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Stranded wire ropes for mine hoisting — Technical delivery requirements

Câbles d'extraction toronnés utilisés dans les mines — Conditions techniques de réception

Reference number
ISO 3154 : 1988 (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 approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3154 was prepared by Technical Committee ISO/TC 82, *Mining*.

This second edition cancels and replaces the first edition (ISO 3154 : 1976), of which it constitutes a minor revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Stranded wire ropes for mine hoisting — Technical delivery requirements

1 Scope and field of application

This International Standard specifies those properties of stranded wire ropes for mine hoisting and of their component parts which form a basis for acceptance.

Full-lock coil ropes, balance ropes and flat ropes used in mines are not covered by this International Standard.

The characteristics of the wire to be used for the manufacture of these ropes are not covered by this International Standard.

2 References

ISO 2232, *Drawn wire for general purpose non-alloy steel wire ropes — Specifications.* [1)]

ISO 2532, *Steel wire ropes — Vocabulary.*

ISO 3155, *Stranded wire ropes for mine hoisting — Fibre components — Characteristics and tests.*

ISO 3156, *Stranded wire ropes for mine hoisting — Impregnating compounds, lubricants and service dressings — Characteristics and tests.*

ISO 6892, *Metallic materials — Tensile testing.*

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

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

3 Components of the rope

3.1 Wires

Stranded wire ropes for hoisting purposes shall be made from round wires[2)]. These shall be either bright or galvanized.

The requirements for wires after manufacture are given in clause 4.

3.2 Fibres

Fibre cores, fibre covers and fibre inserts used in the manufacture of these ropes shall comply with the requirements laid down in ISO 3155.

3.3 Lubricants

The impregnating compounds and lubricants used during the manufacture of these ropes shall comply with the requirements laid down in ISO 3156.

1) Cross-reference to annex A in ISO 2232 applies to the first edition published in 1973.

2) In ropes of triangular strand or flattened strand construction, shaped wires may be used as core members.

4 Requirements

4.1 Requirements for the completed rope

4.1.1 Rope diameter

4.1.1.1 Nominal rope diameter

The nominal diameter shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

4.1.1.2 Actual rope diameter

The actual rope diameter measured on the newly completed rope in the unloaded state shall be not less than the agreed nominal rope diameter and shall not exceed it by more than 5 %.

The actual rope diameter shall be measured by the method laid down in 5.1.1.

4.1.2 Rope length

4.1.2.1 Nominal length

The nominal rope length shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered. Any test pieces shall be included in the ordered length.

4.1.2.2 Actual rope length

The actual rope length measured on the newly completed rope in the unloaded state shall be subject to the following tolerances on the ordered length :

up to and including 400 m : $^{+5}_{0}$ %

over 400 m up to 1 000 m : $^{+20}_{0}$ %

for each further 1 000 m or part thereof : $^{+20}_{0}$ m.

The actual rope length shall be determined by the method agreed according to 5.1.2.

4.1.3 Rope mass per metre

4.1.3.1 Nominal rope mass

The nominal rope mass per metre and the tolerances shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

4.1.3.2 Actual rope mass

The actual rope mass measured on the newly completed rope in the unloaded state shall not differ from the agreed nominal rope mass by less than − 2 % or more than + 5 % and shall be determined by the method laid down in 5.1.3.

4.1.4 Breaking loads

4.1.4.1 General

Two methods of assessment are recognized. Compliance with one or the other shall be agreed between the manufacturer or supplier and the purchaser. The definitions of breaking loads shall be those given in ISO 2532.

4.1.4.2 Method A

In this method, the terms used are "nominal aggregate breaking load" and "measured aggregate breaking load"[1].

a) Nominal aggregate breaking load

The nominal aggregate breaking load shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered[2].

b) Measured aggregate breaking load

The measured aggregate breaking load shall not be less than the nominal aggregate breaking load[3]. It shall be determined by the method laid down in 5.1.4.1.

4.1.4.3 Method B

In this method, the terms used are "minimum breaking load" and "measured breaking load".

a) Minimum breaking load

The minimum breaking load shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

b) Measured breaking load

The measured breaking load shall not be less than the minimum breaking load[3]. It shall be determined by a tensile test to destruction carried out in the manner specified in 5.1.4.2 on a sample of the rope.

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1) It is the practice in some countries to disregard certain components of the rope when assessing the nominal aggregate and the measured aggregate breaking loads; the value determined in this way is called a "reduced aggregate" (nominal or measured) breaking load of the rope. National standards and regulations may specify those components which have to be disregarded.

The reduced nominal and the reduced measured aggregate breaking loads may form a basis for acceptance of the rope.

2) The minimum breaking load may also be agreed between the manufacturer or supplier and the purchaser; in this case, the minimum breaking load is calculated from the nominal aggregate breaking load and an agreed spinning loss factor.

3) In special cases, it may be necessary for the upper limit of breaking load to be the subject of agreement between the manufacturer or supplier and the purchaser.

4.2 Requirements for round wires from rope

4.2.1 Wire diameter

4.2.1.1 Nominal diameters

The intervals separating successive nominal diameters for bright and galvanized wires are given in table 1. The diameter of galvanized wires shall be measured over the galvanized coating.

Table 1

Dimensions in millimetres

Nominal diameter d	Intervals
$d \leqslant 2$	0,05
$d > 2$	0,1

If, for technical reasons, the nominal diameters of the wires differ from these values, the nominal diameters of the wires shall be indicated by the manufacturer or supplier in the confirmation of the order to the rope purchaser and in the full works certificate (see 7.3).

4.2.1.2 Tolerances

For bright and galvanized wires, the tolerances on the diameter shall be as given in table 2.

Table 2

Dimensions and tolerances in millimetres

Nominal diameter of wire d	Tolerances on	
	bright and quality B[1] galvanized wire	quality A[1] galvanized wire
$0,8 \leqslant d < 1$	± 0,02	± 0,03
$1 \leqslant d < 1,6$	± 0,02	± 0,04
$1,6 \leqslant d < 2,4$	± 0,03	± 0,05
$2,4 \leqslant d \leqslant 3,5$	± 0,03	± 0,06

1) See 4.2.5.1.

Galvanized wires may, owing to local irregularities, exceed the tolerances laid down in table 2 over a short length provided that the use of the wires is not affected.

4.2.2 Tensile strength

4.2.2.1 Nominal tensile strength

The nominal tensile strength values (tensile grades) for wires shall be as given in table 3. They shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

Table 3

Nominal tensile strength (Tensile grade) N/mm²
1 570
1 770
1 960

These nominal values are the lower limits for tensile strengths before ropemaking.

The upper limits are equal to the lower limits plus the tolerances given in 4.2.2.2.

If, in exceptional cases, other nominal tensile strengths are necessary, these and the relevant technical requirements shall be agreed between the manufacturer or supplier and the purchaser.

4.2.2.2 Tolerances

The upper limit tolerances for nominal tensile strength shall be as given in table 4.

Table 4

Nominal diameter of wire d	Upper limit tolerances for nominal tensile strength
mm	N/mm²
$0,8 \leqslant d < 1$	350
$1 \leqslant d < 1,5$	320
$1,5 \leqslant d < 2$	290
$d \geqslant 2$	260

4.2.3 Number of reverse bends

The minimum numbers of reverse bends shall be in accordance with table 5.

Table 5

Nominal diameter of wire d	Radius of cylindrical formers	Minimum number of reverse bands when acceptance method A is used					Reduction applicable on bending numbers when acceptance method B is used
		Bright and quality B galvanized wire			Quality A galvanized wire		
		Nominal tensile strength, N/mm²					
mm	mm	1 570	1 770	1 960	1 570	1 770	
$0,8 \leqslant d < 0,9$	2,5	13	12	11	10	9	3
$0,9 \leqslant d < 1$		12	11	10	9	8	
$1 \leqslant d < 1,1$	3,75	17	16	15	14	13	4
$1,1 \leqslant d < 1,2$		15	14	13	12	11	
$1,2 \leqslant d < 1,3$		13	12	11	10	9	
$1,3 \leqslant d < 1,4$		12	11	10	9	8	
$1,4 \leqslant d < 1,5$		11	10	9	8	7	3
$1,5 \leqslant d < 1,6$	5	14	13	12	11	10	
$1,6 \leqslant d < 1,7$		13	12	11	10	9	2
$1,7 \leqslant d < 1,8$		12	11	10	9	8	
$1,8 \leqslant d < 1,9$		11	10	9	8	7	
$1,9 \leqslant d < 2$		10	9	8	7	6	
$2 \leqslant d < 2,1$	7,5	15	14	13	12	11	3
$2,1 \leqslant d < 2,2$		14	13	12	11	10	
$2,2 \leqslant d < 2,3$		13	12	11	10	9	
$2,3 \leqslant d < 2,4$		13	12	11	10	9	
$2,4 \leqslant d < 2,5$		12	11	10	9	8	
$2,5 \leqslant d < 2,6$		11	10	9	8	7	2
$2,6 \leqslant d < 2,7$		10	9	8	7	6	
$2,7 \leqslant d < 2,8$		10	9	8	7	6	
$2,8 \leqslant d < 2,9$		9	8	7	6	5	
$2,9 \leqslant d < 3$		9	8	7	6	5	
$3 \leqslant d < 3,1$	10	12	11	10	9	8	
$3,1 \leqslant d < 3,2$		12	11	10	9	8	
$3,2 \leqslant d < 3,3$		11	10	9	8	7	
$3,3 \leqslant d < 3,4$		11	10	9	8	7	
$3,4 \leqslant d < 3,5$		10	9	8	7	6	

4.2.4 Number of torsions

The minimum number of torsions shall be in accordance with the values specified in table 6.

4.2.5 Zinc coating

4.2.5.1 Qualities

Two grades of galvanizing shall be recognized : these are quality A (heavy galvanizing) and quality B (normal galvanizing).

4.2.5.2 Assessment

The quality of the galvanized coating shall be assessed by the mean mass of zinc deposited per unit area of surface, in grams per square metre.

The zinc coating shall comply with the values given in table 7.

The values given in the column for quality A are not applicable for tensile grades exceeding 1 770 N/mm². For higher tensile grades, values shall be agreed between the manufacturer or supplier and the purchaser.

Table 6

Test length	Nominal diameter of wire d	Minimum number of torsions[1]				
		Bright and Quality B galvanized wire			Quality A galvanized wire	
		Nominal tensile strength, N/mm²				
mm	mm	1 570	1 770	1 960	1 570	1 770
100 × d	$0,8 \leqslant d < 1$	33	31	25	21	19
	$1 \leqslant d < 1,3$	31	29	24	19	17
	$1,3 \leqslant d < 1,8$	30	27	23	18	16
	$1,8 \leqslant d < 2,3$	28	26	21	17	14
	$2,3 \leqslant d < 3$	26	23	19	14	11
	$3 \leqslant d < 3,4$	24	21	18	9	7
	$3,4 < d \leqslant 3,5$	22	19	16	8	6

1) The torsion values apply to round strand ropes.

For shaped strand ropes with more than one layer of round wires in the strands, the values given in table 6 shall be reduced by one torsion each.

For shaped strand ropes with only one layer of round wires in the strands, the values given in table 6 shall be reduced by two torsions each.

Table 7

Nominal diameter of wire d	Minimum surface density of zinc, g/m²	
mm	Quality A	Quality B
$0,8 \leqslant d < 1$	130	70
$1 \leqslant d < 1,2$	150	80
$1,2 \leqslant d < 1,5$	165	90
$1,5 \leqslant d < 1,9$	180	100
$1,9 \leqslant d < 2,5$	205	110
$2,5 \leqslant d < 3,2$	230	125
$3,2 \leqslant d \leqslant 3,5$	250	135

4.3 Requirements for shaped wires from rope

If shaped wires from strand cores contribute an essential part of the breaking strength of the rope, the extent of the tests, the requirements, and the methods of testing shall be agreed between the manufacturer or supplier of the rope and the purchaser.

5 Testing

5.1 Tests on the completed rope

5.1.1 Determination of rope diameter

The actual diameter of the rope shall be measured with a suitable caliper fitted with jaws broad enough to cover not less than two adjacent strands.

Measurements shall be taken on a straight portion of the rope under no-load condition.

The measurements shall be taken at two points spaced at least 1 m apart; at each point two diameters at right angles shall be measured. The average of these four measurements shall be taken as being the actual diameter. It shall be within the tolerances specified by reference to the nominal diameter. The maximum variation between any of the four measurements shall not exceed 4 % of the nominal rope diameter.

In case of dispute, the diameter may be measured under a load not exceeding 5 % of the nominal breaking load of the rope.

5.1.2 Determination of rope length

The method of measuring the rope length shall be agreed between the manufacturer or supplier and the purchaser.

The rope length shall be measured, in metres, with an accuracy of at least ± 2,5 %.

5.1.3 Determination of rope mass

The mass of the rope, including reels and packing material, shall be determined in kilograms.

The mass of reels, slings and packing shall be subtracted from this value to give the total rope mass. The total rope mass shall be divided by the measured rope length.

The actual rope mass, in kilograms per metre, shall be within the tolerances specified in 4.1.3.2.

5.1.4 Determination of breaking loads

5.1.4.1 Measured aggregate breaking load

If acceptance method A is agreed (see 4.1.4.2), the measured (actual) aggregate breaking load of the rope shall be found by adding together the breaking loads of all the individual wires from the rope, after they have been tested as specified in 5.2.3.

The reduced measured aggregate breaking load shall be determined, if so specified (see footnote 1 on page 2).

5.1.4.2 Measured breaking load

5.1.4.2.1 General

If acceptance method B is agreed (see 4.1.4.3), the measured (actual) breaking load of the rope shall be determined as indicated in 5.1.4.2.2 to 5.1.4.2.7.

5.1.4.2.2 Test length

The length of the test piece is made up of the clear test length and an adequate allowance for gripping.

The clear test length shall be equal to at least 30 times the rope diameter, but not less than 1,5 m.

5.1.4.2.3 Test piece

The test piece shall be representative of the rope as a whole and free from any defect. The test piece, before being cut from the rope, shall be served or clamped securely so as to prevent any slackening of the wires within the test length. The rope from which the test piece is taken shall be secured in the same way. Test pieces showing slack wires or other defects shall not be tested.

For testing the rope to destruction, it is useful to provide the ends of the test piece with conical sockets. Care shall be taken to ensure that the casting material penetrates well into the untwisted ends of the test piece. Other methods of fixing the rope ends may be agreed between the manufacturer or supplier and the purchaser.

5.1.4.2.4 Testing machine

A testing machine of suitable capacity and of an accuracy of ± 1 % that is certified periodically by an officially recognized testing authority shall be used.

The sample shall be gripped in such a way that all wires in the rope take part in the acceptance of the load.

The tests shall be carried out at a testing station agreed by the manufacturer or supplier and the purchaser.

5.1.4.2.5 Performance of test

Not more than 80 % of the nominal breaking load may be applied quickly. Thereafter, the load shall be applied slowly and steadily, at a rate not exceeding 10 N/(mm^2·s), until the maximum load is attained.

5.1.4.2.6 Place of fracture

Tests in which fracture occurs less than two rope diameters away from the grips may be discounted at the option of the manufacturer or supplier.

5.1.4.2.7 Recording of elongation

This shall be the subject of special agreement between the manufacturer or supplier and the purchaser. If required, the elongation shall be measured over a test length of at least 500 mm. Elongation readings shall be taken commencing at a load equal to 2 % of the nominal breaking load and thereafter at 10, 20, 30, 50 and 60 % of the minimum breaking load unless continuous recording is available.

In the case where incremental readings are taken, the permanent elongation shall be determined after each measurement by reducing the test load to 2 % of the minimum breaking load and recording the elongation.

The elongation shall be measured to an accuracy of 0,1 mm.

5.2 Test on wires from the rope

5.2.1 Extent of tests

5.2.1.1 Using acceptance method A (see 4.1.4.2)

All tests, with the exception of the test for the galvanized coating, shall be performed on all the round[1)] steel wires in the rope.

In order to obtain test pieces, a suitable length shall be cut from the rope and the wires unlaid.

The galvanized coating tests shall be carried out on 10 % of all the round wires[1)].

The samples shall be taken at random.

5.2.1.2 Using acceptance method B (see 4.1.4.3)

The number of wires of each nominal diameter taken for test from the rope shall be at least 16 % of the total number of wires of that nominal diameter[1)] in the rope, except for galvanizing tests where the number of wires taken shall be 10 % of the total number of the same nominal diameter.

In order to obtain test pieces, a suitable length shall be cut from the rope and the wires unlaid. Wires of equal nominal diameter shall be thoroughly mixed and the appropriate number of wires selected at random.

5.2.2 Measurement of wire diameter

The actual diameter of the steel wire shall be taken as the mean value of two measurements made in mutually perpendicular planes at the same point on the wire. The actual diameter established in this way shall be within the permitted tolerances for the nominal diameter as given in 4.2.1.

1) In some rope constructions, shaped strand centres may be made from wound wires; in these cases, the wires of the shaped components shall be disregarded.

5.2.3 Wire tensile test

The tensile test shall be performed in accordance with the requirements of ISO 6892, but with the following modifications :

a) the gauge length L_o of the test piece shall be 50 mm;

b) it will not normally be necessary to straighten the wires if only the tensile strength is to be tested.

When tested in this manner, the wires shall comply with the values given in 4.2.2.

5.2.4 Reverse bend test

The reverse bend test shall be performed in accordance with the requirements of ISO 7801.

When tested in this manner, the wires shall comply with the values given in 4.2.3.

5.2.5 Torsion test

The torsion test shall be performed in accordance with the requirements of ISO 7800, but with the following modification : the torsion test shall be continued until fracture occurs.

When tested in this manner, the wires shall comply with the values given in 4.2.4.

5.2.6 Tests on galvanized coating

The tests on the galvanizing of the wires shall be performed in accordance with ISO 2232, annex A. The coating shall comply with the values given in 4.2.5.

5.2.7 Compliance with requirements

5.2.7.1 Using acceptance method A (see 4.1.4.2)

Wires from the rope comply with this International Standard,

a) if not more than 5 % of all wires exceed the tolerances on diameter;

b) if not more than 3 % of all wires are more than 50 N/mm² below the minimum values for tensile strength;

c) if not more than 5 % of all wires fall below the minimum values for bends or torsions or both;

d) if the total percentage of all wires with these defects does not exceed 10 %;

e) if, in addition to the above, the percentage of the wires tested that are allowed to fall below the minimum values for mass of galvanized coating is not more than 5 %.

If, in any of the above-mentioned tests, a particular wire fails on more than one test, it shall be considered as one defect only.

5.2.7.2 Using acceptance method B (see 4.1.4.3)

Wires from the rope comply with this International Standard,

a) if not more than one wire in any diameter group fails to pass any of the tests specified, and

b) if two or more wires of any diameter group fail to pass any of the tests specified, all the remaining wires of that group in the rope shall be retested in respect of the tests in which these wires have failed; if the number of wires which fail in these new tests does not exceed 4 % (to the nearest whole number of wires above these 4 %) of the whole number of wires of equal nominal diameter in the rope, the rope shall be deemed to comply with this International Standard.

5.3 Independent tests

In the case of dispute between the manufacturer or supplier and the purchaser over any test result, the manufacturer or supplier shall have the right to have independent tests carried out by a testing authority agreed between the manufacturer or supplier and the purchaser.

If the results of these tests are satisfactory, the rope shall be considered to comply with the specification.

6 Inspection facilities

6.1 When so specified by the purchaser, the manufacturer or supplier shall accord the purchaser or his representative all reasonable facilities to satisfy himself that the rope and its components are in accordance with this International Standard.

6.2 Whenever possible and unless otherwise agreed, all tests and inspection shall be made at the manufacturer's works before despatch.

6.3 When tests are carried out at the manufacturer's works, he shall supply all the necessary test pieces, apparatus and labour, and the testing shall be to the satisfaction of the purchaser or his representative.

7 Certificates

7.1 General

The types of certificate described in 7.2 to 7.4 are recognized. The certificates required by the purchaser shall be stated in the purchaser's order.

7.2 Works certificate

With this certificate the manufacturer or supplier acknowledges the conditions as specified in the purchaser's order (see annex A).

7.3 Full works certificate

The full works certificate gives the results of the tests requested by the purchaser in his order (see annex B).

7.4 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 are laid down in the certificate of acceptance, which is equivalent to the full works certificate.

8 Packing

Ropes shall be supplied on reels. The ropes shall be protected, in transit, against damage by moisture, dust or dirt.