to the wire axis

4 Classification

Bead wire is supplied in two levels of tensile strength, designed as:

NT: Normal standard (or regular) tensile strength

HT: High tensile strength

5 Designation and ordering

5.1 Designation

For products supplied in accordance with this International Standard, the designation shall state, in the following order:

— the term: “bead wire”;

— the coating: see 6.1.2;

— the number of this International Standard, i.e. ISO 16650;

— the tensile strength grade;

— for round wire, the required nominal diameter.

For flat wire, the designation shall state after “bead wire” “flat” and after “ISO 16650” the dimension in the form of width × thickness: e.g. 3 × 1,5.

EXAMPLE Bronze-coated bead wire 1,295 mm high tensile strength in accordance with ISO 16650 is designated as follows:

Bead wire bronze-coated ISO 16650-HT-1,295

5.2 Information to be supplied by the purchaser

The purchaser shall clearly state in his enquiry or order the product and following information:

— the desired quantity;

— the unit and type of delivery;

— the inspection document.

EXAMPLE

20 t **bead wire bronze-coated ISO 16650-HT-1,295 on spools of ca.** 450 kg **ISO 10474.1.B**

6 Requirements

6.1 Material

6.1.1 Steel

The wire shall be made from steel corresponding to ISO 16120-1 and

— for NT, also to ISO 16120-2 or

— for HT, also to ISO 16120-4.

The chemical composition according to the heat analysis shall comply with the limit values shown in Table 1. The permissible deviation of the product analysis from the heat analysis shall be in accordance with ISO 16120-2 and ISO 16120-4.

Table 1 — Chemical composition

Tensile strength	% (mass fraction)				
	C	Sl	Mn	S max.	Zn max.
NT	0,60 to 0,76	0,15 to 0,30	0,40 to 0,70	0,035	0,035
HT	0,77 to 0,90	0,15 to 0,30	0,40 to 0,60	0,025	0,020

6.1.2 Metallic coating

The wire is supplied with one of the following coatings: brass, copper, low-tin bronze or high-tin bronze. The chemical composition shall be in accordance with Table 2. Flat bead wire is only supplied as brass-coated.

In addition, the purchaser may specify the application of a cumar residue coating.

Table 2 — Chemical composition of the coating

Coating material	% (mass fraction)		
	Cu	Sn	Zn
Brass[a]	60 to 77	—	23 to 40
Copper	$\geqslant$ 99,9	—	—
Bronze low-Sn[b]	$\geqslant$ 97	$\leqslant$ 3	—
Bronze high-Sn[b]	80 to 94	6 to 20	—

[a] The maximum range of copper content shall be 5,0 %. A tighter range may be agreed upon.

[b] Depending on the coating thickness the bronze coating may be specified as type 1 or type 2:

— bronze 1: low-coating thickness;

— bronze 2: high-coating thickness.

6.2 Mechanical properties

6.2.1 General

The mechanical characteristics are determined on the material as delivered.

If so agreed upon between the purchaser and the supplier, the tests may be performed on thermally stabilized samples. In such case, the samples are heated in an oven at 150 °C for 1 h and allowed, in air, to cool to room temperature before testing.

6.2.2 Tensile test results

6.2.2.1 General

The following properties shall be noted from the tensile test: the tensile strength, the yield strength and the elongation. The wire shall satisfy the values of tensile strength listed in Table 3.

6.2.2.2 Tensile strength and elongation

Two grades of tensile strength are standardized, normal tensile grade and high tensile grade. The specified minimum tensile strength and elongation are specified for each grade in Table 3.

6.2.2.3 Yield strength and 0,2 % proof strength

The tensile strength corresponding to the 0,2 % proof strength, $R_{p0,2}$, shall be at least 80 % of the minimum tensile strength specified in Table 3.

Table 3 — Requirements for tensile strength and elongation[a, b]

Diameter mm	Tensile strength NT N/mm^2	Tensile strength HT N/mm^2	Minimum elongation at rupture A_t %
$0{,}80 \leqslant d < 0{,}95$	1 900 to 2 300	2 150 to 2 500	5,0
$0{,}95 \leqslant d < 1{,}25$	1 850 to 2 250	2 050 to 2 400	5,0
$1{,}25 \leqslant d < 1{,}70$	1 750 to 2 150	2 050 to 2 400	5,0
$1{,}70 \leqslant d < 2{,}10$	1 500 to 1 800	2 050 to 2 400	5,0
Fil plat 3 × 1,50	1 650 to 1 950		2,0
1 N/mm^2 = 1 MPa			

[a] The variation of the tensile strength in one batch shall not be more than 300 N/mm^2.

[b] The purchaser may specify a different minimum tensile strength. This tensile strength shall be not more than 100 N/mm^2 above the minimum specified in Table 3 and not more than 10 % below the same minimum tensile strength.

6.2.3 Torsion test

The wire shall withstand the minimum number of torsions listed in Table 4 without fracture.

Table 4 — Minimum number of torsions

Nominal wire diameter d mm	Minimum number of torsions N_t
$d <$ 1,00d	50
$1{,}00 \leqslant d < 1{,}25$	25
$1{,}25 \leqslant d < 1{,}50$	22
$1{,}50 \leqslant d$	20

6.3 Surface quality

6.3.1 General

The surface of the wire shall be smooth and free from grease or other contaminants.

6.3.2 Coating thickness

The coating thickness and tolerance on the thickness shall be as listed in Table 5.

Table 5 — Coating thickness

Coating type	Thickness μm
Brass	0,20 ± 0,10
Copper	0,10 ± 0,07
Bronze 1	0,10 ± 0,07
Bronze 2	0,17 ± 0,07

6.4 Delivery conditions

6.4.1 Unit package

The wire shall be supplied in units of one single length.

The unit package of wire shall be wound on spools or as spoolless cores, of dimensions to be agreed upon between the parties concerned.

6.4.2 Welds

Welds at final size are permitted in so far as they permit proper processing. For that purpose the welds shall be smooth, properly cleaned and sufficiently ductile. The weld and heat-affected zone shall have a tensile strength of at least 40 % of the tensile strength specified in Table 3.

6.4.3 Wire straightness

The wire shall be reasonably straight and without excessive residual torsions.

6.4.4 Residual torsions

The number of residual torsions shall be less than one revolution on 9 m or equivalent in case of other test lengths.

6.5 Dimensions and tolerances

6.5.1 Size tolerances

For round wire, the tolerance is as specified in Table 6.

Table 6 — Tolerance on the wire diameter

Wire diameter d mm	Tolerance mm
$d \leqslant$ 1,00	± 0,03
1,00 $< d$	± 0,04

For flat wire 3 mm × 1,5 mm, the width tolerance is ± 0,05 mm, the tolerance on thickness is ± 0,03 mm.

6.5.2 Out-of-roundness

The out-of-roundness shall not be more than half the tolerance range.

6.5.3 Requirements for adhesion

Where an adhesion test is prescribed, the parties shall agree upon the requirements specified.

7 Testing and inspection

7.1 Tests and inspection documents

The testing and reporting shall mean specific inspection and testing in accordance with ISO 10474 and ISO 404.

7.2 Programme for specific inspection

The frequency of testing shall be agreed upon between the parties at the time of enquiry and order.

Where appropriate, statistical testing shall be done according to criteria to be agreed upon between the parties concerned.

7.3 Test procedures

7.3.1 Chemical composition

The methods to be applied for the verification of the product analysis shall be agreed upon at the time of ordering.

In cases of dispute about analytical methods, the chemical composition shall be determined in accordance with a reference method from ISO standards listed in ISO/TR 9769.

7.3.2 Tensile test

The tensile test shall be carried out in accordance with ISO 6892 on samples with the full cross-section of the wire for determination of the tensile strength, the elongation, A_t, at the moment of rupture and the yield strength at 0,2 % proof stress $R_{p0,2}$.

The reference length for the elongation shall be 200 mm $\pm$ 2 mm. Other gauge lengths may be agreed upon between the parties concerned.

7.3.3 Torsion test

The torsion test shall be performed in accordance with ISO 7800. The test length is specified in Table 7.

Table 7 — Test length for the torsion test

Wire diameter mm	Test length
$d <$ 1,00	200 d
1,00 $\leqslant d \leqslant$ 5,00	100 d

7.3.4 Diameter and out-of-roundness

The diameter shall be measured using a micrometer with a precision of $\pm$ 0,001 mm.

7.3.5 Straightness

The wire sample is put on a smooth surface on which two parallel lines, 3 m long and 600 mm apart, are marked. The wire sample is checked to see if it stays within the two lines.

7.3.6 Residual torsions

The wire end is bent at a right angle. A test sample of about 9 m is pulled from the unit package without cutting off or releasing the end. The end of the wire shall not rotate in either direction more than one full revolution around its axis.

7.3.7 Adhesion test

The conditions for executing the adhesion test shall be agreed upon between the parties. Annex A gives information about one of the most widely used methods.

7.4 Retests

Retests shall be performed in accordance with ISO 404.

8 Marking, labelling and packaging

Each spool and each package unit shall be properly marked and identified so as to permit traceability and reference to test reports.

The labels shall show the information listed in Table 8.

Other information shall be the subject of an agreement between the parties concerned.

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

Table 8 — Information on the labels

Information	Spool	Package
Designation	+	+
Manufacturer	+	+
Identification number	+	
Heat number	(+)	
Destination		+
Order number		+
Weight (Net, Gross)		+
Origin		(+)
Customer reference		+
NOTE + = mandatory; (+) = optional.		

Annex A
(informative)

Adhesion testing

One of the most widely used adhesion tests is in accordance with ASTM D 1871-02.

The method which is called in ASTM D 1871-02 as Method 1 is widely used and is described as follows.

The wires are vulcanized into a block or pad of rubber and the load necessary to pull the wires out of the rubber is measured. The direction of pull-out is axial, i.e. along the wire axis. A 12,5 mm thick rubber block with 50 mm long embedment is commonly used but other variations of the length are sometimes specified.

Bibliography

[1] ISO 14284:1996, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

[2] ASTM D 1871-02, *Standard Test Method for Adhesion Between Tire Bead Wire and Rubber*

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