INTERNATIONAL STANDARD ISO 2232

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Drawn wire for general purpose non-alloy steel wire ropes — Specifications

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, Technical Committee ISO/TC 105 has reviewed ISO Recommendation R 2232 and found it suitable for transformation. International Standard ISO therefore replaces ISO Recommendation R 2232-1971.

ISO Recommendation R 2232 was approved by the Member Bodies of the following countries :

Austria	India	South Africa, Rep. of
Belgium	Ireland	Spain
Denmark	Israel	Sweden
Egypt, Arab Rep. of	Italy	Switzerland
France	Netherlands	United Kingdom
Germany	Portugal	

The Member Bodies of the following countries expressed disapproval of the Recommendation on technical grounds :

Japan
New Zealand*
U.S.A.

The Member Bodies of the following countries disapproved the transformation of ISO/R 2232 into an International Standard :

Australia
Austria
Germany
Poland

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* Subsequently, this Member Body approved the Recommendation.

Printed in Switzerland

Drawn wire for general purpose non-alloy steel wire ropes — Specifications

1 SCOPE

This International Standard gives specifications for drawn wire intended for use in the manufacture of general purpose non-alloy steel wire ropes.

It specifies

- the dimensional tolerances;
- the mechanical characteristics, which are determined on the basis of the appropriate techniques described in the corresponding International Standards and ISO Recommendations;[1)]
- the conditions with which their covering, if any, shall comply;
- the conditions of sampling and the terms of acceptance.

2 FIELD OF APPLICATION

This International Standard does not apply to steel wires taken from a rope; it applies to bright or galvanized wires only for use in the manufacture of general purpose wire ropes.

Wires for ropes for special applications, such as the ones listed below, are outside its scope :

- ~~winding~~ ropes for mining purposes as defined by ISO/TC 82, *Mining;*
- ropes for aircraft controls;
- ropes for deep drilling equipment;
- ropes for aerial ropeways;
- ropes for elevators;
- ropes for prestressed concrete.

3 REFERENCES

ISO 89, *Steel — Tensile testing of wire.*

ISO 136, *Steel — Simple torsion testing of wire.*

ISO 144, *Steel — Reverse bend testing of wire.*

ISO 2701, *Drawn wire for general purpose non-alloy steel wire ropes — Sampling and acceptance — Traditional method.*[2)]

4 QUALITY OF COATING

For galvanized wire, galvanizing may, at the request of the user, be

- of quality B, for all wire diameters from 0,20 mm inclusive up to 3,7 mm exclusive;
- of quality AB, for all wire diameters from 0,40 mm inclusive up to 1,9 mm exclusive;
- of quality A, for all wire diameters from 0,40 mm inclusive up to 3,7 mm exclusive.

These quality grades correspond to the different minimum requirements indicated in table 4; each of them has its own mechanical characteristics.

1) Unless particularly mentioned below for certain tests.

2) At present at the stage of draft.

5 DIAMETERS

5.1 Nominal diameter of the wire

The nominal diameter of the wire is the diameter specified by the rope-maker on the order, in millimetres. It shall be the basis on which the values of all characteristics are determined for acceptance of the wire.

5.2 Actual diameter of the wire

The actual diameter of the wire is the diameter given by the arithmetic mean of two measurements, one being perpendicular to the other. These two measurements shall not differ by more than half the total tolerance given in table 1 and their arithmetic mean shall be within the limits of tolerance specified in table 1.

TABLE 1 – **Dimensional limits and tolerances**

Values in millimetres

Diameter		Tolerances		
from (incl.)	to (excl.)	Bright and galvanized wire Quality B	Galvanized wire Quality AB	Galvanized wire Quality A
0,20	0,25	± 0,010		
0,25	0,40			
0,40	0,50	± 0,015	± 0,015	± 0,030
0,50	0,60			
0,60	0,70			
0,70	0,80			
0,80	1,00			
1,00	1,20	± 0,020	± 0,020	± 0,040
1,20	1,30			
1,30	1,50			
1,50	1,60			
1,60	1,80	± 0,025	± 0,025	± 0,050
1,80	1,90			
1,90	2,00			
2,00	2,30			
2,30	2,40			
2,40	2,50	± 0,030		± 0,060
2,50	3,00			
3,00	3,20			
3,20	3,50			
3,50	3,70			

6 BREAKING STRENGTH

6.1 Nominal strength

This International Standard is prepared on the basis of three nominal breaking strengths, as follows :

1) for galvanized wires of quality A and AB only, strength referred to as 145[1], corresponding to 1 420 N/mm² minimum (145 kgf/mm²);

2) for all qualities of wire, strength referred to as 160, corresponding to 1 570 N/mm² minimum (160 kgf/mm²);

3) for bright wires, galvanized quality B wires and galvanized wires quality AB only, strength referred to as 180, corresponding to 1 770 N/mm² minimum (180 kgf/mm²).

These nominal values are the lower limits for strengths. The upper limits are equal to the lower limits plus :

390 N/mm² (40 kgf/mm²) for wires of diameter less than 0,5 mm;

350 N/mm² (36 kgf/mm²) for wires of diameter between 0,5 mm (inclusive) and 1 mm (exclusive);

320 N/mm² (33 kgf/mm²) for wires of diameter between 1 mm (inclusive) and 1,5 mm (exclusive);

290 N/mm² (30 kgf/mm²) for wires of diameter between 1,5 mm (inclusive) and 2 mm (exclusive);

260 N/mm² (27 kgf/mm²) for wires of 2 mm diameter and larger.

6.2 Testing

The tensile test shall be carried out in accordance with the procedure given in ISO 89; however, in view of the number of tests on wire involved in the inspection of a batch, the speed of application of the load may be higher than that specified in ISO 89 but without exceeding a speed producing an elongation of 25 % of the distance between grips within 1 min. A 150 mm test piece should preferably be used.

In the case of dispute, the tensile test shall be performed strictly in accordance with ISO 89, particularly in so far as the speed of application of the load is concerned.

1) Wires having a nominal tensile strength referred to as 145 shall only be used for certain shipping, fishing and inland waterway requirements.

7 SIMPLE TORSION TEST

Depending on its diameter and tensile strength, the wire shall be capable of withstanding before fracture the minimum number of turns indicated in table 2.

The test relates only to wire having a diameter of 0,5 mm and over.

The test shall be carried out in accordance with the procedure given in ISO 136. The length 100 d_1 of the test piece between grips is preferable. When this length is impracticable the alternative length is at the discretion of the wire manufacturer and then the minimum of twists which the wire shall withstand shall be in direct ratio to the number specified in table 2 for a test length of 100 d_1.

8 REVERSE BEND TEST

Depending on its diameter and nominal tensile strength, the wire shall be capable of withstanding without fracture the minimum number of reverse bends indicated in table 3; the bending radii for different wire diameters are also given.

The test relates only to wire having a diameter of 0,5 mm and over.

It shall be carried out in accordance with the procedure given in ISO 144.

TABLE 2 – **Minimum number of turns**

Diameter mm		Right and galvanized wire Quality B		Galvanized wire Quality AB			Galvanized wire Quality A	
from (incl.)	to (excl.)	Nominal strength 160	180	Nominal strength 145	160	180	Nominal strength 145	160
0,20 0,25 0,40	0,25 0,40 0,50							
0,50 0,60 0,70 0,80	0,60 0,70 0,80 1,00	30	28	30	28	26	20	19
1,00 1,20	1,20 1,30	29	26	29	26	23	19	18
1,30 1,50 1,60	1,50 1,60 1,80	28	25	28	25	22	18	17
1,80 1,90 2,00	1,90 2,00 2,30	26	24	26	24	21	18	17
2,30 2,40 2,50	2,40 2,50 3,00	24	22				16	14
3,00 3,20	3,20 3,50	22	20				14	12
3,50	3,70	20	18				12	10

TABLE 3 — **Minimum number of reverse bends**

Diameter	Radius of curvature of the supports	Bright wire and galvanized wire Quality B		Galvanized wire Quality AB			Galvanized wire Quality A	
		Nominal strength		Nominal strength			Nominal strength	
mm	mm	160	180	145	160	180	145	160
0,50	1,25	7	6	7	6	5	6	5
0,55	1,75	13	12	13	12	11	11	10
0,60		11	10	11	10	9	9	8
0,65		9	8	9	8	7	8	7
0,70		8	7	8	7	6	7	6
0,75	2,5	15	14	15	14	13	13	12
0,80		14	13	14	13	12	12	11
0,85		13	12	13	12	11	11	10
0,90		12	11	12	11	10	10	9
0,95		11	10	11	10	9	9	8
1,00		10	9	10	9	8	9	8
1,10	3,75	17	16	17	16	15	15	14
1,20		15	14	15	14	13	13	12
1,30		13	12	13	12	11	11	10
1,40		11	10	11	10	9	9	8
1,50		10	9	10	9	8	8	7
1,60	5	13	12	13	12	11	11	10
1,70		12	11	12	11	10	10	9
1,80		11	10	11	10	9	9	8
1,90		10	9	10	9	8	8	7
2,00		9	8				7	7
2,10	7,5	13	12				11	10
2,20		12	11				10	9
2,30		11	10				9	8
2,40		10	9				8	7
2,50		9	8				7	7
2,60		9	8				6	6
2,70		8	7				6	6
2,80		8	7				5	5
2,90		7	6				5	4
3,00		6	5				4	3
3,10	10	9	8				8	6
3,20		8	7				7	6
3,30		8	7				7	5
3,40		7	6				6	5
3,50		7	6				6	5
3,60		7	6				6	5
3,70		7	6				6	5

NOTE — If the diameter of the wire is between two consecutive diameters of the table, the number of bends corresponding to the next larger diameter shall be taken.

9 TENSILE TEST ON KNOTTED WIRE

This test is limited to wire having a diameter of less than 0,5 mm and replaces, for this wire, the simple torsion test and the reverse bend test.

The length of wire with a single knot shall be capable of withstanding, without breaking, a load equal to not less than 50 % of that corresponding to the nominal strength.

The test shall be carried out in accordance with the procedure given in ISO 89, with the qualification that a simple knot should be made in the middle of the test piece.

10 GALVANIZED WIRE – INSPECTION OF ZINC COATING

The coating of the wire shall comply with the requirements indicated in table 4, relating to the minimum mass of zinc deposited per unit of surface area, the continuity and uniformity of the deposit.

The determination of mass of zinc shall be carried out in accordance with the method described in Annex A, and the test for continuity and uniformity of coating in accordance with the method described in Annex B.

For wires of quality A only, an adhesion test shall be carried out in accordance with the method described in Annex C.

11 ACCEPTANCE CONDITIONS

A method of sampling and the acceptance conditions are given in ISO 2701.

TABLE 4 – **Mass of zinc deposited and number of 1 minute immersions**

Diameter of galvanized wire[1] mm		Quality B galvanizing[2]		Quality AB galvanizing[2]		Quality A galvanizing[2]	
		Nominal strength 160 and 180		Nominal strength 145, 160 and 180		Nominal strength 145 and 160	
from (incl.)	to (excl.)	Minimum mass of zinc g/m²	Number of 1 minute immersions	Minimum mass of zinc g/m²	Number of 1 minute immersions	Minimum mass of zinc g/m²	Number of 1 minute immersions
0,20	0,25	20	No test				
0,25	0,40	30	No test				
0,40	0,50	40	No test	60	No test	75	1/2
0,50	0,60	50	No test	70	No test	90	1/2
0,60	0,70	60	1/2	85	1/2	110	1
0,70	0,80	60	1/2	85	1/2	110	1
0,80	1,00	70	1/2	95	1/2	130	1
1,00	1,20	80	1	110	1	150	1 1/2
1,20	1,30	90	1	120	1	165	1 1/2
1,30	1,50	90	1	120	1	165	1 1/2
1,50	1,60	100	1	130	1 1/2	180	2
1,60	1,80	100	1	130	1 1/2	180	2
1,80	1,90	100	1	130	1 1/2	180	2
1,90	2,00	110	1 1/2			205	2
2,00	2,30	110	1 1/2			205	2
2,30	2,40	110	1 1/2			205	2
2,40	2,50	110	1 1/2			205	2
2,50	3,00	125	1 1/2			230	2 1/2
3,00	3,20	125	1 1/2			230	2 1/2
3,20	3,50	135	2			250	3
3,50	3,70	135	2			250	3

1) Before removing the zinc coating.

2) The galvanizing process is not prescribed.

ANNEX A

DETERMINATION OF MASS OF ZINC DEPOSITED PER UNIT OF SURFACE

A.1 PRINCIPLE

The test consists in dissolving the zinc coating of a sample of wire of given dimensions in a hydrochloric acid solution. The mass of zinc so dissolved is determined either by the difference in mass of the sample before and after dissolving the coating (gravimetric method), or 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 of the sample measured after dissolving the coating, the mass of zinc deposited per unit of surface is obtained.

The gas volumetric method is the easiest to carry out. In case of argument, however, the gravimetric method, by accurately weighing the sample before and after stripping the zinc coating, should be used as a check.

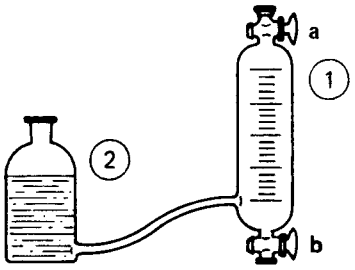
A.2 APPARATUS

The apparatus used consists essentially of the following elements (see the figure) :

1) tube graduated at least in millilitres, with a tap at each end;

2) flask whose lower nozzle is connected by a rubber tube to the bottom of the graduated tube;

3) beaker used for removing the samples.



A.3 PREPARATION OF TEST SPECIMENS

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

300 mm for wires of less than 1,00 mm diameter;

150 mm for wires 1,00 to 1,49 mm diameter;

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

50 mm for wires of more than 3 mm diameter.

Care should be taken to see that these lengths are accurate.

A.4 PROCEDURE

With tap **b** closed, the graduated tube and part of the flask are filled with hydrochloric acid solution containing a suitable inhibitor, e.g hexamethylene tetramine, antimony trichloride, antimony trioxide.

The level of the liquid in the graduated tube is raised in the graduated tube to just under the tap **a** by raising the acid reservoir flask until the two levels are the same.

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

When hydrogen is no longer being 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 onto 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 the table and opening tap **a**.

Tap **b** is then opened so that the test specimen of the wire can be collected in the beaker. This specimen is washed and carefully wiped before measuring its dimensions.

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

A.5 EXPRESSION OF RESULTS

The result is determined after testing of all test specimens.

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

$$m = \frac{2\,720\,V}{\pi\,d\,l}$$

where

d is the bare wire diameter, in millimetres;

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

V is the mean volume in millilitres (cubic centimetres), of hydrogen released during each of the tests.

Where the barometric pressure (p) is known to be outside the limits from 740 to 780 mmHg, the above formula should be multiplied by the factor $p/760$, where p is the barometric pressure, in 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 this wire and of the volume of hydrogen released.

The masses to be obtained, expressed in terms of the diameters of the wires, are shown in table 4.

ANNEX B

TEST FOR CONTINUITY AND UNIFORMITY OF COATING

B.1 PRINCIPLE

The test consists in dipping a sample of the wire for a given length of time one or more times in succession, into a saturated solution of copper sulphate, which gradually dissolves the zinc coating and thus reveals any defects in the continuity of this coating.

The fact that the rate of solubility of the coating in the copper sulphate solution varies appreciably according to the galvanizing process used prevents any other precise conclusion as to the thickness of the coating or its particular qualities of resistance to various kinds of corrosion. The dip test is intended only to reveal a serious eccentricity of coating or any other serious defect in uniformity which may exist even though the mass of zinc per unit of surface complies with this International Standard.

B.2 REAGENT

The reagent used is a fresh saturated solution of copper sulphate, prepared from "pure for analysis" copper sulphate crystals ($CuSO_4.5H_2O$), in the proportion of 360 g minimum of the salt to 1 l of distilled water, at a temperature of 20 ± 2 °C.

The solution shall be prepared entirely while cold. In no case, even in order to complete this solution, shall the liquid be heated. To prevent the operation from taking too long, the procedure may be as follows : the salt to be dissolved should be crushed and then reduced in small quantities by successive portions of the water to be used. When the salt is completely dissolved, the various partial solutions are combined and shaken. As a proof of saturation, a little of the salt should remain undissolved at the bottom of the vessel.

The use of "pure for analysis" copper sulphate does not dispense with the necessity of neutralizing the solution with an excess of chemically pure copper oxide (1 g per litre of solution) and of allowing it to stand at least 24 h before decanting the solution ready for use.

B.3 PREPARATION OF TEST SPECIMEN

The test specimen consists of a piece of wire about 250 mm long, roughly straightened by hand. This test specimen should be completely de-greased with benzene or trichlorethylene. It should then be rinsed in distilled water and wiped with clean cotton wool. After this, it should be held only at the part which is not to be dipped.

B.4 PROCEDURE

The reagent as specified above should be transferred to a glass container of at least 8 cm internal diameter so as to fill it to a depth of at least 10 cm.

The test specimen of the wire is then repeatedly dipped into this reagent, which should be maintained at a temperature of 20 ± 2 °C.

The test specimen, held vertically, should not touch the walls of the container nor should it be moved about during the period of immersion.

After each immersion, any deposited but non-adhering copper should be removed by lightly rubbing with cotton wool under running water.

The number and duration of the immersions to which each test specimen should be subjected, specified as a function of the diameter of the wire, are shown in table 4.

To save time, a maximum of six test specimens may be tested simultaneously, provided that these test specimens do not touch one another.

The solution used should be renewed whenever the series of tests carried out has resulted in dissolving a maximum of 5 g of zinc per litre of reagent.

B.5 INTERPRETATION OF THE TEST

After the number of dips as specified in table 4, the final rinsing and the wiping dry, the test specimen should not show any adherent salmon-red deposit of metallic copper on the steel. Any deposit of metallic copper within 25 mm of the cut end should be disregarded.

Also, an adherent deposit of copper on part of the test specimen which has been subjected to accidental damage by rubbing or mechanical deformation should not be taken into account.

Lastly, if there is any doubt as to the true nature or adhesion of the deposit, a fresh test may be carried out on another test specimen taken from the same coil of wire.