INTERNATIONAL STANDARD

ISO 4344

Second edition
2004-02-01

Steel wire ropes for lifts — Minimum requirements

Câbles en acier pour ascenseurs — Exigences minimales

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4344 was prepared by Technical Committee ISO/TC 105, *Steel wire ropes*.

This second edition cancels and replaces the first edition (ISO 4344:1983), which has been technically revised.

Introduction

This International Standard was developed in response to a worldwide demand for a specification giving minimum requirements for ropes for use on lifts.

As in previous editions of the standard, metric sizes and grades of rope are covered. Additionally, due to widespread application world-wide, information is given in this edition on imperial sizes and grades for comparison and to assist in ensuring that existing levels of safety can be maintained when ropes are selected. It is desirable in such cases that the equipment designer, rope manufacturer or other competent person be consulted prior to ordering a rope.

This International Standard does not limit itself to those classes and constructions covered by the tables. Other stranded rope constructions may also conform to the minimum requirements, and in such cases the manufacturer would specify the minimum breaking force and rope grade.

Steel wire ropes for lifts — Minimum requirements

1 Scope

This International Standard specifies the minimum requirements for the manufacture and testing of stranded carbon steel wire ropes used for suspension duty on traction drive and roped hydraulic lifts, and for compensation and governor duties on passenger and freight lifts, dumbwaiters, personnel hoists and man lifts moving between guides. It gives the minimum breaking forces for the more common sizes, rope grades and rope classes and constructions.

It is applicable to ropes made from bright and galvanized wire finish in various constructions from 6 mm to 38 mm diameter supplied as bulk manufacture and manufactured after its publication date. It is not applicable to ropes for builder's hoists and temporary hoists not running between permanent guides — whether passenger-carrying or not — or to ropes for cableways.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2232, *Round drawn wire for general purpose non-alloy steel wire ropes and for large diameter steel wire ropes — Specifications*

ISO 3108, *Steel wire ropes for general purposes — Determination of actual breaking load*

ISO 4101, *Drawn steel wire for elevator ropes — Specifications*

ISO 4345:1988, *Steel wire ropes — Fibre main cores — Specification*

ISO 4346, *Steel wire ropes for general purposes — Lubricants — Basic requirements*

ISO 17893 [1)], *Steel wire ropes — Vocabulary, designations and classifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17893 and the following apply.

3.1
single tensile rope
rope with outer strands having outer wires of the same tensile strength grade as the inner wires

EXAMPLE 1 570 N/mm^2 throughout the rope.

1) To be published.

3.2
dual tensile rope
rope with outer strands having outer wires of a lower tensile strength grade than that of its inner wires

EXAMPLE 1 370 N/mm^2 outer wires and 1 770 N/mm^2 inner wires.

3.3
production length
length of completed rope equating to one loading of the closing machine

4 Requirements

4.1 Materials

4.1.1 Wire

Before rope making, wires shall conform to the diameter, torsion and, where applicable, zinc-coating requirements of the wire specifications given in Table 1. The mechanical properties of galvanized wires according to ISO 4101 shall be the same as those for bright wires. The requirements for the amount of zinc shall be in accordance with ISO 2232.

Table 1 — Wire specifications

Position of wires in the rope	Wire tensile strength grade N/mm^2				
	1180[a] and 1320[a]	1370	1570 and 1620[b]	1770	1960
Outer wires of outer strands	ISO 4101	ISO 4101	ISO 4101	ISO 4101	ISO 2232
Inner, centre and core wires	—	—	ISO 2232	ISO 2232	ISO 2232
Filler wires	ISO 4101	ISO 4101	ISO 2232	ISO 2232	ISO 2232

[a] Torsion properties as per 1370 N/mm^2 wire tensile strength grade.

[b] Torsion properties as per 1770 N/mm^2 wire tensile strength grade.

The test methods shall be in accordance with those given in ISO 2232.

All wires in the same layer shall be of the same tensile strength grade.

For ropes having galvanized wires, the level of coating shall be Quality B.

The tensile strength grades of the inner wires shall be subject to the wire tensile strength grades limits given in Table 2,

Table 2 — Tensile strength grades of inner wires of dual tensile ropes

Rope grade designation relating to inner wires (nominal value)	Range of wire tensile strength grades N/mm^2
1570	1370 to 1770
1770	1570 to 1960
1960	1770 to 1960

4.1.2 Core

4.1.2.1 General

The core shall be one of the following types:

a) fibre;

b) steel;

c) steel-based composite, i.e. steel plus fibre or steel plus polymer;

d) non-metallic, other than fibre-only.

Because of the large variety of existing designs, such as those prescribed by c) and d), these core types should be the subject of negotiation between purchaser and manufacturer.

4.1.2.2 Fibre core

Fibre cores, before rope making, shall conform to ISO 4345 and, for rope diameters 8 mm and above, shall be doubly closed (i.e. from yarn into strand and from strand into rope).

Natural fibre cores shall be manufactured from new sisal or manila vegetable fibre and, when measured before rope closing in accordance with Annex C of ISO 4345:1988, shall have a lubricant content of 10 % to 15 % by weight of the dry fibre material.

Man-made fibre cores shall be manufactured from polypropylene, polyethylene, polyester or polyamide and, when measured before rope closing in accordance with Annex C of ISO 4345:1988, shall have a lubricant content of 4 % to 10 % by weight of the dry fibre material.

The lubricant and/or impregnating compound used in the manufacture of the fibre core shall be compatible with the lubricant used in rope making.

4.1.2.3 Steel core

Steel cores for ropes larger than 7 mm diameter shall be an independent wire rope.

4.1.3 Lubricant

The lubricant shall be in accordance with ISO 4346.

4.2 Rope manufacture

4.2.1 General

All the wires in a strand shall have the same direction of lay.

In a new rope under tension on the closing machine, there shall be clearance between the outer strands.

The completed rope shall be evenly laid and free from loose wires, distorted strands and other irregularities.

When uncoiled, and under no load, the rope shall not be wavy.

Unless otherwise specified, the rope shall be of bright wire. Galvanized wire ropes shall be subject to agreement between purchaser and supplier.

For galvanized ropes, all the wires shall be galvanized, including those of a steel core where applicable.

4.2.2 Wire joints

Wires over 0,4 mm diameter shall, where necessary, have their ends joined by brazing or welding.

Wires up to and including those of 0,4 mm diameter shall, where necessary, be joined by brazing or welding or simply by ends being inserted into their correct position in the strand's formation.

4.2.3 Fibre core joints

Joints in fibre cores shall be made by splicing.

4.2.4 Lubrication

All of the strands of suspension and compensating ropes shall be lubricated during the stranding process. No lubricant shall be applied during the final closing of the rope.

4.2.5 Preformation and postformation

The rope shall be preformed and/or postformed unless specified otherwise by the purchaser.

4.2.6 Prestretching load limit

Where rope is supplied in the prestretched condition, in order to avoid rope damage, the maximum load to which the rope shall be subjected during the prestreching process shall not exceed 55 % of the minimum breaking force of the rope. The loading may be through static or dynamic means.

4.2.7 Rope ends

The rope ends shall be secured such that they are prevented from unlaying.

4.2.8 Rope construction

The rope construction or class shall be agreed between purchaser and manufacturer and shall be

a) one of the more common rope constructions or classes covered by Tables A.1 to A.5, or

b) another single layer or parallel closed construction not covered by the tables but having no less than six or more than nine outer strands, or

c) another stranded rope construction other than those covered by a) and b).

Where only the class is specified by the purchaser, the construction shall be decided by the manufacturer.

NOTE 1 Each class of rope consists of a number of strand constructions, e.g. 8 × 19 class comprises 8 × 19W (1-6-6+6), 8x19S (1-9-9), 8x21F (1-5-5F-10) and 8x25F (1-6-6F-12).

NOTE 2 Tables A.1, A.2, A.3 and A.4 apply to ropes for suspension and governor duties.

NOTE 3 Tables A.1, A.2 ,A 3, A.4 and A.5 apply to compensating ropes.

4.2.9 Rope grade

4.2.9.1 General

The rope grade shall reflect the tensile strength grades of the outer and inner wires respectively.

EXAMPLE 1 Dual tensile rope grade 1180/1770 represents wire tensile strength grade 1 180 N/mm^2 for the outer wires and wire tensile strength grade 1 770 N/mm^2 for the inner wires

EXAMPLE 2 Single tensile rope grade 1570 represents wire tensile strength grade 1 570 N/mm^2 for both the outer and inner wires (see Table 2).

For the more common classes of rope, the rope grade value R_r, shall be used in the calculation of minimum breaking force of single tensile ropes, and the rope grade value R_{dt} shall be used in the calculation of minimum breaking force of dual tensile ropes. See Annex B for values of R_{dt}.

The rope grades for the various duties shall be in accordance with 4.2.9.2 to 4.2.9.4.

NOTE For other rope grades not following the system given above, see Annex D, which also gives guidance for equivalence.

4.2.9.2 Suspension ropes

Suspension ropes shall be of the following grades.

a) For traction drive lifts (see Tables A.1 to A.3 and Table A.5):

- rope with fibre core: 1180/1770, 1320/1620, 1370/1770, 1570, 1620, 1770;
- rope with steel core and parallel closed ropes: 1370/1770, 1570/1770, 1570, 1770.

b) For roped hydraulic lifts (see Tables A.1 and A.4):

- rope with fibre core: 1370/1770, 1570, 1770, 1320/1620 and 1620;
- rope with steel core and parallel closed ropes: 1370/1770, 1570/1770, 1770.

4.2.9.3 Governor ropes

Governor ropes shall be of the following grades: 1180/1770, 1320/1620, 1370/1770, 1570, 1620, 1770, 1960. See Tables A.1, A.2 and A.3.

4.2.9.4 Compensating ropes

Compensating ropes shall have rope grades in accordance with 4.2.9.2, plus 1960 grade. See Tables A.1 to A.5.

4.2.10 Type and direction of lay

The direction and type of lay shall be one of the following:

a) right ordinary lay (sZ)[2)];

b) left ordinary lay (zS)[3)];

c) right lang lay (zZ)[4)];

d) left lang lay (sS)[5)] .

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2) Formerly referred to as right hand ordinary (designated RHO) and right regular lay (designated RRL)

3) Formerly referred to as left hand ordinary (designated LHO) and left regular lay (designated LRL).

4) Formerly referred to as right hand Langs (designated RHL) or right langs lay (designated RLL).

5) Formerly referred to as left hand Langs (designated LHL) or left lang lay (designated LLL).

The type and direction of lay shall be right ordinary lay (sZ), unless specified otherwise by the purchaser.

4.2.11 Lay length

The lay length of the completed rope shall not exceed 6,75 times the nominal rope diameter.

4.3 Rope designation and classification

Rope classification and designation shall conform to the system requirements of ISO 17893.

4.4 Dimensions

4.4.1 Diameter

4.4.1.1 General

The nominal diameter shall be the dimension by which the rope is designated.

4.4.1.2 Tolerances

When measured in accordance with 5.3, the measured diameter of the rope shall not vary from the nominal diameter when measured under no load, and, when measured under a load equivalent to either 5 % or 10 % of the minimum breaking force of the rope, shall not vary by more than the tolerances given in Tables 3 to 5, as appropriate.

Table 3 — Tolerances on diameter for suspension ropes for traction drive lifts and governor ropes with cores of fibre or other non-metallic materials

Nominal rope diameter d mm	Diameter tolerance as percentage of nominal rope diameter		
	Max. at no load	Min. at 5 % of F_{min}	Min. at 10 % of F_{min}
$\leqslant 10$	$+6$	$+1$	0
> 10	$+5$	$+1$	0

Table 4 — Tolerances on diameter for suspension ropes of traction drive lifts and governor ropes with steel or steel-based composite cores (including parallel closed ropes)

Nominal rope diameter d mm	Diameter tolerance as percentage of nominal rope diameter		
	Max. at no load	Min. at 5 % of F_{min}	Min. at 10 % of F_{min}
$\leqslant 10$	$+3$	0	-1
> 10	$+2$	0	-1

Table 5 — Tolerances on diameter for suspension ropes of roped hydraulic lifts and compensating ropes

Nominal rope diameter d mm	Diameter tolerance as percentage of nominal diameter
$6 \leqslant d < 8$	$^{+6}_{0}$
$\geqslant 8$	$^{+5}_{0}$

4.4.1.3 Permissible differences in diameter

The difference between any two of the four measurements when measured in accordance with 5.3 at a load equivalent to 5 % or 10 % of the minimum breaking force shall not exceed the values given in Table 6 for ovality.

The difference between the average of the two measurements taken at each of the two positions when measured in accordance with 5.3 at a load equivalent to 5 % or 10 % of the minimum breaking force shall not exceed the values given in Table 6 for average diameter variation.

Table 6 — Permissible differences in diameter

Nominal rope diameter d mm	Permissible difference (ovality) % of d	Average diameter variation % of d
< 8	4	3
$\geqslant 8$	3	2

4.4.2 Length

The actual length of rope under no load shall be the specified length subject to the following tolerances:

a) $\leqslant$ 400 m: $^{+5}_{0}$ %;

b) $>$ 400 m and $\leqslant$ 1 000 m: $^{+20}_{0}$ m;

c) $>$ 1 000 m: $^{+2}_{0}$ %.

4.5 Minimum breaking force

The minimum breaking force, F_{min}, for a given diameter, construction or class and rope grade shall be either

a) as given in Tables A.1 to A.5, or

b) as stated by the manufacturer.

For those rope classes covered by Tables A.1 to A.5, the minimum breaking forces of intermediate rope diameters shall be calculated using the formula given in Annex B, with the respective minimum breaking force factors given in Tables A.1 to A.5.

When tested in accordance with 5.4.1, the measured breaking force F_m shall be greater than or equal to the minimum breaking force F_{min}.

Breaking force testing shall be in accordance with Table 7.

NOTE The requirements for breaking force testing take into account whether or not ropes are produced in series, i.e. repeatedly produced, whether or not the minimum breaking force factor is consistent throughout a subgroup of diameters, and whether or not the manufacturer is operating a quality management system in accordance with ISO 9001 certified by an accredited third-party certification body.

Table 7 — Breaking force testing requirements

Minimum breaking force factor	Manufacturer operating quality management system in accordance with ISO 9001:2000 certified by an accredited third-party certification body	Manufacturer NOT operating quality management system in accordance with ISO 9001:2000 certified by an accredited third-party certification body
Same factor throughout a subgroup of rope diameters	Breaking force test in accordance with 5.4.1 on a sample from each production length; or, if produced in series, type testing in accordance with 5.4.2.1 plus periodic breaking force test in accordance with 5.4.1 on a sample from every twentieth production length relating to the subgroup of rope diameters.	Breaking force test in accordance with 5.4.1 on a sample from each production length
Different factor throughout a subgroup of rope diameters	Breaking force test in accordance with 5.4.1 on a sample from each production length; or, if produced in series, type testing in accordance with 5.4.2.2 plus periodic breaking force test in accordance with 5.4.1 on a sample from every twentieth production length of a given rope diameter and construction.	
NOTE Breaking force type testing demonstrates that a steel wire rope produced in series and certified by the manufacturer in accordance with this International Standard possesses the minimum breaking force stated by the manufacturer. The purpose of these tests is to prove the design, material and method of manufacture.		

5 Verification of safety requirements and/or measures

5.1 Materials

Compliance with the wire, core and lubricant requirements shall be through a visual verification of the inspection documents supplied with the wire, core and lubricant, respectively.

5.2 Rope manufacture

Compliance with the requirements for wire joints, fibre core joints, preformation, prestretching and rope ends shall be through visual verification.

5.3 Test on rope for diameter

Diameter measurements shall be taken on a straight portion of rope under two conditions — under no tension and under a tension of either 5 % or 10 % of the minimum breaking force — at two positions spaced at least 1 m apart. At each position, two measurements, at right angles of the circumscribed circle diameter, shall be taken. The measuring equipment shall cover at least two adjacent strands.

For each of the loading conditions, the average of these measurements shall be within the tolerances given in 4.4.1.2 and 4.4.1.3.

The maximum deviation of the measuring equipment shall not be greater than ± 0,02 mm for ropes up to and including 25 mm diameter, and ± 0,05 mm for ropes over 25 mm diameter.

5.4 Test on rope for breaking force

5.4.1 Method of test

The test method shall be in accordance with ISO 3108, except for the following:

a) the minimum free test length, excluding any rope terminations, shall be 600 mm or 30 × nominal rope diameter, whichever is the greater;

b) after 80 % of the minimum breaking force has been applied, the force shall be increased at a rate of not more than 0,5 % of the minimum breaking force per second;

c) the test may be terminated without breaking the rope when the minimum breaking force is achieved or exceeded;

d) the test may be discounted where the rope fractures within a distance equivalent to six rope diameters from the base of the grip or the termination and the minimum breaking force value has not been reached;

e) when the minimum breaking force value is not reached, up to three additional tests are permitted, one of which shall achieve or exceed the minimum breaking force value.

5.4.2 Sampling and acceptance criteria for type testing of ropes produced in series

5.4.2.1 Ropes having same minimum breaking force factor throughout a subgroup of rope diameters

The manufacturer shall divide the intended range into subgroups based on the following:

— from 6 mm up to and including 12 mm;

— over 12 mm up to and including 24 mm;

— over 24 mm up to and including 38 mm.

For each of the subgroups representing the intended range and having the same construction, grade and minimum breaking force factor throughout the band, the manufacturer shall perform a breaking force test in accordance with 5.4.1 on a sample from each of three separate production lengths of rope of different nominal diameters.

If all three samples pass the test, all rope sizes within the subgroup of that particular rope construction, grade and minimum breaking force factor shall be deemed to have satisfied the type testing requirements; otherwise, breaking force testing shall continue on a sample from each consecutive production length of rope within that subgroup until the above requirements are met.

5.4.2.2 Ropes having different minimum breaking force factors throughout a subgroup of rope diameters

The manufacturer shall perform a breaking force test in accordance with 5.4.1 on a sample from each of three separate production lengths of rope of the same nominal diameter.

If all three samples pass the test, the rope with the nominal rope diameter and construction having that particular minimum breaking force factor shall be deemed to have satisfied the breaking force type testing requirements.

If one of the samples fails the test, the tests shall be repeated until the measured breaking forces of three consecutive production lengths of that rope diameter and construction meet or exceed the minimum breaking force value.

6 Information for use

6.1 Certificate

6.1.1 General

A certificate shall be used to confirm conformance to this International Standard.

The certificate shall give at least the following information:

a) certificate number;

b) name and address of manufacturer;

c) rope designation (including nominal rope diameter, construction and grade);

d) minimum breaking force;

e) date of issue of certificate and authentication.

The certificate shall enable traceability of the rope.

The manufacturer shall give guidance in the certificate about rope lubricants for maintenance, compatible with the lubricants used for rope manufacture.

The issuing of a certificate by the manufacturer and the question of whether or not test results are given should be the subject of agreement between purchaser and manufacturer.

6.1.2 Test results

When the results of the tests are required to be confirmed, the certificate shall, additionally, give the measured breaking force of the rope.

6.2 Discard criteria

See Annex E for general guidance on discard criteria.

6.3 Marking

The rope manufacturer's name and address, and the rope length, designation and, if appropriate, certificate number (see 6.1.1), shall be legibly and durably marked on either a tag attached to the rope or label attached to the reel.

Annex A
(normative)

Tables of minimum breaking force values for the more common classes, diameters and grades of ropes

This annex gives tables of minimum breaking force values for the more common classes, diameters and grades of ropes.

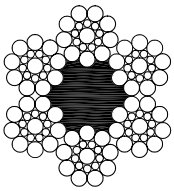
See Annex B for the formula for calculating minimum breaking force, including that for intermediate nominal rope diameters.

NOTE 1 For information, values are given for approximate nominal rope length mass.

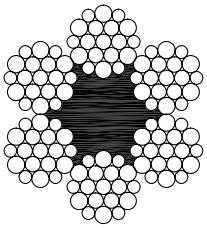
NOTE 2 See Annex C for the calculation of approximate nominal rope length mass, metallic area and approximate outer wire diameter using the respective factors given in the tables

Table A.1 — Lift rope class 6 x 19 with fibre core of bright or zinc coated (Quality B) wire

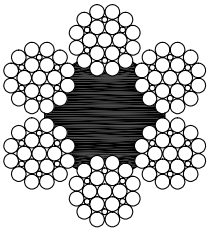
Construction cross section example



6 × 19 Seale + fibre core



6 × 19 Warrington + fibre core



6 × 25 Filler + fibre core

Construction of rope		Construction of strand	
Item	**Quantity**	**Item**	**Quantity**
Strands	6	Wires	19 to 25
Outer strands	6	Outer wires	19 to 12
Layers of strands	1	Layers of wires	2
Wires in rope	114 to 150		

Typical examples		No. of outer wires			Outer wire factor[a]
Rope	**Strand**	**Total**	**Per strand**		a
6 × 19 S	1-9-9	54	9		0,080
6 × 19 W	1-6-6+6	72	12	6	0,073 8
				6	0,055 6
6 × 25 F	1-6-6F-12	72	12		0,064

Min. breaking force factor	$K_1 = 0{,}330$
Length mass factor [a]	$W_1 = 0{,}359$
Nominal metallic cross-sectional area factor [a]	$C_1 = 0{,}384$

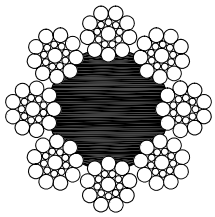
Nominal rope diameter	Approximate nominal length mass[a]	Minimum breaking force (kN)						
		Dual tensile				Single tensile		
mm	kg/100 m	Rope grade 1180/1770	Rope grade 1320/1620	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1620	Rope grade 1770
6	12,9	16,3	16,8	17,8	19,5	18,7	19,2	21,0
6,3	14,2	17,9	—	—	21,5	—	21,2	23,2
6,5 [b]	15,2	19,1	19,7	20,9	22,9	21,9	22,6	24,7
8 [b]	23,0	28,9	29,8	31,7	34,6	33,2	34,2	37,4
9	29,1	36,6	37,7	40,1	43,8	42,0	43,3	47,3
9,5	32,4	40,8	42,0	44,7	48,8	46,8	48,2	52,7
10 [b]	35,9	45,2	46,5	49,5	54,1	51,8	53,5	58,4
11 [b]	43,4	54,7	56,3	59,9	65,5	62,7	64,7	70,7
12	51,7	65,1	67,0	71,3	77,9	74,6	77,0	84,1
12,7	57,9	72,9	75,0	79,8	87,3	83,6	86,2	94,2
13 [b]	60,7	76,4	78,6	83,7	91,5	87,6	90,3	98,7
14	70,4	88,6	91,2	97,0	106	102	105	114
14,3	73,4	92,4	—	—	111	—	—	119
15	80,8	102	—	111	122	117	—	131
16 [b]	91,9	116	119	127	139	133	137	150
17,5	110	138	—	—	166	—	—	179
18	116	146	151	160	175	168	173	189
19 [b]	130	163	168	179	195	187	193	211
20	144	181	186	198	216	207	214	234
20,6	152	192	—	—	230	—	—	248
22 [b]	174	219	225	240	262	251	259	283

[a] Informative only, see also Annex C.

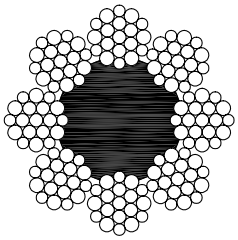
[b] Preferred size for new lifts.

Table A.2 — Lift rope class 8 x 19 with fibre core of bright or zinc coated (Quality B) wire

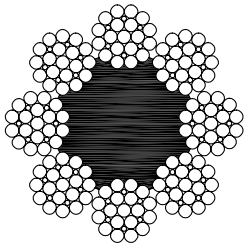
Construction cross section example



8 × 19 Seale + fibre core



8 × 19 Warrington + fibre core



8 × 25 Filler + fibre core

Construction of rope		Construction of strand	
Item	**Quantity**	**Item**	**Quantity**
Strands	8	Wires	19 to 25
Outer strands	8	Outer wires	9 to 12
Layers of strands	1	Layers of wires	2
Wires in rope	152 to 200		

Typical examples		No. of outer wires			Outer wire factor[a] a
Rope	**Strand**	**Total**	**Per strand**		
8 × 19 S	1-9-9	72	9		0,065 5
8 × 19 W	1-6-6+6	96	12	6	0,060 6
				6	0,045 0
8 × 25 F	1-6-6F-12	96	12		0,052 5

Min. breaking force factor	$K_1 = 0{,}293$
Length mass factor [a]	$W_1 = 0{,}340$
Nominal metallic cross-sectional area factor [a]	$C_1 = 0{,}349$

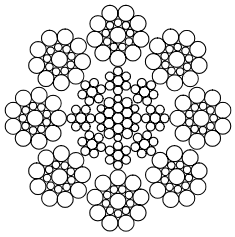
Nominal rope diameter	Approximate nominal length mass[a]	Minimum breaking force (kN)						
		Dual tensile				Single tensile		
mm	kg/100 m	Rope grade 1180/1770	Rope grade 1320/1620	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1620	Rope grade 1770
8[b]	21,8	25,7	26,5	28,1	30,8	29,4	30,4	33,2
9	27,5	32,5	—	35,6	38,9	37,3	—	42,0
9,5	30,7	36,2	37,3	39,7	43,6	41,5	42,8	46,8
10[b]	34,0	40,1	41,3	44,0	48,1	46,0	47,5	51,9
11[b]	41,1	48,6	50,0	53,2	58,1	55,7	57,4	62,8
12	49,0	57,8	59,5	63,3	69,2	66,2	68,4	74,7
12,7	54,8	64,7	66,6	70,9	77,5	74,2	76,6	83,6
13[b]	57,5	67,8	69,8	74,3	81,2	77,7	80,2	87,6
14	66,6	78,7	81,0	86,1	94,2	90,2	93,0	102
14,3	69,5	82,1	—	—	98,3	—	—	—
15	76,5	90,3	—	98,9	108	104	—	117
16[b]	87,0	103	106	113	123	118	122	133
17,5	104	123	—	—	147	—	—	—
18	110	130	134	142	156	149	154	168
19[b]	123	145	149	159	173	166	171	187
20	136	161	165	176	192	184	190	207
20,6	144	170	—	—	204	—	—	—
22[b]	165	194	200	213	233	223	230	251

[a] Informative only, see also Annex C.

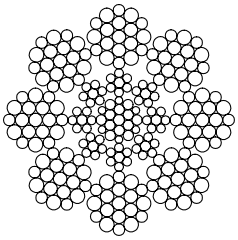
[b] Preferred size for new lifts.

Table A.3 — Lift rope class 8 x 19 with steel core of bright or zinc coated (Quality B) wire

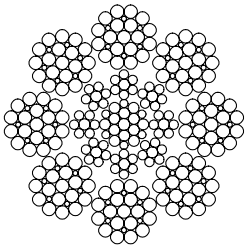
Construction cross section example



8 × 19 Seale + steel core



8 × 19 Warrington + steel core



8 × 25 Filler + steel core

Construction of rope			Construction of strand	
Item		Quantity	Item	Quantity
Strands		8	Wires	19 to 25
Outer strands		8	Outer wires	9 to 12
Layers of strands		1	Layers of wires	2
Wires in outer strands		152 to 200		

Typical examples		No. of outer wires			Outer wire factor[a] a
Rope	Outer strand	Total	Per strand		
8 × 19 S	1-9-9	72	9		0,065 5
8 × 19 W	1-6-6+6	96	12	6	0,060 6
				6	0,045 0
8 × 25 F	1-6-6F-12	96	12		0,052 5

Min. breaking force factor	$K_2 = 0{,}356$
Length mass factor [a]	$W_2 = 0{,}040\ 7$
Nominal metallic cross-sectional area factor [a]	$C_2 = 0{,}457$

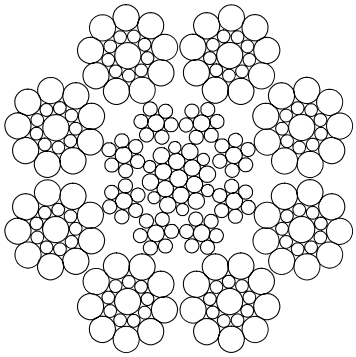
Nominal rope diameter	Approximate nominal length mass[a]	Minimum breaking force (kN)				
		Dual tensile			Single tensile	
mm	Kg/100 m	Rope grade 1180/1770	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1770
8[b]	26,0	33,6	35,8	38,0	35,8	40,3
9	33,0	42,5	45,3	48,2	45,3	51,0
9,5	36,7	47,4	50,4	53,7	50,4	56,9
10[b]	40,7	52,5	55,9	59,5	55,9	63,0
11[b]	49,2	63,5	67,6	71,9	67,6	76,2
12	58,6	75,6	80,5	85,6	80,5	90,7
12,7	65,6	84,7	90,1	95,9	90,1	102
13[b]	68,8	88,7	94,5	100	94,5	106
14	79,8	102	110	117	110	124
15	91,6	118	126	134	126	142
16[b]	104	134	143	152	143	161
18	132	170	181	193	181	204
19[b]	147	190	202	215	202	227
20	163	210	224	238	224	252
22[b]	197	254	271	288	271	305

[a] Informative only, see also Annex C.

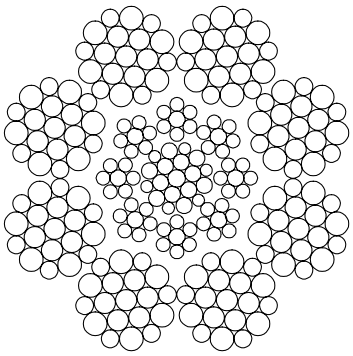
[b] Preferred size for new lifts.

Table A.4 — Lift rope 8 x 19 parallel closed of bright or zinc coated (Quality B) wire

Construction cross section example



8 × 19 Seale parallel closed



8 × 19 Warrington parallel closed

Construction of rope		Construction of strand	
Item	**Quantity**	**Item**	**Quantity**
Strands	8	Wires	19 to 25
Outer strands	8	Outer wires	9 to 12
Layers of strands	1	Layers of wires	2
Wires in outer strands	201 to 307		

Typical examples		No. of outer wires			Outer wire factor[a] a
Rope	**Outer strand**	**Total**	**Per strand**		
8 × 19 S	1-9-9	72	9		0,065 5
8 × 19 W	1-6-6+6	96	12	6	0,060 6
				6	0,045 0
8 × 25 F	1-6-6F-12	96	12		0,052 5

Min. breaking force factor	$K_2 = 0{,}405$
Length mass factor [a]	$W_2 = 0{,}457$
Nominal metallic cross-sectional area factor [a]	$C_2 = 0{,}488$

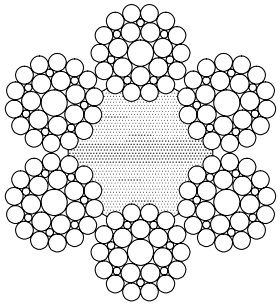
Nominal rope diameter	**Approximate nominal length mass** [a]	**Minimum breaking force** (kN)				
		Dual tensile			**Single tensile**	
mm	kg/100 m	Rope grade 1180/1770	Rope grade 1370/1770	Rope grade 1570/1770	Rope grade 1570	Rope grade 1770
8	29,2	38,2	40,7	43,3	40,7	45,9
9	37,0	48,4	51,5	54,8	51,5	58,1
9,5	41,2	53,9	57,4	61,0	57,4	64,7
10[b]	45,7	59,7	63,6	67,6	63,6	71,7
11[b]	55,3	72,3	76,9	81,8	76,9	86,7
12	65,8	86,0	91,6	97,4	91,6	103
12,7	73,7	96,4	103	109	103	116
13[b]	77,2	101	107	114	107	121
14	89,6	117	125	133	125	141
15	103	134	143	152	143	161
16[b]	117	153	163	173	163	184
18	148	194	206	219	206	232
19[b]	165	216	230	244	230	259
20	183	239	254	271	254	287
22[b]	221	289	308	327	308	347

[a] Informative only, see also Annex C.

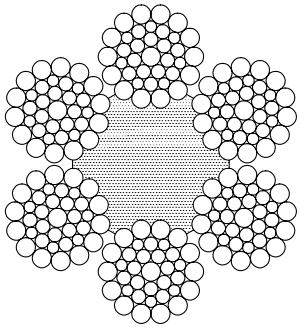
[b] Preferred size for new lifts.

Table A.5 — Compensating rope for bigger diameter of bright or zinc coated (Quality B) wire

Construction cross section example



6 × 29 Filler + fibre core



6 × 36 Warrington Seale + fibre core

Construction of rope			Construction of strand	
Item		**Quantity**	**Item**	**Quantity**
Strands		6	Wires	25 to 41
Outer strands		6	Outer wires	12 to 16
Layers of strands		1	Layers of wires	2 to 3
Wires in rope		150 to 246		
Typical examples		**No. of outer wires**		**Outer wire factor**[a] a
Rope	**Strand**	**Total**	**Per strand**	
6 × 29 F	1-7-7F-14	84	14	0,056
6 × 36WS	1-7-7+7-14			
Rope class 6 × 36				
Min. breaking force factor		$K_1 = 0{,}330$		
Length mass factor [a]		$W_1 = 0{,}367$		
Nominal metallic cross-sectional area factor [a]		$C_1 = 0{,}393$		

Nominal rope diameter mm	**Approximate nominal length mass** [a] kg/100 m	**Rope class**	**Minimum breaking force** (kN) Rope grade 1570	Rope grade 1770	Rope grade 1960
24	211	6 × 36 class (includes 6 × 36 WS and 6 × 29 F)	298	336	373
25	229		324	365	404
26	248		350	395	437
27	268		378	426	472
28	288		406	458	507
29	309		436	491	544
30	330		466	526	582
31	353		498	561	622
32	376		531	598	662
33	400		564	636	704
34	424		599	675	748
35	450		635	716	792
36	476		671	757	838
37	502		709	800	885
38	530		748	843	934

[a] For information only.

Annex B
(normative)

Calculation of minimum breaking force

The minimum breaking force for the ropes covered by Tables A.1 to A.5, F_{min}, expressed in kilonewtons, shall be calculated as follows:

$$F_{min} = \frac{d^2 \times R_r \times K}{1\,000}$$

where

d is the nominal rope diameter, in millimetres;

R_r is the rope grade, in newtons per square millimetre — for dual tensile ropes, the values of R_{dt} in Table B.1 shall apply;

K is the minimum breaking force factor.

NOTE For ropes with fibre cores, the minimum breaking force factors K_1 are as given in Tables A.1, A.2 and A.5. For 8×19 with steel core, the minimum breaking force factor K_2 is as given in Table A.3. For 8×19 parallel closed, the minimum breaking force factor K_2 is as given in Table A.4.

Table B.1 — Values of R_{dt} for dual tensile ropes

Rope grade	Rope class	R_{dt}
1180/1770	6×19 and 8×19 with fibre core	1 370
1180/1770	8×19 with steel core	1 475
1180/1770	8×19 parallel closed	1 475
1320/1620	6×19 and 8×19 with fibre core	1 410
1370/1770	6×19 and 8×19 with fibre core	1 500
1370/1770	8×19 with steel core	1 570
1370/1770	8×19 parallel closed	1 570
1570/1770	6×19 and 8×19 with fibre core	1 640
1570/1770	8×19 with steel core	1 670
1570/1770	8×19 parallel closed	1 670

Annex C
(informative)

Calculation of approximate rope length mass, nominal metallic cross-sectional area and approximate outer wire size

C.1 General

The approximate length mass, nominal metallic cross-sectional area and approximate outer wire diameter may be calculated using the formulae in C.2 to C.4, where

d is the nominal rope diameter, in millimetres;

W is the nominal rope length mass factor for a lubricated rope of a given construction (W_1 is the factor for ropes with a fibre core and W_2 is the factor for ropes with a steel core);

C is the factor for the nominal metallic cross-sectional area (C_1 is the factor for ropes with a fibre core and C_2 is the factor for ropes with a steel core);

a is the factor used in the determination of the approximate nominal outer wire diameter for a given rope construction.

C.2 Approximate nominal rope length mass

$$M = W \times d^2$$

expressed in kilograms per 100 m.

C.3 Nominal metallic cross-sectional area

$$A = C \times d^2$$

expressed in square millimetres.

C.4 Approximate outer wire diameter

$$\delta_a = a \times d$$

expressed in millimetres.

Annex D
(informative)

Comparison of imperial and metric rope sizes, grades and minimum breaking forces

This Annex compares metric rope sizes, grades and minimum breaking forces relating to this International Standard with imperial rope sizes and other known grades for the more common classes of rope.

It is given to assist in ensuring that existing levels of safety are maintained, particularly when equivalent ropes are being selected.

Table D.1 covers rope class 6 × 19 with fibre core.

Table D.2 covers rope class 8 × 19 with fibre core.

Table D.3 covers rope class 8 × 19 with steel core.

Table D.4 covers rope grade equivalents.

Table D.1 — Lift rope class 6 × 19 with fibre core — Imperial sizes, grades, minimum breaking forces and equivalent metric ropes

Nominal diameter		Equivalent nominal dia in Table A.1	Imperial rope		Equivalent rope		Imperial rope		Equivalent rope		Approximate nominal rope length mass			
Imperial	Exact conversion		F_{min} with rope grade traction steel		F_{min} with rope grade 1180/1770		F_{min} with rope grade EHS[a]		F_{min} with rope grade 1770		Imperial size rope		Equivalent metric size rope	
in	mm	mm	lb	kN	lb	kN	lb	kN	lb	kN	lb/ft	kg/100 m	lb/ft	kg/100 m
1/4	6,35	6,3	3 600	16,0	4 300	19,1	5 200	23,1	5 560	24,7	0,10	15	0,10	15,2
5/16	7,94	8	5 600	24,9	6 500	28,9	8 100	36,0	8 410	37,4	0,16	24	0,15	23,0
3/8	9,53	9,5	8 200	36,5	9 180	40,8	11 600	51,6	11 860	52,7	0,23	34	0,22	32,4
7/16	11,1	11	11 000	48,9	12 310	54,7	15 700	69,8	15 910	70,7	0,31	46	0,30	43,4
1/2	12,7	12,7	14 500	64,5	16 400	72,9	20 400	90,7	19 640	87,3	0,40	60	0,39	57,9
9/16	14,3	14,3	18 500	82,3	20 790	92,4	25 700	114	26 780	119	0,51	76	0,49	73,4
5/8	15,9	16	23 000	102	26 080	116	31 600	141	33 720	150	0,63	94	0,62	91,9
11/16	17,5	17,5	27 000	120	31 050	138	38 200	170	40 280	179	0,76	113	0,74	110
3/4	19,1	19	32 000	142	26 640	163	45 200	201	47 430	211	0,90	134	0,87	130
13/16	20,6	20,6	37 000	165	43 200	192	52 900	235	55 800	248	1,06	158	1,02	152
7/8	22,2	22	42 000	187	49 230	219	61 200	272	63 620	283	1,23	183	1,17	174

[a] Extra high strength traction steel.

Table D.2 — Lift rope class 8 × 19 with fibre core - imperial sizes, grades, minimum breaking forces and equivalent metric ropes

Nominal diameter		Equivalent nominal dia in Table A.2	Imperial rope		Equivalent rope		Imperial rope		Equivalent rope		Approximate nominal rope length mass			
Imperial	Exact conversion		F_{min} with rope grade traction steel		F_{min} with rope grade 1180/1770		F_{min} with rope grade EHS[a]		F_{min} with rope grade 1570/1770		Imperial size rope		Equivalent metric size rope	
in	mm	mm	lb	kN	lb	kN	lb	kN	lb	kN	lb/ft	kg/100 m	lb/ft	kg/100 m
1/4	6,35	6,3	3 600	16,0			4 500	20,0			0,09	14		
5/16	7,94	8	5 600	24,9	5 780	25,7	6 900	30,7	7 460	33,2	0,14	21	0,15	21,8
3/8	9,53	9,5	8 200	36,5	8 150	36,2	9 900	44,0	9 800	43,6	0,20	30	0,21	30,7
7/16	11,1	11	11 000	48,9	10 930	48,2	13 500	60,1	13 060	58,1	0,28	42	0,28	41,1
1/2	12,7	12,7	14 500	64,5	14 560	64,7	17 500	77,8	17 420	77,5	0,36	54	0,37	54,8
9/16	14,3	14,3	18 500	82,3	18 460	82,1	22 100	98,3	22 100	98,3	0,46	68	0,47	69,5
5/8	15,9	16	23 000	102	23 150	103	27 200	121	27 650	123	0,57	84	0,59	87,0
11/16	17,5	17,5	27 000	120	27 650	123	32 800	146	33 050	147	0,69	103	0,70	104
3/4	19,1	19	32 000	142	32 600	145	38 900	173	38 890	173	0,82	122	0,83	123
13/16	20,6	20,6	37 000	165	38 200	170	46 000	205	45 860	204	0,96	143	0,97	144
7/8	22,2	22	42 000	187	43 610	194	52 600	234	52 380	233	1,11	165	1,11	165

[a] Extra high strength traction steel.

Table D.3 — Lift rope class 8 × 19 with steel core - imperial sizes, grades, minimum breaking forces and equivalent metric ropes

Nominal diameter		Equivalent nominal dia in Table A.3	Imperial rope	Equivalent rope	Imperial rope	Equivalent rope	Approximate nominal rope length mass	
Imperial	Exact conversion		F_{min} with rope grade traction steel	F_{min} with rope grade 1180/1770	F_{min} with rope grade EHS[a]	F_{min} with rope grade 1570/1770	Imperial size rope	Equivalent metric size rope
inch	mm	mm	lb	kN	lb	kN	lb/ft	kg/100 m
5/16	7,94	8	7 560	33,6	8 560	38,0	0,18	26,0
3/8	9,53	9,5	10 660	47,4	12 070	53,7	0,25	36,7
7/16	11,1	11	14 300	63,5	16 190	71,9	0,33	49,2
1/2	12,7	12,7	19 060	84,7	21 580	95,9	0,44	65,6
5/8	15,9	16	30 250	134	34 240	152	0,70	104
3/4	19,1	19	42 650	190	48 290	215	0,99	147
7/8	22,2	22	57 180	254	64 740	288	1,33	197

[a] Extra high strength traction steel.

Table D.4 — Rope grade equivalents

Rope grade designation	Equivalent
Traction steel	Single tensile 1570, dual tensile 1180/1770 and 1370/1770
Extra high strength traction steel (EHS)	Single tensile 1770, dual tensile 1570/1770 and 1770/1960
Grade E	Dual tensile 1320/1620
Grade A	Single tensile 1620

Annex E
(informative)

Discard criteria for lift ropes

E.1 General

Lift ropes are usually discarded because of broken wires and wear, but other factors, such as reduction in diameter, corrosion or excessive stretch, may also give rise to discard.

The competent person should take all these factors into account when carrying out a thorough examination in order to decide if a set of ropes is fit to remain in service or should be discarded.

Even if only one rope has reached discard criteria, the whole set should be replaced except in those cases where a rope is damaged either during installation or acceptance testing prior to being put into lift service (see E.6).

In the absence of any national regulations or instruction from the original equipment manufacturer, the following is a general guide to discard.

In the case of ropes operating in sheaves of other than cast iron or steel, the competent person should be aware of the possibility of more advanced internal deterioration occurring than that which might be visually obvious from the outside.

E.2 Broken wires

Table E.1 indicates the number of visible broken wires in the worst section of a single layer rope with a fibre core within the set at which replacement or next examination should take place within a specified period and at which replacement should take place immediately. The values apply to suspension ropes, governor ropes and compensating ropes.

For other types of rope, guidance on the number of visible broken wires should be provided by the rope manufacturer.

Table E.1 — Number of visible broken wires — Single layer ropes with fibre cores operating in cast iron or steel sheaves

Condition	Replace ropes or examine within a specified period as stated by the competent person		Discard ropes immediately	
	Class 6 × 19 FC	Class 8 × 19 FC	Class 6 × 19 FC	Class 8 × 19 FC
Broken wires randomly distributed among the outer strands	More than 12 per rope lay [a]	More than 15 per rope lay [a]	More than 24 per rope lay [a]	More than 30 per rope lay [a]
Broken wires predominating in one or two outer strands	More than 6 per rope lay [a]	More than 8 per rope lay [a]	More than 8 per rope lay [a]	More than 10 per rope lay [a]
Adjacent broken wires in one outer strand	4	4	More than 4	More than 4
Valley breaks	1 per rope lay [a]	1 per rope lay [a]	More than 1 per rope lay [a]	More than 1 per rope lay [a]

[a] The length of one rope lay is approximately equivalent to $6 \times d$ (where d is the nominal rope diameter).

E.3 Reduction in diameter

Replacement should be considered if the diameter is reduced by 6 % of the nominal rope diameter.

E.4 Unusual features

If unusual features are evident that might indicate the possibility of advanced internal deterioration, replacement of the ropes should be considered.

EXAMPLE 1 Fretting corrosion, where the rope exudes a red dust or rouge type material from between the strands and/or wires.

EXAMPLE 2 A local reduction in diameter.

E.5 Age

No definite guide to the life of a suspension rope can be given, but particular care should be exercised where ropes have been in service for more than ten years.

E.6 Special situation

When one suspension or compensating rope of a set has been damaged during installation or acceptance testing prior to being subjected to elevator service, it is permissible to replace a single damaged rope with a new rope, provided the following requirements are met:

a) The wire rope data for the replacement rope shall correspond to the wire rope data of the certificate of the original set of ropes.

b) The ropes of the set in question shall not have been shortened since their original installation.

c) The tension of the new replacement rope shall be checked and adjusted as necessary at semi-monthly intervals over a period of not less than two months after installation. If proper equalization of the rope tension cannot be maintained after six months, the entire set of suspension ropes shall be replaced.

d) The replacement rope shall be provided with the same type of suspension rope termination used with the other ropes.

e) The diameter of the replacement rope, under tension, should not vary from the remaining ropes by more than 0,5 % of the nominal diameter of the rope.

Annex F
(informative)

Information recommended to be provided with an enquiry or order

A purchase order for wire rope, in accordance with this International Standard, should include the following information:

a) quantity, in metres;

b) diameter, in millimetres;

c) classification or construction;

d) required minimum breaking force, if not according to standard;

e) finish, if galvanized;

f) grade (if dual tensile, both grades shall be mentioned; i.e. 1370/1770)

g) type of lay;

h) direction of lay, if other than right ordinary lay;

i) preformed or non-preformed;

j) type of core, core material;

k) reference to this International Standard by designation number and date;

l) number and type (reels or coils) of packaging unit;

m) size of package unit, in metres;

n) intended use

   1) suspension rope for

      — traction drive lift,

      — roped hydraulic lift,

   2) governor duties,

   3) compensating duties.

Bibliography

[1] ISO 9001:2000, *Quality management systems — Requirements*

ICS 77.140.65; 91.140.90

Price based on 28 pages