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Zinc-coated steel wires for stranded conductors

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Zinc-coated steel wires for stranded conductors

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ZINC-COATED STEEL WIRES FOR STRANDED CONDUCTORS

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by IEC Technical Committee No. 7: Bare Aluminium Conductors.

This standard replaces Clauses 4, 6 and 14, and Sub-clauses 7.2, 13.1 and 13.4 and requirements of Clause 5 and Sub-clauses 9.1, 13.2 and 13.3 of IEC Publication 209 (1966): Aluminium Conductors, Steel-reinforced.

It also replaces Clauses 4, 6 and 14, and Sub-clauses 7.2, 13.1 and 13.5 and requirements of Clause 5 and Sub-clauses 9.1, 13.2 and 13.4 of IEC Publication 210 (1966): Aluminium Alloy Conductors, Steel-reinforced.

The text of this standard is based on the following documents:

Six Months' Rule	Report on Voting
7(CO)421	7(CO)424

Further information can be found in the Report on Voting indicated in the table above.

The following publication is quoted in this standard:

ISO Standard 1460 (1973): Metallic Coatings — Hot Dip Galvanized Coatings on Ferrous Materials — Determination of the Mass per Unit Area — Gravimetric Method.

ZINC-COATED STEEL WIRES FOR STRANDED CONDUCTORS

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1. Scope

This standard applies to zinc-coated steel wires used in the construction and/or reinforcement of conductors for overhead power transmission purposes.

It is intended to cover all wires used in constructions where the individual wire diameters, including coating, are in the range of 1.25 mm to 5.50 mm.

Three grades of steel are included to reflect the needs of conductor users: regular steel, high strength steel and extra high strength steel.

Two classes of coating represented by minimum zinc mass per unit area are included: Class 1 and Class 2.

2. Values for zinc-coated steel wires

For calculation purposes the following values for zinc-coated steel wires shall be used:

Density at 20 °C of both Class 1 and Class 2	7.78 kg/dm³
Coefficient of linear expansion	11.5×10^{-6} per °C

3. Material

The steel wires shall have the properties specified hereinafter. The slab zinc shall be of 99.85% minimum zinc content. The coating on the wires may be applied by the hot dip or the electrolytic process.

4. Freedom from defects

The uncoated wires shall be smooth and free from all imperfections not consistent with good commercial practice. The zinc-coated wires shall be reasonably smooth and free from all imperfections not consistent with good commercial practice.

5. Diameter and tolerance on diameter

The diameter of the zinc-coated steel wire shall be taken as the mean of two measurements taken at 90° at the same cross-section.

The zinc-coated steel wires shall not depart from the nominal diameter, when measured over the coating, by more than the amounts given in Tables III, IV and V.

It is recognized that the surface of zinc-coatings, particularly those produced by hot dip galvanizing, are not perfectly smooth and free from irregularities. It is therefore intended that these tolerances be used in gauging the diameters within the uniform areas of zinc-coated wire.

6. Length and tolerance on length

Unless otherwise agreed between the purchaser and manufacturer, steel wires shall be supplied with a minimum length specified by the purchaser with a permitted variation of $^{+4}_{0}$%. Random lengths shorter or longer than this requirement are only acceptable if prior agreement between the purchaser and manufacturer is made.

7. Joints

Joints are allowed in the base hot rolled rod or semi-finished wire, before or after heat treatment and prior to cold drawing, by the electric butt or flash welding processes. Finished but uncoated wires from rod which has been welded shall have a minimum ultimate tensile stress not less than 80% of that obtained by tests on the adjacent unwelded wire and in no case shall the welded wire be required to have a strength greater than 90% of the ultimate tensile strength (UTS) values shown in Tables III, IV and V. Other required values from such wires are not changed except that the finished wire from that portion of the rod which was welded shall not be required to pass ductility wrapping and/or torsion tests. The coils containing joints shall be clearly identified.

No joints of any kind shall be made in the finished coated steel wires.

8. Sampling

Samples for tests shall be taken by the manufacturer from 10% of the individual lengths of steel wire. In cases of wire supply in large quantities and where the manufacturer has a demonstrated capability of meeting or exceeding properties, the number of test samples may be reduced, with the agreement of the purchaser and the manufacturer, to a level which ensures that each production lot of wire is given adequate monitoring.

9. Place of testing

Unless otherwise agreed between the purchaser and the manufacturer at the time of ordering, all tests shall be made at the manufacturer's works.

10. Mechanical tests

All tests shall be made on the finished coated wires.

10.1 *Stress at 1% extension*

One specimen from each of the tests samples shall be gripped in the jaws of the tensile testing machine. A load corresponding to the appropriate tensile stress given in Column 2 of Table I shall be applied and an extensometer applied on a 250 mm gauge length and ajusted to the initial setting given in Column 3 of Table I. (A gauge length of 100 mm or 200 mm may be used if agreed between the purchaser and manufacturer. The initial settings of the extensometer will be adjusted in the proportion of the actual test length divided by the 250 mm length shown in Table I.) The gauge length shall be marked on the wire prior to application of load when it is required for subsequent measurements.

TABLE I

Initial stress and extensometer setting for determination of stress 1% extension

Actual diameter (mm)		Initial stress (MPa)	Initial setting of extensometer (gauge length 250 mm)*
Over	Up to and including		
1.24	2.25	100	0.125
2.25	3.00	200	0.250
3.00	4.75	300	0.375
4.75	5.5	400	0.500

* For other gauge lengths, use an initial setting factor of gauge length/250 mm.

The load shall then be increased uniformly until the extensometer indicates an extension of 1% of the original gauge length. At this point, the load shall be read from which the value of the stress at 1% extension shall be calculated by dividing this load by the area of the wire based on actual wire diameter. The value obtained for the specimen shall be not less than the value given in the appropriate column of Tables III, IV and V.

The specimen may subsequently be used for the tensile and elongation tests.

10.2 *Tensile test*

The breaking load of one specimen cut from each of the test samples shall be determined by means of a suitable testing machine.

The load shall be applied uniformly above and below 1% extension and the rate of increasing separation of the jaws of the testing machine shall be not less than 0.1 times the gauge length in millimetres per minute and not greater than 0.4 times the gauge length in millimetres per minute.

The ultimate tensile stress calculated by dividing the breaking load by the area of the wire based on actual wire diameter shall not be less than the value given in the appropriate column of Tables III, IV and V.

The specimen may subsequently be used for the ultimate elongation if a test gauge length was marked on the wire as described in the test for stress at 1% extension.

10.3 *Ductility test*

The choice between an ultimate elongation test and a torsion test is to be at the discretion of the manufacturer, unless previously agreed between the manufacturer and purchaser at the time of placing the order, and the choice of one test or the other in no way prejudices the quality of steel used.

a) Elongation test

The ultimate elongation measured under no load after the specimen has been marked as described in the stress at 1% extension test and loaded as described in the tensile test shall be determined on one specimen from each of the test samples. After the wire is broken the specimen ends shall be carefully placed together at the distance between the gauge marks measured. The elongation is the increase in gauge length expressed as a percentage of the original gauge length.

For this test to be valid the specimen must break between the gauge marks.

The ultimate elongation shall be not less than the value given in the appropriate column of Tables III, IV and V.

For routine quality control purposes a factored gauge length may be used (see footnotes to Tables III, IV and V). However, in cases of dispute, the 250 mm gauge length shall be mandatory.

b) Torsion test (not applicable to Class 2 zinc coating)

As an alternative to the ultimate elongation test, one specimen cut from each sample may be given a torsion test. The specimen shall be gripped in two vice-clamps one of which shall be free to move longitudinally during the test. A small tensile load, not exceeding 2% of the wire breaking strength, shall be applied to the sample during testing. The specimen shall be twisted on its longitudinal axis by causing one of the vices to revolve until fracture occurs and the number of twists shall be indicated by a counter or other suitable device. The rate of twisting shall not exceed 60 turns per minute. The number of twists on a length 100 times the wire diameter shall be not less than the value given in the appropriate column of Tables III, IV and V.

c) *Wrapping test*

One specimen cut from each sample of coated steel wire shall be wrapped around a mandrel at a rate not exceeding 15 turns per minute, of diameter given in the appropriate column of Tables III, IV and V to form a close helix of eight turns. The wire shall not break.

11. Zinc coating test

11.1 *Determination of mass of zinc coating*

The mass of coating may be obtained by either a volumetric or gravimetric method. The former has an acceptable degree of accuracy and has the advantage of rapidity. It is therefore the preferred method for routine testing of all the sizes of wire which can be conveniently accommodated in the measuring apparatus. In case of dispute, the gravimetric method shall be accepted as the arbitration method.

The mass shall be not less than the appropriate value given in Table II.

TABLE II

Zinc coating mass requirements

Wire diameter (mm)		Minimum mass of zinc coating (g/m^2)	
Over	Up to and including	Class 1	Class 2
1.24	1.50	185	370
1.50	1.75	200	400
1.75	2.25	215	430
2.25	3.00	230	460
3.00	3.50	245	490
3.50	4.25	260	520
4.25	4.75	275	550
4.75	5.50	290	580

11.2 *Gas volumetric method*

The gas volumetric method for determining the mass of zinc coating is described in Appendix A.

11.3 *Gravimetric method*

The gravimetric method for determining the mass of zinc coating is described in Appendix B.

11.4 *Test for adherence of zinc coating*

One specimen cut from each of the samples of coated steel wire shall be wrapped at a rate not exceeding 15 turns per minute in a close helix of at least eight turns round a cylindrical mandrel having a diameter of four times the diameter of the wire for wires of diameter up to and including 3.50 mm and five times the diameter of the wire for wires of diameter greater than 3.50 mm.

The zinc coating shall remain firmly adherent to the steel and shall not crack or flake to such an extent that any zinc can be removed by rubbing with the bare fingers.