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Steel wire rod for bridge cable wire

Fil machine en acier pour câbles de ponts

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Steel wire rod for bridge cable wire

1 Scope

This document specifies requirements for wire rod for bridge cable wire, which is widely used in parallel wire cables or semi-parallel wire cables for suspension bridges, stay bridges or other structures involving the use of parallel wires.

ISO 16120-4 provides additional wire rod materials and their technical and qualitative requirements for their possible application as bridge cable wire.

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 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 404:2013, *Steel and steel products — General technical delivery requirements*

ISO 3887, *Steels — Determination of the depth of decarburization*

ISO 4967, *Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams*

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

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

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 16120-1:2017, *Non-alloy steel wire rod for conversion to wire — Part 1: General requirements*

ISO 16120-4:2017, *Non-alloy steel wire rod for conversion to wire — Part 4: Specific requirements for wire rod for special applications*

ISO 16124:2015, *Steel wire rod — Dimensions and tolerances*

ISO 16574, *Determination of percentage of resolvable pearlite in high carbon steel wire rod*

EN 10204, *Metallic products — Types of inspection documents*

3 Terms and definitions

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

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

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

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

3.1
out-of-roundness
difference between the maximum and minimum diameter measured at the same cross-section of wire rod

3.2
batch
wire rods with the same dimension and grade produced from the same heat and the same process in one continuous production operation

4 Designation

In the designation ##DB-#, ##is the indicative average content of carbon; “D” signifies that it is for wire-drawing; “B” means wire rod for bridge cable wire; “#” signifies serial number of steel grades with the same carbon content.

Example Grade 82DB-3

82 denotes the mid-point of the 0,80/0,85 % carbon range;

D denotes that the grade is for wire drawing;

B denotes that the end product is bridge wire;

3 denotes serial number of steel grades with the same carbon content.

5 Ordering information

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) quantity to be delivered;

b) nominal dimensions;

c) a reference to this document, i.e. ISO 6819:2023;

d) steel grade, including any permitted additions/variations;

e) delivery condition;

f) special requirements, if any.

6 Production process

Steelmaking shall be conducted by basic oxygen furnace or electric-arc furnace and ladle refining. Unless otherwise agreed at the time of order, the steelmaking method is left to the discretion of the supplier.

7 Requirements

7.1 General

The general requirements shall be in as specified in ISO 16120-1.

7.2 Dimensions and tolerances

The nominal dimensions of wire rod shall be 11 mm to 16 mm. The tolerances on diameter and out-of-roundness shall be in accordance with T2 in ISO 16124:2015. Other alternatives may be agreed between supplier and purchaser.

7.3 Coil weight

Each coil shall be one continuous length of wire rod. Coil weight may be agreed between supplier and purchaser.

7.4 Chemical composition

For heat analysis, the values shown in Table 2 shall apply. If product analysis is required, the permissible deviations relative to the specified value of the heat analysis are given in Table 3.

Table 2 — Steel grade and chemical composition (heat analysis)

Grade	Chemical composition, mass fraction %							
	C	Si	Mn	P	S	Cr	Cu	N
82DB-1	0,80 to 0,85	0,15 to 0,35	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
82DB-2	0,80 to 0,85	0,35 to 0,80	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
82DB-3	0,80 to 0,85	0,80 to 1,30	0,20 to 0,60	≤0,020	≤0,010	0,15 to 0,60	≤0,20	≤0,007
82DB-4	0,80 to 0,85	0,80 to 1,30	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
87DB-1	0,85 to 0,90	0,15 to 0,35	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
87DB-2	0,85 to 0,90	0,35 to 0,80	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
87DB-3	0,85 to 0,90	0,80 to 1,30	0,20 to 0,60	≤0,020	≤0,010	0,15 to 0,60	≤0,20	≤0,007
87DB-4	0,85 to 0,90	0,80 to 1,30	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
92DB-1	0,90 to 0,95	0,15 to 0,35	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
92DB-2	0,90 to 0,95	0,35 to 0,80	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
92DB-3	0,90 to 0,95	0,80 to 1,30	0,20 to 0,60	≤0,020	≤0,010	0,15 to 0,60	≤0,20	≤0,007
92DB-4	0,90 to 0,95	0,80 to 1,30	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
97DB-1	0,95 to 1,00	0,15 to 0,35	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
97DB-2	0,95 to 1,00	0,35 to 0,80	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007
97DB-3	0,95 to 1,00	0,80 to 1,30	0,20 to 0,60	≤0,020	≤0,010	0,15 to 0,60	≤0,20	≤0,007
97DB-4	0,95 to 1,00	0,80 to 1,30	0,60 to 0,90	≤0,020	≤0,010	≤0,35	≤0,20	≤0,007

Upon agreement between the purchaser and the manufacturer, the grades may contain additions of boron (B), and the content of B shall be 0,000 5 % to 0,004 0 %. When the content of C is 0,4 % or more, the effect of improving hardenability by the addition of B is generally not recognized. The purpose of addition of B is to stabilize the structural control in the general transformation temperature range.

Addition of other alloy elements shall be mutually agreed.

Table 3 — Permissible deviation in the product analysis in relation to the specified heat analysis

Element	over max limit %	under min limit %
C	0,04	0,04
Si	0,04	0,04
Mn	0,06	0,06
P	0,005	—
S	0,005	—
Cr	0,05	0,05[a]
Cu	0,05	—

[a] Applies to grades 82DB-3, 87DB-3, 92DB-3, 97DB-3 only.

7.5 Mechanical properties

By agreement between supplier and purchaser, the wire rod may be supplied with guaranteed mechanical properties, and these values shall be agreed at the time of order. For guidance, the values applicable to each grade may be as designated in Annex A. Patenting or alternative heat treatment may be necessary in order to achieve these informative values.

7.6 Delivery condition

Wire rod shall be supplied in hot-rolled or heat-treated condition.

7.7 Internal soundness and surface quality

The wire rod shall have no internal or surface discontinuities, such as shrink holes, cracks, folds, incrustations, notches, scabs or rolling burrs, which can be detrimental to its subsequent processing.

7.8 Surface discontinuities

Unless otherwise agreed between the supplier and purchaser, the wire rod shall not have any surface discontinuities exceeding 0,10 mm on radial depth and 0,15 mm actual length, when measured according to ISO 16120-1:2017, Annex B.

7.9 Decarburization

The depth of decarburization shall be in accordance with Class B in ISO 16120-4:2017.

7.10 Non-metallic inclusions

The limit values of non-metallic inclusions for all the inspected samples shall be in accordance with ISO 16120-4.

7.11 Microstructure

7.11.1 Resolvable pearlite

If required by the purchaser, the resolvable pearlite content of grade 82DB shall be ≤15 % and grades 87DB- 97DB ≤10 %. Patenting or alternative heat treatment may be necessary in order to achieve these values. In this case, the number of specimens or samples shall be as given in ISO 16120-1:2017, Table 2.

The test method for measurement of resolvable pearlite shall be as given in ISO 16574. For grades without an intentional addition of Cr, the microstructure shall be free of martensite and bainite. For grades with an intentional addition of Cr, isolated martensitic grains are allowed.

7.11.2 Cementite network

The number of specimens or samples shall be as given in ISO 16120-1:2017, Table 2. The test method for determination of cementite network in wire rod is specified in ISO 16120-1:2017, Annex E and Class E is not allowed, unless otherwise agreed.

7.12 Core segregation

If agreed at the time of enquiry and order, wire rod shall be inspected for core segregation. Not more than 10 % of the samples tested shall be of Class 4; Class 5 is not allowed (see ISO 16120-1:2017, Annex A). It is recommended that the evaluation be done as part of a quality system.

8 Inspection

Inspection and inspection documents shall be in accordance with ISO 404 and ISO 10474.

9 Test methods

9.1 General

Unless otherwise stated below, or otherwise agreed between supplier and purchaser, the sampling and testing frequency shall be as follows: one per 20 t with a minimum of three and a maximum of five per batch.

9.2 Tolerances in diameter and out-of-roundness

Each coil shall be tested for diameter and out-of-roundness. The product shall conform to the dimensional tolerances via a combination of physical (vernier/micrometer) measurements and automated measurement techniques.

9.3 Chemical composition

Where it has been agreed to verify the chemical composition of the product, sampling and preparation of samples for heat analysis shall be carried out in accordance with ISO 14284. The methods to be applied for the verification of the product analysis shall be agreed upon at the time of ordering. In case of dispute about analytical methods, the chemical composition shall be determined in accordance with a reference method.

9.4 Tensile strength

Samples shall be taken and prepared in accordance with ISO 377. The tensile test shall be carried out on wire rods in the as-delivered condition and in accordance with ISO 6892-1.

9.5 Decarburization

Samples shall be taken to perform decarburization inspection in accordance with ISO 3887.

9.6 Non-metallic inclusions

Non-metallic inclusion inspection shall be carried out by the “worst field” method, as defined in ISO 4967 (method A). The worst field for each individual inclusion type shall be recorded and a mean value calculated.

9.7 Core segregation

The method for determining the core segregation shall be micrographic examination on a transverse section of the sample, as specified in ISO 16120-1:2017, Annex A. Ten samples per batch shall be taken to perform core segregation inspection.

10 Retests

Retests shall be in accordance with ISO 16120-1:2017, 9.6.

11 Marking

Each coil in each consignment shall be marked with the following information:

a) dimensions of the cross-section of the wire rod;

b) steel grade;

c) heat number;

d) the name and, if applicable, the symbol of the supplying mill;

e) any subsequently agreed information;

f) special requirements, if any.

Unless otherwise agreed upon, the marking shall withstand pickling. The durability of the labels utilized for marking shall be agreed upon at the time of ordering.

12 Disputes

In case of dispute, the sampling conditions and test methods used to evaluate the dispute characteristics shall be those described in ISO 404:2013, 8.3.3 and 8.3.4, or in EN 10204.

Annex A
(informative)

Mechanical properties

Table A.1 — Mechanical properties

Grade	Tensile strength, R_m MPa		Reduction of area, Z %
	11,0 mm≤d_N≤12,5 mm	d_N>12,5 mm	
82DB-1	≥1 230	≥1 200	≥34
82DB-2	≥1 250	≥1 220	≥32
82DB-3	≥1 270	≥1 240	≥30
82DB-4	≥1 270	≥1 240	≥30
87DB-1	≥1 280	≥1 250	≥32
87DB-2	≥1 290	≥1 260	≥30
87DB-3	≥1 300	≥1 270	≥28
87DB-4	≥1 300	≥1 270	≥28
92DB-1	≥1 330	≥1 300	≥30
92DB-2	≥1 340	≥1 310	≥28
92DB-3	≥1 350	≥1 320	≥26
92DB-4	≥1 350	≥1 320	≥26
97DB-1	≥1 380	≥1 350	≥25
97DB-2	≥1 390	≥1 360	≥23
97DB-3	≥1 400	≥1 370	≥21
97DB-4	≥1 400	≥1 370	≥21
NOTE 1 The above limits apply to all coils in a batch. NOTE 2 The variation of tensile strength within each batch shall be </= 100 MPa.			