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(JWPA)

Hot-dip galvanized and zinc-aluminium
coated high tensile steel wire for parallel
wire cables

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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Symbols and units	4
5 Designation of the product	4
6 Information required by the manufacturer	5
7 Quality requirements	5
7.1 Materials and manufacture	5
7.2 Standard properties	6
7.3 Special properties	8
8 Inspection	8
8.1 Inspection and inspection documents	8
8.2 Number of samples and test pieces	8
8.3 Reinspection	9
8.4 Sorting and reprocessing	9
9 Test methods	10
9.1 Testing of standard properties	10
9.2 Testing of special properties	13
10 Delivery conditions	13
Annex A (normative) Axial force fatigue test	14
Annex B (normative) Isothermal stress relaxation test	15
Annex C (informative) Calculation of the density of steel wire and diameter of bare steel wire	16
Annex JA (informative) Comparison table between JIS and corresponding International Standard	17

Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Wire Products Association (JWPA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act.

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Hot-dip galvanized and zinc-aluminium coated high tensile steel wire for parallel wire cables

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 19203** : 2018, Edition 1, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

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

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 19203 : 2018 *Hot-dip galvanized and zinc-aluminium coated high tensile steel wire for bridge cables — Specifications* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0201 *Glossary of terms used in iron and steel (Heat treatment)*

JIS G 0202 *Glossary of terms used in iron and steel (Testing)*

JIS G 0203 *Glossary of terms used in iron and steel (Products and quality)*

JIS G 0415 *Steel and steel products — Inspection documents*

NOTE Corresponding International Standard : ISO 10474 : 2013 *Steel and steel products — Inspection documents*

JIS G 3502 *Piano wire rods*

JIS G 3504 *Wire rods for bridge cable*

JIS H 0401 *Test methods for hot dip galvanized coatings*

JIS H 2107 *Zinc ingots*

JIS Z 2241 *Metallic materials — Tensile testing — Method of test at room temperature*

JIS Z 2273 *General rules for fatigue testing of metals*

JIS Z 2276 *Method of tensile stress relaxation test for metallic materials*

JIS Z 2371 *Methods of salt spray testing*

JIS Z 8401 *Rounding of numbers*

ISO 7802 *Metallic material — Wire — Wrapping test*

ASTM B 997 *Standard Specification for Zinc-Aluminum Alloys in Ingot Form for Hot-Dip Coatings*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in JIS G 0201, JIS G 0202, and JIS G 0203 apply.

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 that is manufactured by cold working wire rod (3.1) and is yet to be coated

3.3

hot-dip zinc 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, or that is first coated with zinc in a bath of molten zinc and then coated with zinc-aluminium alloy in a bath of molten zinc-aluminium alloy

NOTE In this document, “steel wire” or “wire” refers to hot-dip zinc or zinc-aluminium coated steel wire, unless otherwise specified.

“Zinc-aluminium coated steel wire” usually refers to steel wire coated with 95 % zinc and 5 % zinc aluminium.

3.5

stabilized wire

steel wire that is given a final thermo-mechanical treatment, i.e. given tension treatment while being heated at a prescribed temperature

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 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 The unit of product is either the unit of manufacture (3.8) or a smaller coil cut from a unit of manufacture.

3.10

inspection

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

3.11

factory production control

permanent internal production control exercised by the manufacturer

3.12

standard property

property prescribed as part of factory production control (3.11) requirements for every unit of inspection (3.9)

3.13

special property

property prescribed that is not determined as part of factory production control (3.11) requirements

3.14

free coil diameter

diameter drawn by a steel wire when the steel wire is placed on a flat floor (see 9.1.9)

3.15

free ring lift

distance between the floor surface and the end of a steel wire when the steel wire is placed on a flat floor (see 9.1.9)

3.16

unit of heat steel

quantity of steel corresponding to the same single melting operation

3.17

parallel wire cable

cable manufactured by bundling steel wires arranged in parallel without applying twists like a wire rope

NOTE Parallel wire cables are mainly used as main cables for suspension bridges.

4 Symbols and units

For the purpose of this Standard, the following symbols and units apply.

- percentage of elongation after fracture : A (%)
- nominal diameter of the steel wire : d (mm)
- modulus of elasticity : E (GPa)
- value of a strain for a force equal to x : ε_x
- minimum ultimate tensile force or guaranteed ultimate tensile force : F_m (kN),
calculated by nominal tensile strength $\times S_n$
- free coil diameter : D (m)
- free ring lift : H (cm)
- ultimate tensile force : R_m (MPa)
- gauge length (without force on the test piece) : L_0 (mm)
- 0.2 % offset proof strength : $R_{p0.2}$ (MPa)
- nominal cross-sectional area of the steel wire : S_n (mm²), calculated by $\pi \times d^2/4$

5 Designation of the product

The steel wire shall be ordered in accordance with this document and be designated by at least the symbols of the following items.

The coating symbol shall be as agreed between the manufacturer and the customer.

- Reference to this Standard (**JIS G 3571**)
 - Nominal diameter
 - Nominal tensile strength. Suffix “R” to indicate when relaxation properties are specified.
 - Coating type
 - Example 1 Zinc coated steel wire with nominal diameter 5.00 mm and nominal tensile strength 1 960 MPa is designated
JIS G 3571—5.00—1960—Zn
 - Example 2 Zinc-aluminium coated steel wire with nominal diameter 7.00 mm and nominal tensile strength 1 860 MPa is designated
JIS G 3571—7.00—1860—ZnAl
 - Example 3 Zinc coated steel wire with nominal diameter 5.00 mm and nominal tensile strength 1 960 MPa, when relaxation property is specified, is designated
JIS G 3571—5.00—1960R—Zn
- NOTE “Zn” is used for hot-dip zinc coated and “ZnAl” for zinc-aluminium alloy coated.

6 Information required 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 a unit bundle;
- requirements for documentary information to accompany the delivery.

Examples Delivery note, type and content of inspection document, copies of force-extension diagrams

7 Quality requirements

7.1 Materials and manufacture

7.1.1 The bare steel wires shall be produced from wire rod that conforms to **JIS G 3502** or **JIS G 3504**.

7.1.2 Zinc ingot metal to be used shall be purest zinc ingot specified in **JIS H 2107**. Zinc-aluminium ingot shall conform to **ASTM B 997**. For zinc-aluminium coating, addition of aluminium to the coating bath for the purpose of keeping the aluminium concentration stable is permissible.

7.1.3 Bare steel wires shall be zinc or zinc-aluminium coated after heat-treatment and drawing. Once coated, steel wires shall not be given any treatment that may alter their mechanical or corrosion protection properties, except where relaxation property is specified.

Steel wires manufactured from in-line patented wire rods do not require heat treatment.

7.1.4 Coated wires may be stabilized depending on the final product relaxation requirement specified by the customer.

7.1.5 Steel wires shall have no welding points.

7.1.6 Special rust proof treatment for enhancing rust preventive power of steel wires during construction, if required by the customer in addition to coating, may be agreed between the manufacturer and the customer.

7.2 Standard properties

7.2.1 Geometrical properties

The nominal diameter, permitted deviation on nominal diameter and out-of-round shall satisfy Table 1 when measured in accordance with 9.1.1. If steel wires with other diameters than Table 1 are requested by the customer, the permitted deviation and out-of-roundness requirements shall be agreed between the manufacturer and the customer.

All the values of nominal diameter, permitted deviation on nominal diameter, and out-of-roundness include the metallic coating.

NOTE 1 Generally, 5.00 mm to 6.00 mm steel wires are used in the main cables of suspension bridges, and 7.00 mm wires in cables of cable-stayed bridges.

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

Unit: mm

Nominal diameter d	Permitted deviation on wire diameter	Out-of-round
$5.00 \leq d \leq 6.00$	± 0.06	≤ 0.06
7.00	± 0.07	≤ 0.07

7.2.2 Straightness

7.2.2.1 General matters

The steel wire shall be uniform in straightness along its length commensurate with the requirements specified in 7.2.2.2 and 7.2.2.3 and there shall not be defects, such as bend, twist, etc., that are detrimental to use.

7.2.2.2 Free coil diameter

The free coil diameter (D) of steel wires shall be not less than 4 m when determined in accordance with 9.1.9. Other free coil diameter requirement, if requested by the customer, may be agreed between the manufacturer and the customer.

7.2.2.3 Free ring lift