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Steel wire ropes for lifts — Minimum requirements

Câbles en acier pour ascenseur — Exigences minimales

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 4344:2004), which has been technically revised.

The main changes are as follows:

— added more rope grades commonly used in lifts and deleted rope grades rarely used in lifts;

— added more rope constructions commonly used in lifts;

— revised the requirement of lubricant content for rope cores;

— added the requirement of lubricant content for strands;

— revised diameter tolerances of steel core ropes;

— added the requirement of tensile strength for wires after rope making;

— added the information for rope selection, installation and maintenance;

— revised rope discard criteria.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

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

It is desirable in such cases that the equipment designer, rope manufacturer or other competent person be consulted prior to ordering a rope.

This document 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 document specifies the minimum requirements for the manufacture and testing of stranded carbon steel wire ropes for lifts, made from bright and galvanized wire finish in various constructions from 6 mm to 38 mm diameter.

It is applicable to ropes used for suspension duty on traction drive and roped hydraulic lifts, and for compensation and governor duties on passenger lifts, freight lifts, service lifts, and man lifts moving between guides.

It is not applicable to ropes for

— builder's hoists,

— temporary hoists not running between permanent guides,

— cable-ways,

— mine hoists.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 non-alloy steel wires for general purpose wire ropes, large diameter wire ropes and mine hoisting wire ropes —Specifications*

ISO 3108, *Steel wire ropes — Test method — Determination of measured breaking force*

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 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 17893, *Steel wire ropes — Vocabulary, designation and classification*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
composite steel core
CSC
wire rope core which is made of steel wires plus a fibre or polymer core

4 Requirements

4.1 Material

4.1.1 Wire

4.1.1.1 Wire properties and grades

Before rope making, wire properties shall be in accordance with ISO 4101 or ISO 2232.

Wire grades shall meet the following tensile strength grades given in Table 1.

Table 1 — Wire properties and grades

Position of wires in the rope	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	—	—	ISO 2232	ISO 2232	ISO 2232
Filler wires	ISO 4101	ISO 4101	ISO 2232	ISO 2232	ISO 2232

[a] Torsion properties are performed at 1370 MPa wire tensile strength grade.

[b] Torsion properties are performed at 1770 MPa wire tensile strength grade.

Wire grades not given in Table 1, shall be subject to agreement between the purchaser and the manufacturer.

4.1.1.2 Wire finish

Unless otherwise specified by the purchaser, the rope shall be made from bright wires.

Galvanized wire ropes shall be subject to agreement between the purchaser and the manufacturer, the level of coating shall be Class B.

4.1.2 Core

4.1.2.1 General

The core shall be one of the following types:

a) fibre core;

b) steel core;

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

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

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

4.1.2.2 Fibre core

Fibre cores (FC) including natural fibre cores (NFC), synthetic fibre cores (SFC) and solid polymer cores (SPC), shall conform to ISO 4345. Natural fibre cores and synthetic fibre cores shall be doubly closed (i.e. from yarn into strand and from strand into rope) and solid polymer cores can be one layer or multiple layers. Unless otherwise specified by the purchaser, all the fibre cores shall conform to the following requirements.

a) Natural fibre cores shall be manufactured from new sisal or manila vegetable fibre and, when measured after rope closing in accordance with Annex A or ISO 4345:1988, Annex C, shall have a lubricant content of 8 % to16 % by weight of the dry fibre material.

b) Synthetic fibre cores and solid polymer cores shall be manufactured from one or more than one of the following materials: polypropylene, polyethylene, polyester or polyamide.

   When measured after rope closing in accordance with Annex A or ISO 4345:1988, Annex C, synthetic fibre cores for suspension ropes shall have a lubricant content of 6 % to 15 % by weight of the dry material; synthetic fibre cores for governor ropes and compensating ropes shall have a lubricant content of 3 % to 10 % by weight of the dry material.

c) The lubricant used in the manufacture of the fibre core shall not affect the lubricant used in rope making.

d) Consideration of environmental humidity and temperature shall be given to potential rope abnormal elongation and shrinkage when using natural fibre core ropes for governor and compensating duties.

e) Fibre cores can include a core colour tracer for purposes of identifying the rope manufacturer, and manufacturers can add their own information on the colour tracer, might include the manufacturer's name, brand, telephone number, etc.

4.1.2.3 Steel core

Steel cores (WC) include independent wire rope cores (IWRC), parallel closed wire rope cores (PWRC) and wire strand cores (WSC).

Steel cores for ropes larger than 7 mm diameter shall not be a wire strand core.

4.1.2.4 Steel-based composite core

Typical steel-based composite cores (SCC) include composite steel cores (CSC) and polymer coated steel cores (EPIWRC).

The fibres or polymers in steel-based composite cores shall be made from one or more than one of the following materials: polypropylene, polyethylene, polyester or polyamide.

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 and in the same layer shall be of the same tensile strength grade.

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 unlaying, loose wires, distorted strands and other irregularities. Indentations caused by forming toolings, e.g. dies, preformers and postformers, are allowed.

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

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 butt welding. All welds shall be annealed.

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

The spacing between any two adjacent joints shall not be less than 18 times of the rope nominal diameter.

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, governor and compensating ropes shall be lubricated during the stranding process. Unless otherwise specified by the purchaser, no lubricant shall be applied during the final closing of the rope.

Unless otherwise specified by the purchaser, the rope shall meet the following requirements.

— For suspension and compensating ropes, when measured after rope closing in accordance with Annex A, the outer strands shall have a lubricant content of 0,6 % to 1,8 % by weight of wires.

— For governor ropes, when measured after rope closing in accordance with Annex A, the outer strands shall have a lubricant content of 0,5 % to 1,25 % by weight of wires.

4.2.5 Preformation and postformation

Unless otherwise specified by the purchaser, the ropes shall be preformed and/or postformed.

4.2.6 Prestretching load limit

Where rope is supplied in the pre-stretched condition, in order to avoid rope damage, the maximum load to which the rope shall be subjected during the pre-stretching 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 the purchaser and the manufacturer and shall be:

a) one of the more common rope constructions or classes covered by Tables B.1 to B.11 in Annex B, where

Tables B.1 to B.8 apply to suspension ropes,

Tables B.1 to B.9 apply to governor ropes,

Tables B.1 to B.11 apply to compensating ropes, or

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

c) another stranded rope construction specified by the purchaser 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 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).

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, and shall be one of the following grades. Other rope grades shall be subject to the agreement between the purchaser and the manufacturer.

4.2.9.2 Suspension ropes

Suspension ropes shall be of the following grades.

a) For traction drive lifts (see Tables B.1 to B.8):

- rope with fibre core: 1320/1620, 1370/1770, 1570/1770, 1620/1770, 1570, 1620, 1770, 1960;
- rope with steel core and parallel closed ropes: 1370/1770, 1570/1770, 1570, 1770, 1960.

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

- rope with fibre core: 1320/1770, 1370/1770, 1620/1770, 1570 and 1620, 1770;
- rope with steel core and parallel closed ropes: 1370/1770, 1570/1770, 1570, 1770, 1960.

4.2.9.3 Governor ropes

Governor ropes shall be of the following grades: 1320/1620, 1370/1770, 1620/1770, 1570, 1620, 1770, 1960. (See Tables B.1 to B.9.)

4.2.9.4 Compensating ropes

Compensating ropes shall have rope grades in accordance with 4.2.9.2. (See Tables B.1 to B.11.)

4.2.10 Type and direction of lay

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

a) right ordinary lay (sZ);

NOTE 1 Formerly referred to as right hand ordinary (designated RHO) and right regular lay (designated RRL).

b) left ordinary lay (zS);

NOTE 2 Formerly referred to as left hand ordinary (designated LHO) and left regular lay (designated LRL).

c) right lang lay (zZ);

NOTE 3 Formerly referred to as right hand langs (designated RHL) or right lang lay (designated RLL).

d) left lang lay (sS).

NOTE 4 Formerly referred to as left hand langs (designated LHL) or left lang lay (designated LLL).

The direction and type of rope lay should be right ordinary lay (sZ), if not be specified by the purchaser.

4.2.11 Lay length

Unless otherwise specified by the purchaser, the lay length of the completed rope shall not exceed 6,75 times the nominal rope diameter.

4.3 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

Unless otherwise specified by the purchaser, when measured in accordance with 5.2, the measured diameter of the rope shall not exceed the tolerances given in Tables 2 to 4.

Considering the different requirements in lift designs, two grade of diameter tolerances are given in Table 3 for suspension ropes of traction drive lifts and governor ropes with steel or steel-based composite cores (including parallel closed ropes). Purchasers can choose the diameter tolerance according to their needs.

Table 2 — 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]	**Tolerance on nominal rope diameter** [%]		
	Max. at no load	Min. at 5 % of F_{min}	Min. at 10 % of F_{min}
≤10	+6	+1	0
> 10	+5	+1	0

Table 3 — Tolerances on diameter for suspension ropes of traction drive lifts and governor ropes with steel or steel-based composite cores (including parallel closed ropes)

Tolerance	**Nominal rope diameter** *d* [mm]	**Tolerance on nominal rope diameter** [%]		
		Max. at no load	Min. at 5 % of F_{min}	Min. at 10 % of F_{min}
Grade A	≤10	+3	0	-1
	>10	+2	0	-1
Grade B	≤10	+4	+1	0
	>10	+3	+1	0

Table 4 — Tolerances on diameter for suspension ropes of roped hydraulic lifts and compensating ropes

Nominal rope diameter d [mm]	Tolerance on nominal rope diameter [%]
6 ≤ d < 8	+6 0
≥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 5.2 at a load equivalent to 5 % or 10 % of the minimum breaking force shall not exceed the values given in Table 5 for ovality.

The difference between the average of the two measurements taken at each of the two positions when measured in accordance with 5.2 at a load equivalent to 5 % or 10 % of the minimum breaking force shall not exceed the values given in Table 5 for average diameter variation.

Table 5 — Permissible differences in diameter

Nominal rope diameter d [mm]	Ovality % of d	Average diameter variation % of d
<8	4	3
≥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) ≤400 m: 0~+5 %

b) >400 m and ≤ 1 000 m: 0~+20 m

c) >1 000 m: 0~+2 %

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 B.1 to B.11, or

b) as stated by the manufacturer.

For those rope classes covered by Tables B.1 to B.11, the minimum breaking forces of intermediate rope diameters shall be calculated using the formula given in Annex C, with the respective minimum breaking force factors given in Tables B.1 to B.11.

When tested in accordance with 5.3, the measured breaking force F_m shall be greater than or equal to the minimum breaking force F_{min}.

Approximate rope length mass, nominal metallic cross-sectional area and approximate outer wire size are also given in Table B.1 to B.11 by calculation using the formulae in Annex D for information only.

4.6 Wire tensile strength

If the purchaser requires a wire test report after rope making, additional wire test shall be done as follows.

Take the wires at random from one outer strand in the rope, not including the king wire and filler wires, to test their actual tensile strength. The taken wires which have same nominal diameter and tensile strength shall meet the following requirements:

a) the average tensile strength value shall not be less than its lower limit of nominal tensile strength;

b) the tensile strength of each wire shall be within ±8 % of the average value.

4.7 Rope stretch

Rope stretch properties including elastic stretch and construction stretch may be subject to the negotiation between the manufacturer and the purchaser. See Annex E for the test method.

5 Verification of requirements and test methods

5.1 Materials

Conformance 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 Test on rope for diameter

5.2.1 Equipment

The measuring equipment shall cover at least two adjacent strands (see Figure 1). The maximum deviation of the measuring equipment shall not be greater than ±0,03 mm for ropes up to and including 25 mm diameter, and ±0,05 mm for ropes over 25 mm diameter.

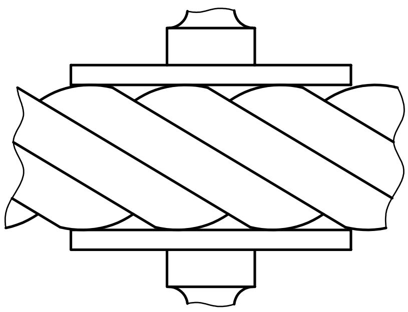


Figure 1 — Method of measuring rope diameter

5.2.2 Measured 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 average of these four measurements shall be measured diameter.

5.2.3 Ovality

The specific value of maximum difference of two measurements at any position with nominal diameter shall be ovality.

5.2.4 Variation

The specific value of the difference of arithmetic mean value of each position measurements with nominal diameter shall be average diameter variation.

5.3 Test on rope for breaking force

Unless otherwise specified by the purchaser, the test method shall be in accordance with ISO 3108.

5.4 Test on rope for lubricant content

See Annex A for determination of lubricant content or ISO 4345:1988, Annex C.

5.5 Test on rope for wire tensile strength

The test shall be performed according to ISO 6892-1.

5.6 Additional test

When any one or more than one of test items including breaking force, lubricant content, wire tensile strength are nonconformant, up to three additional tests for each nonconformity item are permitted, one of which shall have a conformant result.

6 Sampling and acceptance criteria

Samples for testing shall be taken in accordance with Table 6, unless other methods of sampling have been agreed between the purchaser and the supplier.

Each lot of ropes shall be of same diameter, construction, tensile grade, wire finish and lay direction.

Table 6 — Sampling and acceptance criteria

Size of lot	Number of samples	Number failures for acceptance	Number failures for rejection
2 to 8	2	0	1
9 to 15	3	0	1
16 to 25	5	1	2
26 to 50	8	1	2
51 to 150	13	1	2
151 to 280	20	2	3

7 Information for use

7.1 Certificate

7.1.1 General

A certificate shall be used to confirm conformance to this document.

The certificate shall be used to give at least the following information:

a) certificate number;

b) name and address of manufacturer;

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

d) minimum breaking force;

e) date of issue of certificate and authentication.

f) diameter tolerance grade, if needed, for suspension ropes with steel or steel-based composite core (including parallel closed ropes)

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.

7.1.2 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.

7.2 Information for selection, installation, maintenance

See Annex F for general guidance on selection, installation, maintenance.

7.3 Discard criteria

Ropes shall be regularly checked and to be replaced and discarded according to Annex G for discard criteria.

7.4 Marking

The rope manufacturer's name and address, and the rope length, designation and, if appropriate, certificate number (see 7.1.1), shall be legibly and durably marked on either a tag attached to the rope or label attached to the reel.

7.5 Information recommended to be provided for an enquiry or an order

The information listed in Annex H are recommended to be provided for an enquiry or an order.

Annex A
(normative)

Determination of lubricant content: gravimetric method

A.1 Equipment, reagent and sample length

A.1.1 Equipment

a) analytical balance, accuracy class 0,001 g

b) beaker

c) weighing bottle

d) funnel

e) drying baker

f) filter paper

g) tweezers

A.1.2 Reagent

a) normal heptane or

b) 120# gasoline

c) other reagent

A.1.3 Rope sample length

About 100 mm

A.2 Sampling

A.2.1 Take a rope sample about 100 mm. To ensure the accuracy of the test result, the sample shall be free any foreign matter or scraping.

A.2.2 Unclose the rope sample to strands and a core.

A.2.3 Weigh the strands as m_1 and weigh the core as m_2.

A.3 Test procedure

A.3.1 Test on strands

A.3.1.1 Unclose all the strands to wires, and then dip the wires into a beaker with normal heptane or gasoline. All the wire shall be immersed in the reagent 30 min above.

A.3.1.2 Use tweezers to shake the wires meanwhile.

A.3.1.3 After cleaning, dry at 100 °C to 105 °C for 1 h.

A.3.1.4 Take out all the wires and then put them into a drying vessel to cool down to indoor temperature.

A.3.1.5 Weigh the wires without lubricant as m_3.

A.3.2 Test on natural fibre core

A.3.2.1 Weigh a weighing bottle and then put the natural fibre core in it.

A.3.2.2 Dry at 100 °C to 105 °C for 2 h.

A.3.2.3 Take out the natural fibre core, and then put it into a drying vessel to cool down to indoor temperature.

A.3.2.4 Weigh and remove the bottle weight as the weight of dry natural fibre core m_4.

A.3.2.5 Unclose the dry natural fibre core to yarns and then dip them into a beaker with normal heptane or gasoline. All the yarns shall be immersed in the reagent 24 h above.

A.3.2.6 Dump the yarns and the reagent into a funnel with a piece of filter paper, weigh the filter paper in advance. Spray the yarns and the filter paper with cleaned reagent until the reagent filtered out is lucid.

A.3.2.7 Put the yarns with the filter paper into a weighing bottle which the weight is known.

A.3.2.8 Dry at 100 °C to 105 °C for 2 h.

A.3.2.9 Take out the yarns and the filter paper, and then put them into a drying vessel to cool down to indoor temperature.

A.3.2.10 Weigh and remove the filter paper weight as dry fibres weight without lubricant m_5.

A.3.3 Test on synthetic fibre core

A.3.3.1 Unclose the synthetic fibre core to fibres and then dip them into a beaker with normal heptane or gasoline. All the fibres shall be immersed in the reagent 24 h above.

A.3.3.2 Use tweezers to shake the fibres meanwhile.

A.3.3.3 After cleaning, dry at 100 °C to 105 °C for 1 h.

A.3.3.4 Take out all the fibres and then put them into a drying vessel to cool down to indoor temperature.

A.3.3.5 Weigh the fibres without lubricant as m_6.

A.4 Calculation

A.4.1 Lubricant content of strands

$$M_s = \frac{m_1 - m_3}{m_3} \times 100$$

where

M_s is the lubricant content of strands, expressed in percentage;

m_1 is the weight of strands with lubricants, expressed in grams;

m_3 is the weight of wires without lubricants, expressed in grams.

A.4.2 Lubricant content of natural fibre core

$$M_{NF} = \frac{m_4 - m_5}{m_5} \times 100$$

where

M_{NF} is the lubricant content of natural fibre core, expressed in percentage;

m_4 is the weight of dry natural fibre core with lubricants, expressed in grams;

m_5 is the weight of dry natural fibre core without lubricants, expressed in grams.

A.4.3 Lubricant content of synthetic fibre core

$$M_{SF} = \frac{m_2 - m_6}{m_6} \times 100$$

where

M_{SF} is the lubricant content of synthetic fibre core, expressed in percentage;

m_2 is the weight of the core with lubricants, expressed in grams;

m_6 is the weight of synthetic fibre core without lubricants, expressed in grams.

Annex B
(normative)

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

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

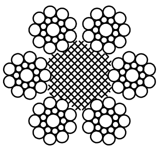
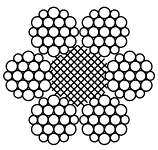
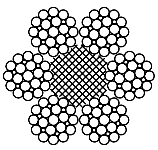
See Annex C for the formula for calculating minimum breaking force, including that for intermediate nominal rope diameters.

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

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

NOTE 3 The minimum breaking force values given in this annex are minimum requirements just for the more common classes of ropes. For lift system design, if the purchaser needs more detailed information of a detailed construction of rope in any class including approximate mass, breaking force and nominal metallic cross-sectional area, please consult the manufacturer.

Table B.1 — Class 6 × 19 with fibre or polymer core and wire strand core

Construction cross section example	Construction of rope		Construction of strand	
	Item	Quantity	Item	Quantity
 6×19S-FC  6×19W-FC  6×25F-FC	Strands Outer strands Layers of strands Wires in rope	6 6 1 114 to 150	Wires Outer wires Layers of wires	19 to 25 9 to 12 2

Typical examples		No. of outer wires			Outer wire factor[a]
Rope	Outer strand	Total	Per strand		a
6 × 19 S	1-9-9	54	9		0,079 7
6 × 19 W	1-6-6+6	72	12	6	0,075 6
				6	0,056 9
6 × 25 F	1-6-6F-12	72	12		0,063 7

Rope core type	Fibre core (FC)	Wire strand core (WSC)
Min. breaking force factor	K_1=0,330	K_2=0,356
Length mass factor [a]	W_1=0,359	W_2=0,418
Nominal metallic cross-sectional area factor [a]	C_1=0,384	C_2=0,438

Nominal rope diameter [mm]	Approximate mass[a] [kg/100m]		Minimum breaking force [kN]									
			Dual tensile			Single tensile						
			1320/1620 1320/1770	1370/1770	1570/1770 1620/1770	1570	1620	1770		1960		
	FC	WSC	FC	FC	FC	FC	FC	FC	WSC	FC	WSC	

[a] Informative only, see also Annex D.

[b] Preferred sizes for new lifts.

Table B.1 *(continued)*

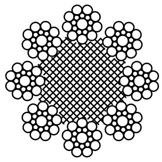
6	12,9	15,0	16,8	17,8	19,5	18,7	19,2	21,0	22,7	23,3	25,1
6,3	14,2	16,6	—	—	21,5	—	21,2	23,2	25,0	25,7	27,7
6,5[b]	15,2	17,7	19,7	20,9	22,9	21,9	22,6	24,7	26,6	27,3	29,5
8[b]	23,0		29,8	31,7	34,6	33,2	34,2	37,4		41,4	
9	29,1	—	37,7	40,1	43,8	42,0	43,3	47,3	—	52,4	—
9,5	32,4		42,0	44,7	48,8	46,8	48,2	52,7		58,4	
10[b]	35,9		46,5	49,5	54,1	51,8	53,5	58,4		64,7	
11[b]	43,4	—	56,3	59,9	65,5	62,7	64,7	70,7	—	78,3	—
12	51,7		67,0	71,3	77,9	74,6	77,0	84,1		93,1	
12,7	57,9		75,0	79,8	87,3	83,6	86,2	94,2		104	
13[b]	60,7	—	78,6	83,7	91,5	87,6	90,3	98,7	—	109	—
14	70,4		91,2	97,0	106	102	105	114		127	
14,3	73,4		—	—	111	—	— —	119		132	
15	80,8	—	—	111	122	117	137	131	—	146	—
16[b]	91,9		119	127	139	133		150		166	
17,5	110		—	—	166	—	—	179			
18	116	—	151	160	175	168	173	189	—	—	—
19[b]	130		168	179	195	187	193	211			
20	144		186	198	216	207	214	234			
20,6	152	—	—	—	230	—	—	248	—	—	—
22[b]	174		225	240	262	251	259	283			
22,4	180	—	233	248	272	260	268	293	—	—	—
25	224		291	309	338	324	334	365			

a Informative only, see also Annex D.

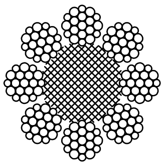
b Preferred sizes for new lifts.

Table B.2 — Class 8 × 19 with fibre or polymer core

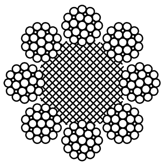
Construction cross section example



8 × 19 S-FC



8 × 19 W-FC



8 × 25F-FC

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]
Rope	Outer strand	Total	Per strand	a
8 × 19 S	1-9-9	72	9	0,065 4
8 × 19 W	1-6-6+6	96	12 6	0,062 1
			6	0,046 8
8 × 25 F	1-6-6F-12	96	12	0,052 4

Min. breaking force factor	$K_1 = 0{,}293$
Length mass factor [a]	$W_1 = 0{,}345$
Nominal metallic cross-sectional area factor [a]	$C_1 = 0{,}359$

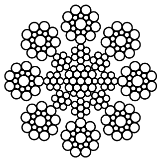
Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN]						
		Dual tensile			Single tensile			
		1320/1620 and 1320/1770	1370/1770	1570/1770 and 1620/1770	1570	1620	1770	1960
8[b]	22,1	26,4	28,1	30,8	29,4	30,4	33,2	36,8
9	27,9	—	35,6	38,9	37,3	—	42,0	46,5
9,5	31,1	37,3	39,7	43,4	41,5	42,8	46,8	51,8
10[b]	34,5	41,3	44,0	48,1	46,0	47,5	51,9	57,4
11[b]	41,7	50,0	53,2	58,1	55,7	57,4	62,8	69,5
12	49,7	59,5	63,3	69,2	66,2	68,4	74,7	82,7
12,7	55,6	66,6	70,9	77,5	74,2	76,6	83,6	92,6
13[b]	58,3	69,8	74,3	81,2	77,7	80,2	87,6	97,1
14	67,6	81,0	86,1	94,2	90,2	93,0	102	113
14,3	70,5	—	—	98,3	—	—	—	—
15	77,6	—	99,0	108	104	—	117	129
16[b]	88,3	106	113	123	118	122	133	147
17,5	106	—	—	147	—	—	—	176
18	112	134	142	156	149	154	168	186
19[b]	125	149	159	173	166	171	187	207
20	138	165	176	192	184	190	207	230
20,6	146	—	—	204	—	—	—	—
22[b]	167	200	213	233	223	230	251	278
22,4	173	207	221	241	231	238	260	288
25	216	258	275	300	288	297	324	359

[a] Informative only, see also Annex D.

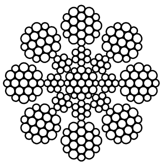
[b] Preferred sizes for new lifts.

Table B.3 — Class 8 × 19 with independent wire rope core or polymer coated steel core

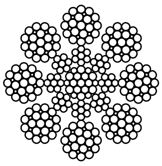
Construction cross section example



8 × 19 S-IWRC



8 × 19 W-IWRC



8 × 25 F-IWRC

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]
Rope	Outer strand	Total	Per strand		a
8 × 19 S	1-9-9	72	9		0,064 1
8 × 19 W	1-6-6+6	96	12	6	0,059 7
				6	0,045 0
8 × 25 F	1-6-6F-12	96	12		0,051 4

Min. breaking force factor	K_2 = 0,382
Length mass factor [a]	W_2 = 0,412
Nominal metallic cross-sectional area factor [a]	C_2 = 0,466

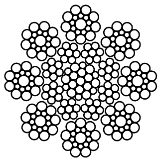
Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN]				
		Dual tensile		Single tensile		
		1370/1770	1570/1770	1570	1770	1960
6	14,8	21,6	23,0	21,6	24,3	27,0
6,5	17,4	25,3	27,0	25,3	28,6	31,6
8[b]	26,4	38,4	40,8	38,4	43,3	47,9
9	33,4	48,6	51,7	48,6	54,8	60,6
9,5	37,2	54,1	57,6	54,1	61,0	67,6
10[b]	41,2	60,0	63,8	60,0	67,6	74,9
11[b]	49,9	72,6	77,2	72,6	81,8	90,6
12	59,3	86,4	91,9	86,4	97,4	108
12,7	66,5	96,7	103	96,7	109	121
13[b]	69,6	101	108	101	114	127
14	80,8	118	125	118	133	147
15	92,7	135	144	135	152	168
16[b]	105	154	163	154	173	192
18	133	194	207	194	219	243
19[b]	149	217	230	217	244	270
20	165	240	255	240	270	299
22[b]	199	290	309	290	327	362
22,4	207	301	320	301	339	376
25	258	375	399	375	423	468

a Informative only, see also Annex D.

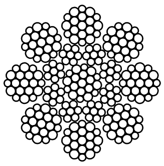
b Preferred sizes for new lifts.

Table B.4 — Class 8 × 19 parallel closed

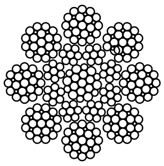
Construction cross section example



8 × 19 S-PWRC



8 × 19 W-PWRC



8 ×25 F-PWRC

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		

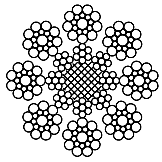
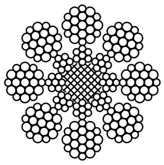
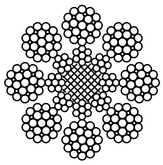
Typical examples		No. of outer wires			Outer wire factor[a]
Rope	Outer strand	Total	Per strand		a
8 × 19 S	1-9-9	72	9		0,064 1
8 × 19 W	1-6-6+6	96	12	6	0,059 7
				6	0,045 0
8 × 25 F	1-6-6F-12	96	12		0,051 4
Min. breaking force factor			K_2 = 0,405		
Length mass factor [a]			W_2 = 0,437		
Nominal metallic cross-sectional area factor [a]			C_2 = 0,493		

Nominal rope diameter [mm]	Approximate mass [a] [kg/100 m]	Minimum breaking force [kN]				
		Dual tensile		Single tensile		
		1370/1770	1570/1770	1570	1770	19600
6	15,7	22,9	24,3	22,9	25,8	28,6
6,5	18,4	26,9	28,6	26,8	30,2	33,5
8	28,0	40,7	43,3	40,7	45,9	50,8
9	35,4	51,5	54,8	51,5	58,1	64,3
9,5	39,4	57,4	61,0	57,4	64,7	71,6
10[b]	43,7	63,6	67,6	63,6	71,7	79,4
11[b]	52,9	76,9	81,8	76,9	86,7	96,0
12	62,9	91,6	97,4	91,6	103	114
12,7	70,5	103	109	103	116	128
13[b]	73,9	107	114	107	121	134
14	85,7	125	133	125	141	156
15	98,3	143	152	143	161	179
16[b]	112	163	173	163	184	203
18	142	206	219	206	232	257
19[b]	158	230	244	230	259	287
20	175	254	271	254	287	318
22[b]	212	308	327	308	347	384
22,4	219	319	339	319	360	398
25	273	397	423	397	448	496

[a] Informative only, see also Annex D.

[b] Preferred sizes for new lifts.

Table B.5 — Class 8 × 19 with composite steel core

Construction cross section example	Construction of rope		Construction of strand	
	Item	Quantity	Item	Quantity
 8 × 19 S-CSC	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		
 8 × 19 W-CSC				
 8 × 25 F-CSC				

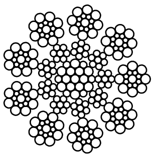
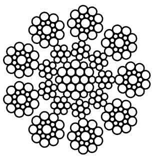
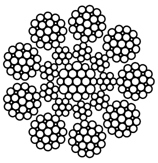
Typical examples		No. of outer wires			Outer wire factor[a]
Rope	Outer strand	Total	Per strand		a
8 × 19 S	1-9-9	72	9		0,064 1
8 × 19 W	1-6-6+6	96	12	6	0,059 7
				6	0,045 0
8 × 25 F	1-6-6F-12	96	12		0,051 4
Min. breaking force factor			K_2 = 0,352		
Length mass factor [a]			W_2 = 0,378		
Nominal metallic cross-sectional area factor [a]			C_2 = 0,430		

Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN]				
		Dual tensile		Single tensile		
		1370/1770	1570/1770	1570	1770	1960
8[b]	24,2	35,4	37,6	35,4	39,9	44,2
9	30,6	44,8	47,6	44,8	50,5	55,9
9,5	34,1	49,9	53,1	49,9	56,2	62,3
10[b]	37,8	55,3	58,8	55,3	62,3	69,0
11[b]	45,7	66,9	71,1	66,9	75,4	83,5
12	54,4	79,6	84,6	79,6	89,7	99,3
12,7	61,0	89,1	94,8	89,1	100	111
13[b]	63,9	93,4	99,3	93,4	105	117
14	74,1	108	115	108	122	135
15	85,1	124	132	124	140	155
16[b]	96,8	141	150	141	159	177
18	122	179	190	179	202	224
19[b]	136	200	212	200	225	249
20	151	221	235	221	249	276
22[b]	183	267	285	267	302	334
22,4	190	277	295	277	313	346
25	236	345	367	345	389	431

[a] Informative only, see also Annex D.

[b] Preferred sizes for new lifts.

Table B.6 — Class 9 × 19 with independent wire rope core or polymer coated steel core

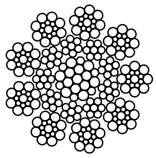
Construction cross section example	Construction of rope			Construction of strand	
	Quantity		Item	Quantity	Item
 9×17S-IWRC	Strands		9	Wires	17 to 29
	Outer strands		9	Outer wires	8 to 14
 9×19S-IWRC	Layers of strands		1	Layers of wires	2
	Wires in outer strands		153 to 261		
 9×25F-IWRC	Typical examples		No. of outer wires		Outer wire factor[a]
	Rope	Outer strand	Total	Per strand	a
	9×17S	1-8-8	72	8	0,064 0
	9×19S	1-9-9	81	9	0,058 8
	9×21F	1-5-5F-10	90	10	0,054 5
	9×25F	1-6-6F-12	108	12	0,047 1
	9×26WS	1-5-5+5-10	90	10	0,054 5
	Min. breaking force factor				K_2=0,388
	Length mass factor [a]				W_2=0,422
	Nominal-metallic cross-sectional area factor [a]				C_1=0,473

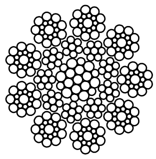
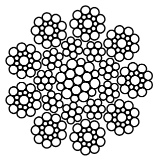
Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN]			
		Dual tensile	Single tensile		
		1570/1770	1570	1770	1960
8[b]	27,0	41,5	39,0	44,0	48,7
9	34,2	52,5	49,3	55,6	61,6
9,5	38,1	58,5	55,0	62,0	68,6
10[b]	42,2	64,8	60,9	68,6	76,0
11[b]	51,1	78,4	73,7	83,1	92,0
12	60,7	93,3	87,7	98,9	109
12,7	68,1	104	98,2	110	122
13[b]	71,3	109	103	116	128
14	82,7	127	119	135	149
15	95,0	145	137	155	171
16[b]	108	165	156	175	195
18	137	210	197	223	246
19[b]	152	234	220	248	275
20	169	259	244	275	304
22[b]	204	313	294	332	368
22,4	212	325	306	345	382
25	264	405	381	429	475

a Informative only, see also Annex D.

b Preferred sizes for new lifts.

Table B.7 — Class 9 × 19 parallel closed

Construction cross section example	Construction of rope		Construction of strand	
	Quantity	Item	Quantity	Item
	Strands	9	Wires	17 to 29
	Outer strands	9	Outer wires	8 to 14
	Layers of strands	1	Layers of wires	2
9×17S-PWRC	Wires in outer strands	153 to 261		

Construction cross section example	Typical examples		No. of outer wires		Outer wire factor[a] a
	Rope	Outer strand	Total	Per strand	
	9×17S	1-8-8	72	8	0,064 0
	9×19S	1-9-9	81	9	0,058 8
9×19S-PWRC	9×21F	1-5-5F-10	90	10	0,054 5
	9×25F	1-6-6F-12	108	12	0,047 1
	9×26WS	1-5-5+5-10	90	10	0,054 5
	Min. breaking force factor				K_2=0,410
	Length mass factor [a]				W_2=0,448
9×25F-PWRC	Nominal-metallic cross-sectional area factor [a]				C_2=0,500

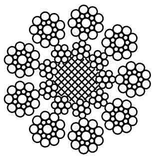
Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN]			
		Dual tensile	Single tensile		
		1570/1770	1570	1770	1960
8[b]	28,7	43,8	41,2	46,4	51,4
9	36,3	55,5	52,1	58,8	65,1
9,5	40,4	61,8	58,1	65,5	72,5
10[b]	44,8	68,5	64,4	72,6	80,4
11[b]	54,2	82,8	77,9	87,8	97,2
12	64,5	98,6	92,7	105	116
12,7	72,3	110	104	117	130
13[b]	75,7	116	109	123	136
14	87,8	134	126	142	158
15	101	154	145	163	181
16[b]	115	175	165	186	206
18	145	222	209	235	260
19[b]	162	247	232	262	290
20	179	274	257	290	321
22[b]	217	331	312	351	389
22,4	225	343	323	364	403
25	280	428	402	453	502

[a] Informative only, see also Annex D.

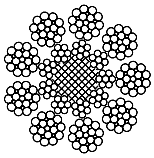
[b] Preferred sizes for new lifts.

Table B.8 — Class 9 × 19 with composite steel core

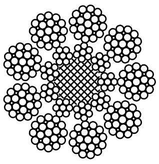
Construction cross section example



9×19S-CSC



9×21F-CSC



9×25F-CSC

Construction of rope		Construction of strand	
Quantity	Item	Quantity	Item
Strands	9	Wires	17 to 29
Outer strands	9	Outer wires	8 to 14
Layers of strands	1	Layers of wires	2
Wires in outer strands	153 to 261		

Typical examples		No. of outer wires		Outer wire factor[a]
Rope	Outer strand	Total	Per strand	a
9×17S	1-8-8	72	8	0,064 0
9×19S	1-9-9	81	9	0,058 8
9×21F	1-5-5F-10	90	10	0,054 5
9×25F	1-6-6F-12	108	12	0,047 1
9×26WS	1-5-5+5-10	90	10	0,054 5

Min. breaking force factor	K_2=0,345
Length mass factor [a]	W_2=0,371
Nominal-metallic cross-sectional area factor [a]	C_1=0,421

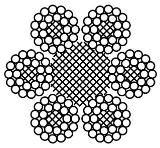
Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN]				
		Dual tensile		Single tensile		
		1370/1770	1570/1770	1570	1770	1960
8[b]	23,7	34,7	36,9	34,7	39,1	43,3
9	30,1	43,9	46,7	43,9	49,5	54,8
9,5	33,5	48,9	52,0	48,9	55,1	61,0
10[b]	37,1	54,2	57,6	54,2	61,1	67,6
11[b]	44,9	65,5	69,7	65,5	73,9	81,8
12	53,4	78,0	83,0	78,0	87,9	97,4
12,7	59,8	87,4	92,9	87,4	98,5	109
13[b]	62,7	91,5	97,4	91,5	103	114
14	72,7	106	113	106	120	133
15	83,5	122	130	122	137	152
16[b]	95,0	139	147	139	156	173
18	120	175	187	175	198	219
19[b]	134	196	208	196	220	244
20	148	217	230	217	244	270
22[b]	180	262	279	262	296	327
22,4	186	272	289	272	306	339
25	232	338	360	338	381	422

[a] Informative only, see also Annex D.

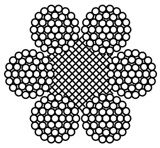
[b] Preferred sizes for new lifts.

Table B.9 — Class 6 × 19M and 6 × 36M with fibre core

Construction cross section example



6×24MFC-FC



6×37M-FC

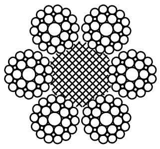
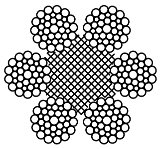
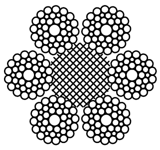
Construction of rope		Construction of strand	
Item	Quantity	Item	Quantity
Strands	6	Wires	24 to 37
Outer strands	6	Outer wires	15 to 18
Layers of strands	1	Layers of wires	2 to 3
Wires in outer strands	150 to 246		

Typical examples		No. of outer wires		Outer wire factor[a]
Rope	Outer strand	Total	Per strand	a
6×24	FC-9-15	90	15	0,053 2
6×37	1-6-12-18	108	18	0,046 5
Rope construction			6×24MFC-FC	6×37M-FC
Min. breaking force factor			K_1=0,280	K_1=0,295
Length mass factor [a]			W_1=0,318	W_1=0,346
Nominal-metallic cross-sectional area factor[a]			C_1=0,338	C_1=0,371

Nominal rope diameter [mm]	Approximate mass [a] [kg/100 m]		Minimum breaking force [kN]			
	6×24MFC-FC	6×37M-FC	6×24MFC-FC		6×37M-FC	
			1570	1770	1570	1770
6	11,9	12,4	15,8	17,8	16,6	18,8
6,5	14,0	14,6	18,6	21,7	19,5	22,0
8	20,4	22,1	28,1	31,7	29,6	33,4
9	25,8	28,0	35,6	40,1	37,5	42,3
10	31,8	34,6	44,0	49,6	46,3	52,2
11		41,9			56,0	63,2
12	—	49,8	—	—	66,7	75,2
13		58,5			78,3	88,2
14		67,8			90,8	102
16	—	88,6	—	—	119	134
18		112			150	169
20		138			185	209
22	—	167	—	—	224	253
24		199			267	301
26		234			313	353
28	—	271	—	—	363	409
32		354			474	535

[a] Informative only, see also Annex D.

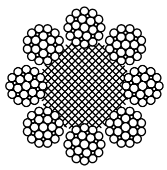
Table B.10 — Class 6 × 36 with fibre core for compensating duty only

<table>
<tr><td rowspan="14">Construction cross section example

6×29F-FC

6×36WS-FC

6×41WS-FC</td><td colspan="3">Construction of rope</td><td colspan="2">Construction of strand</td></tr>
<tr><td colspan="2">Item</td><td>Quantity</td><td>Item</td><td>Quantity</td></tr>
<tr><td colspan="2">Strands</td><td>6</td><td>Wires</td><td>25 to 41</td></tr>
<tr><td colspan="2">Outer strands</td><td>6</td><td>Outer wires</td><td>12 to 16</td></tr>
<tr><td colspan="2">Layers of strands</td><td>1</td><td>Layers of wires</td><td>2 to 3</td></tr>
<tr><td colspan="2">Wires in outer strands</td><td>150 to 246</td><td></td><td></td></tr>
<tr><td colspan="2">Typical examples</td><td colspan="2">No. of outer wires</td><td rowspan="2">Outer wire factor[a]
a</td></tr>
<tr><td>Rope</td><td>Outer strand</td><td>Total</td><td>Per strand</td></tr>
<tr><td>6×29F</td><td>1-7-7F-14</td><td>84</td><td>14</td><td>0,056 2</td></tr>
<tr><td>6×36WS</td><td>1-7-7+7-14</td><td>84</td><td>14</td><td>0,056 2</td></tr>
<tr><td>6×41WS</td><td>1-8-8+8-16</td><td>96</td><td>16</td><td>0,050 0</td></tr>
<tr><td colspan="4">Min. breaking force factor</td><td>K_1=0,338</td></tr>
<tr><td colspan="4">Length mass factor [a]</td><td>W_1=0,378</td></tr>
<tr><td colspan="4">Nominal-metallic cross-sectional area factor [a]</td><td>C_1=0,413</td></tr>
</table>

Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN] Single tensile 1570	1770	1960
13	63,8	89,7	101	112
14	74,0	104	117	130
16	96,7	136	153	169
18	122	172	193	214
19	136	191	216	239
20	151	212	239	265
22	183	256	289	320
24	217	305	344	381
26	255	358	404	448
28	296	416	469	519
30	340	477	538	596
32	387	543	612	678
34	437	613	691	766
36	490	687	775	858
38	545	766	863	956

[a] Informative only, see also Annex D.

Table B.11 — Class 8 × 19 with fibre core for compensating duty only

Construction cross section example	Construction of rope		Construction of strand	
	Item	Quantity	Item	Quantity
 8×25F-FC	Strands	8	Wires	25 to 36
	Outer strands	8	Outer wires	10 to 14
	Layers of strands	1	Layers of wires	2 to 3
	Wires in outer strands	200 to 288		

Typical examples		No. of outer wires		Outer wire factor[a]
Rope	Outer strand	Total	Per strand	a
8×25F	1-6-6F-12	96	12	0,052 4
Min. breaking force factor				K_1=0,301
Length mass factor [a]				W_1=0,369
Nominal-metallic cross-sectional area factor [a]				C_1=0,368

Nominal rope diameter [mm]	Approximate mass[a] [kg/100 m]	Minimum breaking force [kN] Single tensile 1570	1770	1960
24	213	272	307	340
26	249	320	360	400
28	289	371	418	463
30	332	426	480	531
32	378	484	546	604
34	427	546	616	682
36	478	612	691	765
38	533	682	769	852

[a] Informative only, see also Annex D.

Annex C
(normative)

Calculation of minimum breaking force

The minimum breaking force for the ropes covered by Tables B.1 to B.11, F_{min}, expressed in kilonewtons, shall be calculated as follows:

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

where

d is the nominal rope diameter, in millimetres;

R_r is the rope grade, in newtons per square millimetres — for dual tensile ropes, the values of R_{dt} in Table C.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 B.1, B.2, B.9, B.10 and B.11. For ropes with steel cores, the minimum breaking force factors K_2 are as given in Table B.1, B.3 and B.4. For ropes with composite steel cores, the minimum breaking force factors K_2 are as given in Table B.5 and B.8. For ropes parallel closed, the minimum breaking force factors K_2 are as given in Table B.6 and B.7.

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

Rope grade	Rope class	R_{dt}
1320/1620 and 1320/1770	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
1370/1770	8 × 19 and 9× 19 with composite steel core	1 570
1570/1770 and 1620/1770	6 × 19 and 8 × 19 with fibre core	1 640
1570/1770	8 × 19 and 9× 19 with steel core	1 670
1570/1770	8 × 19 and 9× 19 with composite steel core	1 670
1570/1770	8 × 19 and 9 × 19 parallel closed	1 670
NOTE For other dual grade ropes not mentioned in this table, the manufacturer can provide the detailed breaking force, if needed.		

Annex D
(informative)

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

D.1 General

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

D.2 Approximate nominal rope length mass

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

expressed in kilograms per 100 m.

D.3 Nominal metallic cross-sectional area

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

expressed in square millimetres.

D.4 Approximate outer wire diameter

$$\delta = a \times d$$

expressed in millimetres.

Annex E
(informative)

Determination of construction stretch and elastic stretch

E.1 Equipment required

A universal tensile testing machine that is capable of accommodating an at least 600 mm of rope sample is needed and an extensometer with at least 200 mm space is preferred.

If the tester jaws cannot directly and firmly clamp the ends of the rope sample, the rope ends should be fixed by pouring, thimble terminations and clamps or wedge sockets type terminations before the test.

E.2 Test procedure

E.2.1 General

There are two methods as given in E.2.2 and E.2.3. Test method 1 is preferred for an accurate measure, Test method 2 is only applied to a rough measure in the case of without an extensometer.

E.2.2 Test method 1 — Measuring with an extensometer

Step 1: Attach the rope sample with at least 600 mm length on the test machine.

Step 2: Apply less than 3 % minimum breaking force to straighten the rope and then install the extensometer on the rope. Set the extensometer reading to zero.

Step 3: Apply 3 % minimum breaking force and record the reading plus the extensometer length as initial length l_0.

Step 4: Apply 10 % minimum breaking force and release to 3 %. Repeat at least 10 loading cycles.

Step 5: Prior to the last loading, at 3 % minimum breaking force, the reading of extensometer is construction displacement $l_1 - l_0$; record the reading plus initial length as final length l_1.

Step 6: Apply 10 % minimum breaking force, the reading of extensometer is elastic displacement $l_2 - l_1$; record the reading plus final length as loaded length l_2.

E.2.3 Test method 2 — Measuring with rope length

Step 1: Attach the rope sample with at least 600 mm length on the test machine.

Step 2: Apply 3 % minimum breaking force and measure rope length to ±2 mm as initial length l_0.

Step 3: Apply 10 % minimum breaking force and release to 3 %. Repeat at least 10 loading cycles.

Step 4: Prior to the last loading, hold at 3 % minimum breaking force, measure rope length to ±2 mm as final length l_1.

Step 5: Apply 10 % minimum breaking force, measure rope length to ±2 mm as loaded length l_2.

E.3 Calculation

E.3.1 Construction stretch

$$\delta_C = \frac{(l_1 - l_0)}{l_0} \times 100$$

where

δ_C is the construction stretch, expressed in percentage;

l_0 is the initial length, expressed in millimetres;

l_1 is the final length, expressed in millimetres.

E.3.2 Elastic stretch

$$\delta_E = \frac{(l_2 - l_1)}{l_1} \times 100$$

where

δ_E is the elastic stretch, expressed in percentage;

l_2 is the loaded length, expressed in millimetres.

Annex F
(informative)

Information for selection, storage, transportation, installation and maintenance for lift ropes

F.1 Selection

When ropes with tensile grade higher than 1 770 MPa are used, the hardness of traction sheave grooves should match with the ropes.

Attention should be paid to avoid damage caused by fleet angle.

F.2 Storage

The ropes shall be stored in a well-ventilated dry place and free from rain, direct sunlight, acid and alkali.

F.3 Transportation

When loading and unloading, ensure the ropes are not to be damaged by the forklift or by falling down. During transportation, the ropes shall be in a container or covered by a waterproof material to be free from rain and dew.

F.4 Installation

During installation, avoid rope surface damage, excessive positive rotation and contra-rotation which lead short rope life. The following rope releasing ways are recommended:

1) for ropes in coils, a coil stand is recommended as Figure F.1,

2) for ropes in reels, a reel stand is recommended as Figure F.2.

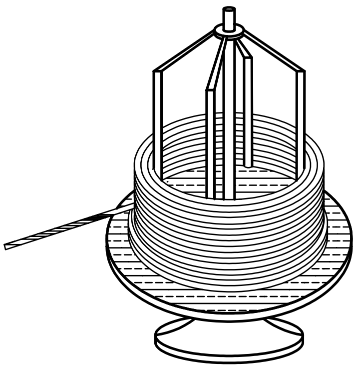


Figure F.1 — Coil stand

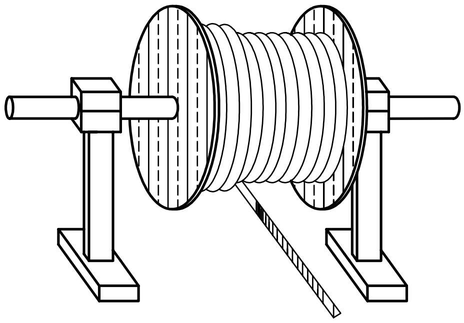


Figure F.2 — Reel stand

After installation, adjust the rope tensions to be even, the variation should not more than ±5 % of the average value.

F.5 Maintenance

Fixed period maintenances are necessary, the items should include cleaning, lubrication, wire breaks and rope diameter inspection, readjust rope tension, etc.

Generally, relubrication after 250,000 travels is recommended. The lubricant for maintenance shall be compatible with the rope manufacturing lubricant.

In any case, do not use solvents to clean the ropes, such as kerosene, diesel and gasoline or detergent. Soft iron brushes, compressed air and inline cleaning and lubrication system are recommended.

As an aid to visual inspection, an NDT (non-destructive testing) device could be applied to rapid detection of wire breaks, the portion of the rope close to the terminations should be visually inspected.

Annex G
(normative)

Discard criteria for lift ropes

G.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 G.6).

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

In the case of ropes operating in sheaves of anything 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.

G.2 Broken wires

Table G.1 indicates the number of visible broken wires in the worst section of a rope 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 G.1 — Number of visible broken wires

Condition	Replace ropes or examine within a specified period as stated by the competent person			Discard ropes immediately		
	Class 6×19	Class 8×19	Class 9×19	Class 6×19	Class 8×19	Class 9×19
Broken wires randomly distributed among the outer strands	More than 12 per rope lay[a]	More than 15 per rope lay[a]	More than 17 per rope lay[a]	More than 24 per rope lay[a]	More than 30 per rope lay[a]	More than 34 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 9 per rope lay[a]	More than 8 per rope lay[a]	More than 10 per rope lay[a]	More than 11 per rope lay[a]
Adjacent broken wires in one outer strand	4	4	4	More than 4[a]	More than 4[a]	More than 4[a]
Valley breaks	1 per rope lay[a]	1 per rope lay[a]	1 per rope lay[a]	More than 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 × d (where d is the nominal rope diameter).

G.3 Reduction in diameter

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

G.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.

G.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.

G.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 under consideration 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 H
(informative)

Information recommended to be provided with an enquiry or order

A purchase order for wire rope, in accordance with this document, 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 document 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 28590, *Sampling procedures for inspection by attributes — Introduction to the ISO 2859 series of standards for sampling for inspection by attributes*

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