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Hot-dip galvanized and zinc-aluminium coated high tensile steel wire for bridge cables — Specifications

Fils d'acier à haut carbone galvanisés ou revêtus de zinc-aluminium pour câbles de ponts — Spécifications

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

Hot-dip galvanized and zinc-aluminium coated high tensile steel wire for bridge cables — Specifications

1 Scope

This document specifies the requirements for hot-dip galvanized (hereinafter referred to as zinc coated) and zinc-aluminium coated high tensile wires, which are widely used in parallel wire cables or semi-parallel wire cables for suspension bridges, stay bridges and other structures involving the use of parallel wires.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 752:2004, *Zinc ingots*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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

ISO 7802, *Metallic materials — Wire — Wrapping test*

ISO 7989-2, *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Part 2: Zinc or zinc-alloy coating*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 10474:2013, *Steel and steel products — Inspection documents*

ISO 15630-3:2010, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 3: Prestressing steel*

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

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

ISO 22034-2, *Steel wire and wire products — Part 2: Tolerances on wire dimensions*

ASTM B 997, *Standard specification for Zinc-Aluminum alloy in ingot form for hot-dip coatings*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
wire rod
hot rolled steel delivered in coils, used for cold working treatments such as wire drawing

3.2
bare steel wire
product manufactured by cold working *wire rod* (3.1) that is in a suitable metallurgical condition for cold working

3.3
hot-dip zinc coated steel wire
hot-dip galvanized coated steel wire
steel wire that is coated with zinc in a bath of molten zinc

3.4
zinc-aluminium coated steel wire
steel wire that is coated with zinc-aluminium alloy in a bath of molten zinc-aluminium alloy

Note 1 to entry: In this document, "steel wire" or "wire" refers to zinc or zinc-aluminium coated steel wire, unless otherwise specified.

3.5
stabilized wire
steel wire that is given a final thermo-mechanical treatment

3.6
out-of-round
arithmetic difference between the maximum and minimum diameters of the steel wire at the same cross section

3.7
semi-parallel wire cable
specified number of steel wires bundled together with a maximum lay angle of 4°

Note 1 to entry: Semi-parallel wire cables are usually used for cable stayed bridge and suspenders for suspension and arch bridges.

3.8
unit of manufacture
coil of steel wire produced from one coil of *wire rod* (3.1)

3.9
unit of product
coil of steel wire delivered to a customer

Note 1 to entry: The unit of product is either the *unit of manufacture* (3.8) or a smaller coil cut from a unit of manufacture.

3.10
unit of inspection
quantity of product presented at any one time for examination and release purposes

3.11
inspection
conformity evaluation by observation and judgement accompanied as appropriate by measurement, testing or gauging

3.12
factory production control
permanent internal production control exercised by the manufacturer

3.13
standard property
property prescribed as part of *factory production control* (3.12) requirements for every unit of *inspection* (3.10)

3.14
special property
property prescribed that are not determined as part of *factory production control* (3.12) requirements

3.15
maximum
value which no test result shall exceed

3.16
minimum
value below which no test result shall fall

3.17
unit heat of steel
quantity of steel corresponding to the same single melting operation identified by a single number so designated by the steel manufacturer(s)

4 Symbols

Symbol	Unit	Designation	Reference
A	%	percentage of elongation after fracture	7.2.3
d	mm	nominal diameter of the steel wire	7.2, 7.3, Annex A, Annex C
E	GPa	modulus of elasticity	7.2.3, 9.1.3
ε_x	—	value of the strain for a force equal to x	9.1.3
Fm	KN	minimum ultimate tensile force (or guaranteed ultimate tensile force), $Fm = R_m \times Sn$	9.1.3
F_r	KN	fluctuating force range in the axial load fatigue test	7.3
h_b	mm	bow height in the plane of bow	7.2
R_m	MPa	ultimate tensile strength	7.2, 7.3
L_0	mm	gauge length (without force on the test piece)	7.2, 9.1.2
$R_{p0,2}$	MPa	0,2 % offset proof strength	7.2
Sn	mm^2	nominal cross sectional area of the steel wire	7.2, 7.3

5 Designation of the product

The steel wire shall be ordered in accordance with this document and be designated as follows:

a) ISO 19203;

b) nominal diameter, in millimetres;

c) nominal tensile strength, in MPa;

d) coating type;

e) a suffix “R” to indicate when relaxation properties are specified, e.g. 1 960R.

NOTE “Zn” is used for hot-dip zinc coated and “ZnAl” for zinc-aluminium alloy coated.

EXAMPLE 1 Zinc coated steel wire with nominal diameter 5 mm and nominal tensile strength 1 960 MPa is designated

ISO 19203-5,00-1960-Zn

EXAMPLE 2 Zinc-aluminium coated steel wire with nominal diameter 7 mm and nominal tensile strength 1 860 MPa is designated

ISO 19203-7,00-1860-ZnAl

EXAMPLE 3 Zinc coated steel wire with nominal diameter 5 mm and nominal tensile strength 1 960 MPa, when relaxation property specified, is designated

ISO 19203-5,00-1960R-Zn

6 Information needed by the manufacturer

The following information shall be obtained by the manufacturer at the time of enquiry and order:

— designation of the product in accordance with Clause 5;

— packaging and protection requirements and, in the case of products supplied in bundles, the maximum mass of the bundles;

— requirements for documentary information to accompany the delivery (i.e. delivery note, type and content of inspection document, copies of force/extension diagrams);

— special requirements for labelling.

7 Requirements

7.1 Materials and manufacture

7.1.1 The bare steel wires shall be produced from wire rod that conforms to ISO 16120-1 and ISO 16120-4.

7.1.2 Zinc ingot metal shall conform to ZN-3 or higher under ISO 752:2004, 6.1. ZnAl ingot shall conform to ASTM B 997.

7.1.3 Bare steel wires shall be zinc or zinc-aluminium coated after drawing.

7.1.4 Coated wires may be stabilized depending on the final product relaxation requirement. Stabilized steel wire requirements shall be specified by the customer.

7.1.5 Welding points present in steel wire rod before the drawing process are acceptable if agreed between manufacturer and customer.

Mechanical properties of the welding points and the number of welding points shall be agreed between the manufacturer and the customer.

7.2 Standard properties

7.2.1 Geometrical properties

The geometrical properties shall be defined by a nominal diameter, *d*, permitted deviation on nominal diameter and out-of-round which all include the metallic coating, see Table 1.

NOTE 1 Generally, 5 mm steel wires are used in the main cables of suspension bridges, and 7 mm wires in cables of cable-stayed bridges. Steel wires with other dimensions can be supplied if agreed between the manufacturer and the customer.

NOTE 2 The calculation of the density of steel wires and diameter of bare steel wire is described in Annex C.

Table 1 — Nominal diameters, permitted deviation and out-of-round

Nominal diameter, d[a] mm	Permitted deviation on nominal diameter mm	Out-of-round mm
5,00	±0,06	≤ 0,06
7,00	±0,07	≤ 0,07
a The nominal values and tolerance include the wire coating.		

7.2.2 Straightness

7.2.2.1 General

The steel wire shall be uniform in straightness along its length commensurate with the requirements specified in 7.2.2.2, and there shall not be defects, such as bend, twist, etc.

7.2.2.2 Bow height

The bow height (h_b), which indicates the straightness of the product, shall be determined by measuring, in the plane of the bow, the distance between the steel wire and a line joining the ends of a rule of length 1 m in contact with the wire, lying on a flat horizontal surface with a flatness tolerance of 1 mm/m (see Figure 1).

The maximum bow height shall be agreed by the manufacturer and the customer.

Dimensions in millimetres

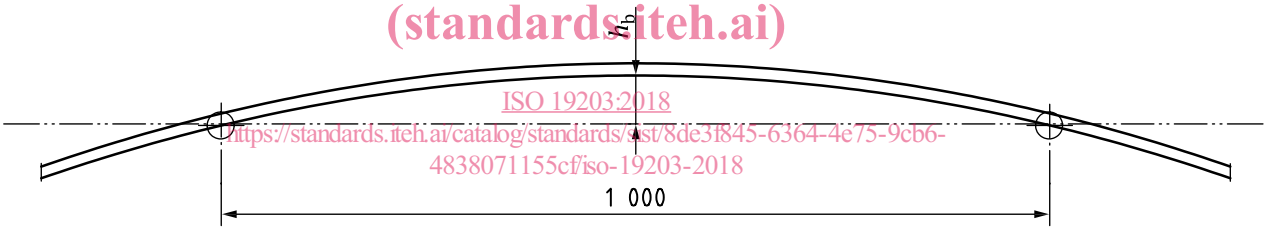

Figure 1 — Measurement of bow height

7.2.3 Mechanical and coating properties

The mechanical and coating properties of the steel wires shall conform to Table 2.

Table 2 — Typical diameter, mechanical and coating properties of steel wires

Property	Nominal tensile strength grade, MPa				
	1 570	1 670	1 770[c]	1 860[c]	1 960[c]
Typical nominal diameter d	5,0 mm and 7,0 mm				
Ultimate tensile strength R_m, MPa[a]	1 570 ≤ R_m < 1 770	1 670 ≤ R_m < 1 870	1 770 ≤ R_m < 1 970	1 860 ≤ R_m < 2 060	1 960 ≤ R_m < 2 160
0,2 % offset proof strength $R_{p0,2}$, MPa (minimum)[a,b]	1 180	1 250	1 330	1 400	1 470
Elongation after fracture A, % (minimum)	4,0 (on a gauge length L_0 of 250 mm)				
Modulus of elasticity E, GPa	200 ± 10				
a Tensile strength and proof strength shall be calculated from the nominal cross-sectional area.					
b The minimum proof strength shall be 0,75 × nominal tensile strength grade, rounded to the nearest 10 MPa.					
c A higher number of torsions can be agreed upon between manufacturer and customer.					