
INTERNATIONAL STANDARD



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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

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FOREWORD

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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.

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It has been approved by the Member Bodies of the following countries :

Austria	Germany	Spain
Belgium	Hungary	Sweden
Bulgaria	India	Thailand
Chile	Ireland	Turkey
Czechoslovakia	Poland	United Kingdom
Egypt, Arab Rep. of	Romania	U.S.S.R.
France	South Africa, Rep. of	Yugoslavia

No Member Body expressed disapproval of the document.

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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 which form a basis for acceptance of stranded wire ropes for mine hoisting and of their component parts. Full-lock coil ropes, balance ropes and flat ropes used in mines are not covered by this International Standard.

2 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 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 and lubricants — Characteristics and tests.*

3 COMPONENTS OF THE ROPE

3.1 Wires

Stranded wire ropes for hoisting purposes shall be made from round wires²⁾. These shall be either bright or galvanized.

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

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

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 and service dressing of these ropes shall comply with the requirements laid down in ISO 3156.

1) Only : Annex A — Determination of mass of zinc deposited per unit of surface.
Annex B — Test for continuity and uniformity of coating.

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

4 REQUIREMENTS

4.1 Requirements on the completed rope

4.1.1 Rope diameter

4.1.1.1 NOMINAL ROPE DIAMETER

The nominal rope 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 new, 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 new completed rope in the unloaded state shall be subject to the following tolerances on the ordered length :

up to and including 400 m : $\begin{matrix} +5 \\ 0 \end{matrix} \%$

over 400 m : $\begin{matrix} +20 \\ 0 \end{matrix} \text{ m}$ for each 1 000 m or part thereof.

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 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 new 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 according to the method laid down in 5.1.3.

4.1.4 Breaking loads

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 load shall be those given in ISO 2532.

4.1.4.1 METHOD I

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 purchaser and the manufacturer or supplier when the rope is ordered.²⁾

b) Measured aggregate breaking load

The measured aggregate breaking load shall be not less than the nominal aggregate breaking load³⁾. It shall be determined by the method laid down in 5.1.4.1.

4.1.4.2 METHOD II

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 purchaser and the manufacturer or supplier when the rope is ordered.

b) Measured breaking load

The measured breaking load shall be not less than the minimum breaking load³⁾. It shall be determined by a tensile test to destruction on a sample of the rope carried out in the manner specified in 5.1.4.2.

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 purchaser and the manufacturer or supplier; 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, if 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 on 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
$\leq 2,0$	0,05
$> 2,0$	0,1

If, for technical reasons, the nominal diameters of the wires differ from these values, the nominal diameters of the stranded 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.

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 in millimetres

Nominal diameter of wire d	Tolerance	
	Bright and Quality B* galvanized wire	Quality A* galvanized wire
$0,8 \leq d < 1,0$	$\pm 0,02$	$\pm 0,03$
$1,0 \leq d < 1,6$	$\pm 0,02$	$\pm 0,04$
$1,6 \leq d < 2,4$	$\pm 0,03$	$\pm 0,05$
$2,4 \leq d \leq 3,5$	$\pm 0,03$	$\pm 0,06$

* 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/mm ²	kgf/mm ²
1 570*	160
1 770*	180
1 960	200

* These tensile grades should be preferred.

These nominal values are the lower limits for tensile strengths.

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

TABLE 4

Nominal diameter of wire d	Tolerance for nominal tensile strength	
	N/mm ²	kgf/mm ²
mm		
$0,8 \leq d < 1,0$	350	36
$1,0 \leq d < 1,5$	320	33
$1,5 \leq d < 2,0$	290	30
$d \geq 2,0$	260	27

4.2.3 Number of reverse bends

The minimum numbers of reverse bends shall be in accordance with table 5.¹⁾

TABLE 5

Nominal diameter of wire <i>d</i>	Radius of cylindrical formers	Minimum number of reverse bends when Acceptance Method I is used					Reduction applicable on bending numbers when Acceptance Method II is used
		Bright and Quality B galvanized wire			Galvanized wire Quality A		
		Nominal tensile strength, N/mm ² (kgf/mm ²)					
mm	mm	1570 (160)	1770 (180)	1960 (200)	1570 (160)	1770 (180)	
0,8	2,5	14	13	12	12	10	3
0,9		12	11	10	10	8	3
1,0		10	9	8	8	6	3
1,1	3,75*	18	17	16	14	13	4
1,2		16	15	14	13	11	4
1,3		14	13	12	11	9	4
1,4		12	11	10	9	8	4
1,5		10	9	8	8	7	3
1,6	5	15	14	12	11	10	3
1,7		13	12	11	10	9	2
1,8		12	11	10	9	8	2
1,9		11	10	9	8	7	2
2,0		10	9	8	7	6	2
2,1	7,5	16	15	14	14	12	3
2,2		15	14	13	13	11	3
2,3		14	13	12	12	10	3
2,4		13	12	11	11	9	3
2,5		12	11	10	10	8	3
2,6		11	10	9	9	7	2
2,7		10	9	8	8	6	2
2,8		9	8	7	7	5	2
2,9		8	7	6	7	5	2
3,0		8	7	6	6	4	2
3,1	10	13	12	11	10	8	2
3,2		12	11	10	9	7	2
3,3		11	10	9	9	7	2
3,4		10	9	8	8	6	2
3,5		9	8	7	7	5	2

* The bending radius of 3,75 mm has been adopted only recently and until further experience is gained, some discretion should be used in applying the numbers relating to this radius.

Values falling between the nominal diameter values listed in table 5 shall comply with the reverse bend numbers of the next higher nominal diameter.

1) Table 5 will be reconsidered after a period of 3 years.

4.2.4 Number of turns

The minimum number of turns shall be in accordance with the values specified in table 6.¹⁾

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 :

- a) by the mean mass of zinc deposited per unit area of surface, in grams per square metre;

- b) by the continuity and the uniformity of the zinc coating (Preece test)²⁾.

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 (180 kgf/mm²). For higher tensile grades, values shall be agreed between the purchaser and the manufacturer or supplier.

4.3 Requirements on 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 purchaser and the manufacturer or supplier of the rope.

TABLE 6

Test length	Nominal diameter of wire <i>d</i>	Minimum number of turns				
		Bright and Quality B galvanized wire			Quality A galvanized wire	
		Nominal tensile strength, N/mm ² (kgf/mm ²)				
mm	mm	1570 (160)	1770 (180)	1960 (200)	1570 (160)	1770 (180)
100 × <i>d</i>	0,8 ≤ <i>d</i> < 1,0	33	31	25	21	19
	1,0 ≤ <i>d</i> < 1,3	31	29	24	19	17
	1,3 ≤ <i>d</i> < 1,8	30	27	23	18	16
	1,8 ≤ <i>d</i> < 2,3	28	26	21	17	14
	2,3 ≤ <i>d</i> < 3,0	26	23	19	14	11
	3,0 ≤ <i>d</i> < 3,4	24	21	18	9	7
	3,4 ≤ <i>d</i> ≤ 3,5	22	19	16	8	6

TABLE 7

Nominal diameter of wire <i>d</i>	Quality B		Quality A	
	Minimum mass of zinc	Minimum number of immersions	Minimum mass of zinc	Minimum number of immersions
mm	g/m ²		g/m ²	
0,8 ≤ <i>d</i> < 1,0	70	0,5	130	1
1,0 ≤ <i>d</i> < 1,2	80	1	150	1,5
1,2 ≤ <i>d</i> < 1,5	90	1	165	1,5
1,5 ≤ <i>d</i> < 1,9	100	1	180	2
1,9 ≤ <i>d</i> < 2,5	110	1,5	205	2
2,5 ≤ <i>d</i> < 3,2	125	1,5	230	2,5
3,2 ≤ <i>d</i> ≤ 3,5	135	2	250	3

1) Table 6 will be reconsidered after a period of 3 years.

2) See annex B of ISO 2232.

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 and 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 must 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 rope length shall be measured, in metres, with an accuracy of at least $\pm 2,5$ %.

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

5.1.3 Determination of rope mass

The mass of the rope, including reels and packing material, shall then be determined, in kilograms. The mass of reels, slings and packing shall be subtracted from this to give the total rope mass. The total rope mass shall be divided by the measured rope length.

This 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 I is agreed (see 4.1.4.1), 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, page 2).

5.1.4.2 MEASURED BREAKING LOAD

If Acceptance Method II is agreed (see 4.1.4.2), the measured (actual) breaking load of the rope shall be determined as indicated below.

5.1.4.2.1 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.

5.1.4.2.2 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 seized 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 has to 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.

5.1.4.2.3 Testing machine

A testing machine of suitable capacity and of an accuracy of ± 1 % having been certified 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 purchaser and the manufacturer or supplier.

5.1.4.2.4 Performance of test

Not more than four-fifths 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/mm² (1 kgf/mm²) per second until the maximum load is attained.

5.1.4.2.5 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.

5.1.4.2.6 Recording of elongation

This shall be the subject of special agreement between the purchaser and the manufacturer or supplier. If required, the elongation shall be measured over a test length of at least 500 mm. Records shall be taken starting at a load equal to 2 % of the minimum 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 discontinuous recording is used, after each measurement the permanent elongation is determined by unloading until 2 % of the minimum breaking load is reached.

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

5.2 Tests on wires from the rope

5.2.1 Extent of tests

5.2.1.1 USING ACCEPTANCE METHOD I (see 4.1.4.1)

All tests, with the exception of the test for the galvanized coating, shall be performed on all the round¹⁾ steel wires in the rope.

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

The galvanized coating tests shall be carried out on 10 % of all the round wires¹⁾.

The samples shall be taken at random.

5.2.1.2 USING ACCEPTANCE METHOD II (see 4.1.4.2)

The number of wires of each nominal diameter taken for test from the rope shall be at least 10 % of the total number of wires of that nominal diameter¹⁾ 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 unlaidd. 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 equal to 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.

5.2.3 Wire tensile test

The tensile test shall be performed in accordance with the requirements of ISO 89 but with the following modifications :

- The gauge length L_0 of the test piece shall be 50 mm (see 6.2 of ISO 89).
- It will not normally be necessary to straighten the wires if only the tensile strength is to be tested (see 6.4 of ISO 89).

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 144.

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 136, but with the following modification :

- The torsion test shall be continued until fracture occurs (see clause 2 of ISO 136).

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 test on the galvanizing of the wires shall be performed in accordance with annexes A and B of ISO 2232. The coating shall comply with the values given in 4.2.5.

5.2.7 Terms of acceptance

Wires from the rope comply with this International Standard if they meet the following requirements :

5.2.7.1 USING ACCEPTANCE METHOD I (see 4.1.4.1)

- Not more than 5 % of all the wires shall exceed the tolerances on diameter.
- Not more than 3 % of all the wires shall fall below the minimum values for tensile strength.
- Not more than 5 % of all the wires shall fall below the minimum values for bends or torsions or both.

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

d) The total percentage of all wires with these defects shall not exceed 10 %.

e) The percentage of the wires tested that are allowed to fall below the minimum values for mass of galvanized coating and Preece test shall not be more than 5 % for each characteristic, with a total of not more than 7 % for both characteristics.

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

5.2.7.2 USING ACCEPTANCE METHOD II (see 4.1.4.2)

a) Not more than one wire in any diameter group shall fail to pass any of the tests specified.

b) However, if two or more wires of any diameter group do fail to pass any of the tests specified, all the remaining wires of that group in the rope shall be re-tested in respect of the tests in which the wires have failed; if the number of wires which fail in these 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 purchaser and the manufacturer or supplier 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 purchaser and the manufacturer or supplier.

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

6 FACILITIES FOR INSPECTION

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 works of the manufacturer 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

The following types of certificate are recognized. The certificates required by the purchaser shall be stated in the purchase order.

7.1 Works Certificate

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

7.2 Full Works Certificate

The Full Works Certificate gives the results of the tests requested by the purchaser in his order (see annex B).

7.3 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 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.

ANNEX A

EXAMPLE OF A WORKS CERTIFICATE FOR WIRE ROPES

Works certificate

Manufacturer :
 Commission Number :
 Purchaser :
 Purchaser's Order Number :
 Date of delivery :
 Nominal diameter : mm
 Length : m
 Construction :
 Type and direction of lay :
 Tensile grade of the wires : N/mm² (kgf/mm²)
 Surface finish of wires :
 Nominal aggregate breaking load or
 Minimum breaking load : N (kgf)
 Rope mass per metre : kg/m
 Total mass of the rope : kg
 Reel Number :
 Remarks :

It is certified that the above-mentioned rope conforms to ISO 3154

.....
Place, Date

.....
Signature (Stamp)