
**Steel wire ropes — Pre-fabricated
parallel wire strands for suspension
bridge main cable — Specifications**

*Câbles en acier — Câbles à fils parallèles préfabriqués pour câble
porteur de pont suspendu — Spécifications*

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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.

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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 105, *Steel wire ropes*.

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 ropes — Pre-fabricated parallel wire strands for suspension bridge main cable — Specifications

1 Scope

This document specifies the production methods, specifications, requirements, test methods, inspection rules, marks, packing, transportation and storage for pre-fabricated parallel wire strand (PPWS), which are made of hot-dip galvanized or zinc-aluminium coated high tensile steel wires described in ISO 19203.

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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 4986, *Steel casting — Magnetic particle inspection*

ISO 4992-2, *Steel castings — Ultrasonic examination — Part 2: Steel castings for highly stressed components*

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

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

ISO 17558:2006, *Steel wire ropes — Socketing procedures — Molten metal and resin socketing*

ISO 19203, *Steel wire rod and wire products — Hot-dip galvanized and zinc-aluminium coated steel wires for bridge cables — Specifications*

EN 1774, *Zinc and zinc alloys — Alloys for foundry purposes — Ingot and liquid*

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:

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

— IEC Electropedia: available at <http://www.electropedia.org/>

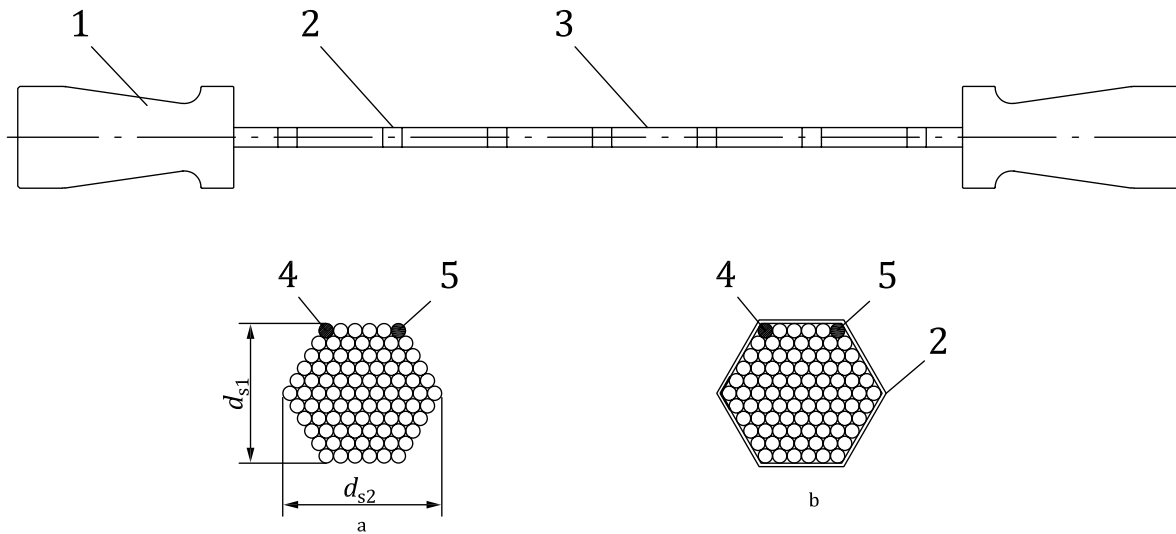
3.1

pre-fabricated parallel wire strand

PPWS

strand factory pre-fabricated by assembling a group of wires laid parallel in a hexagonal (regular or irregular) shape, bound together at intervals by binding tape, and fitted with *sockets* (3.3) at each end

Note 1 to entry: The section and the structure of PPWS is shown in [Figure 1](#).



Key

- | | | | |
|---|---------------------|----------|---|
| 1 | socket | d_{s1} | hexagon diagonal distance (across corners), in mm |
| 2 | binding tape | d_{s2} | hexagon width distance (across flats), in mm |
| 3 | PPWS | a | Cross-section of strand (without binding tape). |
| 4 | gauge wire | b | Cross-section of strand (with binding tape). |
| 5 | coloured wire (red) | | |

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Figure 1 — Diagram of structure of PPWS

3.2

binding tape

plastic tape reinforced by plastic fibres

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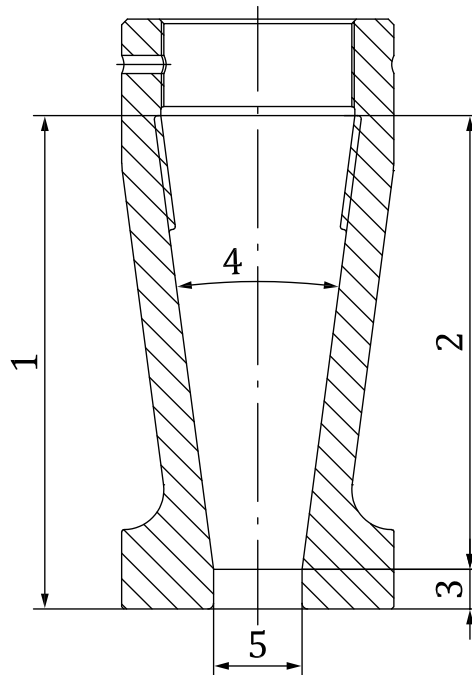
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Note 1 to entry: The tapes are bound at intervals to keep the shape of strand tight and can permit the wires to open or spread sufficiently to adjust the stresses in the strand during reeling and unreeling.

3.3

socket

PPWS (3.1) termination incorporating a socket basket (3.5), see Figure 2

**Key**

- 1 overall basket length [tapered portion plus parallel portion(s), if applicable, plus radius at rope entry]
- 2 tapered portion of socket basket
- 3 parallel portion of socket basket and any radius at strand entry
- 4 angle of tapered basket
- 5 diameter at strand entry

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Figure 2 — Typical socket basket

Note 1 to entry: Length adjusting system shall be provided at connection between PPWS socket and anchorage structure.

3.4**socketing medium**

molten metal alloy or resin

3.5**socket basket**

tapered portion of a *socket* (3.3) within which the evenly splayed out wires are secured

3.6**PPWS grade**

R_m

level of requirement of nominal tensile strength grade which is designated by a number

EXAMPLE 1 770, 1 960.

Note 1 to entry: PPWS (3.1) strength grade correspond to the strength grades of the wires in the PPWS. It is expressed in MPa.

3.7**nominal wire diameter**

d

nominal diameter of the perpendicular cross-section of the steel wire after coating

Note 1 to entry: It is expressed in millimetres.

3.8
nominal metallic cross-sectional area

A
design value obtained from the sum of the metallic cross-sectional areas of the wires in the *PPWS* (3.1) based on their nominal diameters:

$$A = \frac{\pi}{4} d^2 \times n$$

where n is the number of steel wires composing *PPWS*

Note 1 to entry: It is expressed in mm².

3.9
nominal breaking force

F_n
value of minimum breaking force based on the nominal wire sizes, wire tensile strength grades for the *PPWS* (3.1) class or construction as given in the manufacturer's design, which is obtained as follows:

$$F_n = R_m \times A / 1\ 000$$

Note 1 to entry: It is expressed in kN.

3.10
measured breaking force

F_m
breaking force obtained using a prescribed method

Note 1 to entry: It is expressed in kN.

3.11
nominal *PPWS* length mass

m
mass of unit length of *PPWS* (3.1) obtained from the product of the *nominal metallic cross-sectional area* (3.8) and density of steel wires after coating and calculated as follows:

$$m = A \times \gamma_w$$

where γ_w is the density of coated steel wire

Note 1 to entry: It is expressed in kg/m.

Note 2 to entry: γ_w is expressed in kg/m³ (see ISO 19203:2018, Annex C).

3.12
unstressed length

length which corresponds to the actual length without load supplied using a prescribed method

3.13
free length

L_0
cable length excluding *socket* (3.3) lengths, which is the length between the front faces of sockets

Note 1 to entry: It is expressed in m.

3.14
gauge wire

wire used to control the length of the *PPWS* (3.1) during manufacturing, which is measured and marked under specific marking load while temperature is uniform

3.15**coloured wire**

wire used to check twist condition of PPWS (3.1) during construction, which is painted with distinct colour on its total length

3.16**unit of product**

set of 20 pieces of PPWSs (3.1) subsequently produced

4 Designation of product

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

- a) ISO 19427;
- b) PPWS;
- c) nominal diameter of steel wire, in millimetres;
- d) number of steel wires composing PPWS;
- e) PPWS grade;
- f) coating type:

EXAMPLE 1 A PPWS made up of 91 pieces of zinc coated steel wires with diameter of 5 mm and grade of 1770, is designated:

ISO 19427-PPWS-5,00-91-1770-Zn (standards.iteh.ai)

where Zn is hot-dip zinc coated.

EXAMPLE 2 A PPWS made up of 127 pieces of zinc-aluminium alloy coated steel wires with diameter of 7 mm and grade of 1860, is designated:

ISO 19427-PPWS-7,00-127-1860-ZnAl

where ZnAl is zinc-aluminium alloy coated.

5 Requirements**5.1 Traceability**

The traceability shall be done from the beginning to the end of manufacturing. The manufacturer shall use suitable means to ensure the conformity of products and identify the status of products with respect to monitoring and measurement requirements throughout production and delivery.

The manufacturer shall control the unique identification of the products, and shall retain the documented information necessary to enable traceability.

5.2 Lengths and fabrication tolerances

5.2.1 The gauge wire shall be in the outside of the PPWS. The total length of the PPWS and all measuring points for the sockets, saddles and the key point such as main span middle point and side span middle point shall be marked on the gauge wire under specific marking load while temperature is uniform. The length of gauge wire shall take into account elongation, sag correction and temperature correction based on unstressed length of the cable.

The tension load shall be varied according to the wire diameter. For 5 mm diameter wires, the load shall be more than 50 kg. For 7 mm diameter wires, the load shall be more than 100 kg.

5.2.2 The gauge wire tolerance of the total length shall be within $(L_0 / 15\ 000)$ for lengths more than 30 m. The tolerance shall be within 2 mm for total lengths less than or equal to 30 m. The length tolerance between the marks of the gauge wire shall be within $(L_0 / 15\ 000)$ or 2 mm, whichever is greater.

5.2.3 The coloured wire shall be in the outside of the PPWS to check the twist condition of the PPWS during the erection process. The coloured wire shall also be made by covering the steel wire with colour paint, such as red, along the total length.

5.2.4 The mark of the total length of the PPWS and all measuring points for the sockets, saddles and the key points such as the main span middle point and side span middle point shall be transferred and marked according to the mark of the gauge wire.

5.2.5 Tolerance for the total length of the PPWS is composed of allowances associated with manufacturing of gauge wire and socketing. The allowance for gauge wire is $\pm(1/15\ 000 L_0)$ or 2 mm, whichever is greater. The allowance for socketing is ± 5 mm.

NOTE In case of using Zn alloy as a filler material, the alloy shrinks at ambient temperature. As a result, this shrink causes initial cone draw when PPWS are loaded. The manufacturer needs to minimize this initial cone draw in an appropriate way, such as pre-compression from a back face of a socket cone.

5.3 Material and manufacture

5.3.1 The wires of PPWS shall conform to ISO 19203. Welds are not allowed in the wires in PPWS.

5.3.2 When placing the order, the purchaser may nominate the material of sockets. Socket material shall be agreed between the purchaser and manufacturer. The chemical composition and mechanical properties, such as tensile and Charpy properties, shall be agreed between the purchaser and manufacturer.

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5.3.3 The socket castings shall be subject to visual, magnetic particle and ultrasonic inspection. The other non-destructive examinations (such as liquid penetration, radiographic etc.) shall be done in conditions agreed at the time of enquiry and order. The severity levels for every method, areas of the socket to be tested, percentage and/or frequency of testing shall be agreed between the manufacturer and purchaser. The acceptance criteria (severity level) shall be agreed between the manufacturer and purchaser.

5.3.4 For each socket, wherever transitions cause stress concentrations, transitions shall generally be rounded and machined. Edges on the sockets shall be rounded to make them suitable for zinc coating or painting. Specification for corrosion protection of socket shall be specified by the purchaser.

5.3.5 The socketing medium is as follows:

- Zinc-copper alloy: ZnCu₂, which contains $(98 \pm 0,2)$ % Zn, $(2,0 \pm 0,2)$ % Cu.
- Zinc-aluminum-copper alloy: ZnAl₆Cu₁ in accordance with EN 1774, which contains $(5,8 \pm 0,2)$ % Al, $(1,4 \pm 0,2)$ % Cu and the rest, of Zn.
- The resin compound material may be used in the socketing medium of PPWS. The physical property of resin shall meet the requirements of ISO 17558:2006, Annex C.
- The manufacturer may use other socketing medium if the purchaser agrees.

5.3.6 Bundles of steel wires shall be wrapped by binding tape to form the shape in hexagon as in [Annex A](#). The binding tape interval distance is 1,5 m to 2,5 m. Typical sectional dimensions are given in [Annex B](#).

5.3.7 The binding tape shall have sufficient strength to confine the wires of the PPWS during reeling but it shall permit the wires to open or spread sufficiently to adjust for the stresses in the PPWS during reeling.

5.3.8 During socketing, the following requirements shall be met:

- The individual steel wires of each PPWS shall be splayed out and cleaned.
- Inserting the PPWS bundle end into the socket. Concentricity of the PPWS and the socket shall be optimized by positioning and alignment of PPWS axis and socket axis.
- The wires shall be evenly distributed within the cone.
- The wires shall be securely clamped together so that the wires do not slip during socketing.

5.3.9 After socketing, the following requirements shall be met:

- The socket basket is filled to the top with the socketing medium.
- The back of the molten metal cone shall be pressed into the socket with a load of not less than 50 % of the nominal breaking force or 1,1 times the service load of the PPWS applied by a suitable diameter jacking head, the pressure being maintained for 5 min.
- Initial cone draw in the resin socket assembly shall be removed by proof loading or alternative means.
- The axis of the PPWS and the front surface of the socket shall be at a right angle in any direction. The angle deviation shall be no more than 0,5°.

5.3.10 The PPWS shall be coiled or reeled on a drum or frame. The coiling or reeling diameter shall meet the following requirements:

- The coil or reel diameter shall be larger than 1,8 m for PPWS of 5 mm diameter wires.
- The coil or reel diameter shall be larger than 2,1 m for PPWS of 7 mm diameter wires.

NOTE The PPWS is composed of wires: an inner diameter of a coiled or reeled PPWS can be changed by considering the diameter of wire.

5.4 Mechanical property

5.4.1 Tensile property

The measured breaking force of the PPWS shall be equal to or greater than the nominal breaking force of the PPWS. The typical nominal breaking force are given in [Annex C](#).

5.4.2 Modulus of elasticity

The modulus of elasticity shall be (200 ± 10) GPa.

5.4.3 Fatigue property

If requested, the fatigue property of the PPWS shall meet the following requirements.

- The load cycle is 2×10^6 , the upper load is $0,45 \times F_n$, the stress range shall be 150 MPa according to the PPWS strength.
- Break is allowed in a maximum of 5 % of the total number of wires.