INTERNATIONAL STANDARD

ISO 9975

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Round non-alloy steel wires for locked coil mine winding ropes — Specifications

Fils tréfilés ronds en acier non allié pour câbles clos d'extraction minière — Spécifications

Reference number
ISO 9975:1990(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9975 was prepared by Technical Committee ISO/TC 105, *Steel wire ropes*.

Annexes A and B form an integral part of this International Standard. Annex C is for information only.

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Round non-alloy steel wires for locked coil mine winding ropes — Specifications

1 Scope

This International Standard specifies round non-alloy steel drawn wires to be used in the manufacture of locked coil mine winding ropes as defined in ISO 5614. It specifies

— the dimensional tolerances;

— the mechanical characteristics;

— the conditions with which coatings, if any, shall comply;

— the conditions of sampling and control.

It applies to round, bright or zinc-coated wires of quality B and of nominal diameters between 1 mm and 3,5 mm.

It does not apply to steel wire taken from manufactured ropes.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5614:1988, *Locked coil wire ropes for mine hoisting — Technical delivery requirements.*

ISO 6892:1984, *Metallic materials — Tensile testing.*

ISO 7800:1984, *Metallic materials — Wire — Simple torsion test.*

ISO 7801:1984, *Metallic materials — Wire — Reverse bend test.*

ISO 7802:1983, *Metallic materials — Wire — Wrapping test.*

3 Wire characteristics

3.1 General conditions of manufacture

Wire shall be made by the basic open hearth, electric furnace, or basic oxygen steel process, or by equivalent methods.

The finished wires shall not show superficial or internal defects detrimental to their use.

When specified, the wires shall be supplied with a zinc coating applied by the hot-dip or the electrolytic process. For the former case, the zinc used shall be 99,9 % pure.

3.2 Diameter

3.2.1 Nominal diameter, d

The nominal diameter of the wire, in millimetres, is that by which the wire is designated. It shall be the basis on which the values of all characteristics are determined for acceptance of the wire.

3.2.2 Actual diameter

The actual diameter of the wire is the arithmetic mean of two measurements carried out in accordance with 5.1. It shall be within the limits of tolerance specified in table 1.

3.2.3 Ovality of the wire

The arithmetic difference between the two measurements of the diameter shall be not more than half the tolerance specified in table 1.

Table 1 — Tolerances on diameter

Values in millimetres

Nominal diameter of wire d	Tolerance on diameter Bright and zinc-coated wires quality B
$1 \leqslant d < 1{,}6$	$\pm$ 0,02
$1{,}6 \leqslant d < 2{,}4$	$\pm$ 0,03
$2{,}4 \leqslant d \leqslant 3{,}5$	$\pm$ 0,03

3.3 Tensile grades

The tensile grades of wire are

— 1 570 N/mm^2

— 1 770 N/mm^2

— 1 960 N/mm^2

These nominal values are the lower limits of strength. The upper limits are equal to the lower limits plus the tolerances specified in table 2.

NOTE 1 Other tensile grades may be used by agreement between the manufacturer and the supplier.

The test shall be performed in accordance with 5.2.

Table 2 — Tolerances on tensile grade

Nominal diameter of wire d mm	Tolerance on tensile grade N/mm^2
$1 \leqslant d < 1{,}5$	320
$1{,}5 \leqslant d < 2$	290
$2 \leqslant d \leqslant 3{,}5$	260

3.4 Reverse bend strength

The wire shall withstand, without breaking, the minimum number of reverse bends specified in table 3 for the appropriate diameter, tensile grade and finish. The radius of curvature of the supports for the various wire diameters is also specified.

The test shall be performed in accordance with 5.3.

If the tensile grade of a wire lies between two tensile grades given in table 3, then the number of reverse bends for the next upper tensile grade shall be chosen.

Table 3 — Minimum number of reverse bends

Nominal diameter of wire d mm	Radius of curvature of supports mm	Minimum number of reverse bends		
		Bright wires and zinc-coated wires quality B		
		Tensile grade N/mm²		
		1 570	1 770	1 960
$1 \leqslant d < 1{,}1$	3,75	17	16	15
$1{,}1 \leqslant d < 1{,}2$		16	15	14
$1{,}2 \leqslant d < 1{,}3$		14	13	12
$1{,}3 \leqslant d < 1{,}4$		12	11	10
$1{,}4 \leqslant d < 1{,}5$		10	9	8
$1{,}5 \leqslant d < 1{,}6$	5	14	13	12
$1{,}6 \leqslant d < 1{,}7$		13	12	11
$1{,}7 \leqslant d < 1{,}8$		12	10	9
$1{,}8 \leqslant d < 1{,}9$		10	9	8
$1{,}9 \leqslant d < 2$		9	8	7
$2 \leqslant d < 2{,}1$	7,5	16	15	14
$2{,}1 \leqslant d < 2{,}2$		15	14	13
$2{,}2 \leqslant d < 2{,}3$		14	13	12
$2{,}3 \leqslant d < 2{,}4$		13	12	11
$2{,}4 \leqslant d < 2{,}5$		12	11	10
$2{,}5 \leqslant d < 2{,}6$		11	10	9
$2{,}6 \leqslant d < 2{,}7$		10	9	8
$2{,}7 \leqslant d < 2{,}8$		9	8	7
$2{,}8 \leqslant d < 2{,}9$		9	7	6
$2{,}9 \leqslant d < 3$		8	7	6
$3 \leqslant d < 3{,}1$	10	13	12	11
$3{,}1 \leqslant d < 3{,}2$		12	11	10
$3{,}2 \leqslant d < 3{,}3$		11	10	—
$3{,}3 \leqslant d < 3{,}4$		10	9	—
$3{,}4 \leqslant d \leqslant 3{,}5$		9	8	—

3.5 Torsional strength

The wire shall withstand, without breaking, the minimum number of torsions specified in table 4 for given diameter and tensile grade.

The test shall be performed in accordance with 5.4.

If the tensile grade of a wire lies between two tensile grades given in table 4, then the number of reverse bends for the next upper tensile grade shall be chosen.

Table 4 — Minimum number of torsions

Nominal diameter of wire d mm	Minimum number of torsions		
	Bright wires and zinc-coated wires quality B		
	Tensile grades N/mm²		
	1 570	1 770	1 960
$1 \leqslant d < 1{,}3$	33	31	26
$1{,}3 \leqslant d < 1{,}8$	32	29	25
$1{,}8 \leqslant d < 2{,}3$	30	28	23
$2{,}3 \leqslant d < 3$	28	25	21
$3 \leqslant d < 3{,}4$	26	23	20
$3{,}4 \leqslant d \leqslant 3{,}5$	24	21	18

3.6 Zinc coating

The minimum mass of zinc shall be 65 g/m².

The zinc coating process is not specified.

The inspection of zinc coating shall be performed in accordance with 5.5.

4 Sampling

Samples for testing shall be taken in accordance with table 5, unless other methods of sampling have been agreed between purchaser and supplier.

Test lengths shall be long enough for the tests and check tests to be carried out.

Table 5 — Sampling

Delivery unit	Samples for	
	mechanical tests	inspection tests for galvanized coating
Production coil	At both ends of each coil	At both ends of every five coils
Bobbins and spools	At one end of each bobbin or spool	At one end of every three bobbins or spools

5 Tests

5.1 Measurement of diameter

The diameter shall be determined from two measurements in two perpendicular directions in the same section and on the same diametrical plane, using a micrometer accurate to 0,01 mm.

5.2 Tensile test

The tensile test shall be carried out in accordance with ISO 6892. The rate of stressing may be greater than that specified in ISO 6892, in view of the number of tests on wire involved in the inspection of the batch. However, it shall not exceed a rate producing an elongation of 25 % of the distance between grips within 1 min. The length of the test piece shall preferably be such that the distance between the grips of the testing machine is 100 mm.

In case of dispute, the tensile test shall be performed strictly in accordance with ISO 6892, particularly with regard to the rate of stressing.

5.3 Reverse bend test

The test shall be carried out in accordance with ISO 7801, with the radius of curvature of supports specified in table 3.

5.4 Simple torsion test

The test shall be carried out in accordance with ISO 7800, with the number of torsions specified in table 4.

A length of $100d$ for the test piece between grips is preferred. If this length cannot be adopted, an alternative length shall be chosen at the wire manufacturer's discretion. In this case, the minimum number of torsions which the wire shall withstand shall be proportional to the number specified in table 4, for a test length of $100d$.

5.5 Inspection of zinc coating

The determination of mass of zinc shall be carried out in accordance with annex A. An adhesion test shall be carried out in accordance with annex B.

6 Certificate

According to the purchaser's order, one of the following control documents may be established.

6.1 Certificate of conformity

By this certificate, the manufacturer acknowledges that the conditions as specified in the purchaser's order are fulfilled.

6.2 Full works certificate

This certificate shall give the results of tests carried out by the manufacturer in accordance with this International Standard.

6.3 Certificate of acceptance

In particular cases, when requested by the purchaser, tests may be undertaken after manufacture in the presence of the purchaser or his representative. The test results shall be provided in the certificate of acceptance, which is equivalent to a full works certificate.

7 Marking

Each delivery unit shall be marked and identified by a durable label securely fixed to each coil or bobbin clearly indicating at least the following:

a) the name of the manufacturer or supplier;

b) the indications relative to the wire (diameter, surface condition, tensile grade, and mass or length per delivery unit);

c) the number of the customer's order;

d) the number of the bobbin or coil.

8 Information to be supplied by the purchaser

The purchaser shall indicate with the order:

a) reference to this International Standard;

b) the nominal diameter of the wire;

c) the surface finish (bright, zinc-coated quality B);

d) the tensile grade of wire;

e) the type of certificate to be supplied by the manufacturer;

f) the mass or length of the delivery unit.

Annex A
(normative)

Determination of mass of zinc deposited per unit surface area

A.1 General

Two methods are recognized: the gravimetric method described in ISO 1460 and the gas volumetric method described below.

The gas volumetric method is the easiest to carry out. In case of dispute, however, the gravimetric method shall be used.

A.2 Gas volumetric method

A.2.1 Principle

The zinc coating of a test specimen of wire of given dimensions is dissolved in a hydrochloric acid solution. The mass of zinc so dissolved is determined by measuring the volume of hydrogen released during dissolution of the coating (gas volumetric method). By relating the mass of zinc determined in this way to the surface area of the test specimen measured after dissolving the coating, the mass of zinc deposited per unit surface area is obtained.

A.2.2 Reagents

A.2.2.1 Hydrochloric acid, solution of suitable concentration.

A.2.2.2 Inhibitor, for example hexamethylene tetramine ($C_6H_{12}N_4$), antimony(III) chloride ($SbCl_3$) or antimony oxide (Sb_2O_3).

A.2.3 Apparatus

The apparatus used consists of the following elements (see figure A.1).

A.2.3.1 Tube, graduated in millilitres at least, with a tap at each end.

A.2.3.2 Flask, with a nozzle near the bottom connected by a rubber tube to a nozzle near the bottom of the graduated tube as shown in figure A.1.

A.2.3.3 Beaker, for holding the test specimen after removal of the zinc coating.

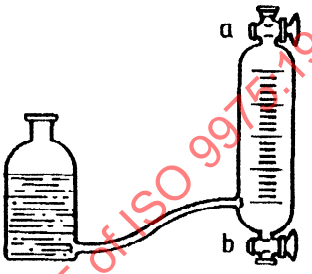

Figure A.1

A.2.4 Preparation of test specimens

After carefully straightening the samples of wire, test specimens shall be cut to a length of

150 mm for wires 1 mm to 1,49 mm in diameter;

100 mm for wires 1,5 mm to 3 mm in diameter;

50 mm for wires of more than 3 mm in diameter.

NOTE 2 Test specimens more than 100 mm long may be cut into several pieces of approximately equal length prior to insertion into the graduated tube.

A.2.5 Procedure

With tap **b** closed, the graduated tube and part of the flask are filled with hydrochloric acid solution (A.2.2.1) containing a suitable inhibitor (A.2.2.2).

The level of the liquid in the graduated tube (A.2.3.1) is raised to just under tap **a** by raising the acid reservoir flask (A.2.3.2). The level in the tube and flask should be the same.

After introducing the test specimen into the graduated tube, tap **a** is closed and the hydrogen released by the action of the acid on the zinc coating is allowed to accumulate in the upper part of the graduated tube.

When hydrogen is no longer released, the flask is lowered in relation to the graduated tube so as to bring the levels of the solution in the tube and in the flask into the same plane. The position of the meniscus of the liquid in the tube then indicates the volume of hydrogen released.

The remaining part of the solution contained in the graduated tube is collected in the flask by placing the flask on a table and opening tap **a**.

Tap **b** is then opened so that the test specimen can be extracted into the beaker (A.2.3.3). The test specimen is washed and carefully wiped before measuring its length and diameter.

The test is carried out on one test specimen at a time, the temperature in the tube being held at 20 °C ± 2 °C.

The number of test specimens tested shall be the subject of agreement between the interested parties.

A.2.6 Expression of results

The mass, m, in grams per square metre, of zinc deposited per unit surface area is given by the equation

$$m = \frac{2720V}{\pi dl}$$

where

d is the diameter, in millimetres, of the uncoated wire;

l is the length, in millimetres, of the test specimen of wire;

V is the mean volume, in millilitres, of hydrogen released during each test.

Where the barometric pressure is known to be outside the range 740 mmHg to 780 mmHg[1)], the right-hand side of the equation should be multiplied by the factor $p/760$ where p is the pressure, in conventional millimetres of mercury.

In practice, tables allow the mass of zinc per square metre of the surface of the uncoated wire to be read directly as a function of the diameter of the wire and the volume of hydrogen released.

1) 1 mmHg = 133,322 Pa