BRITISH STANDARD

BS EN
12385-6:2004

Steel wire ropes — Safety —

Part 6: Stranded ropes for mine shafts

The European Standard EN 12385-6:2004 has the status of a British Standard

ICS 77.140; 77.140.65

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 12385-6:2004. It supersedes BS 302-6:1987 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MHE/2, Wire ropes, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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Foreword

This document EN 12385-6:2004 has been prepared by Technical Committee CEN/TC 168 “Chains, ropes, slings, webbing and accessories - Safety”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2004, and conflicting national standards shall be withdrawn at the latest by August 2004.

The other Parts of this European Standard are:

— *Part 1: General requirements*

— *Part 2: Definitions, designation and classification*

— *Part 3: Information for use and maintenance*

— *Part 4: Stranded ropes for general lifting applications*

— *Part 5: Stranded ropes for lifts*

— *Part 7: Locked coil ropes for mine shafts*

— *Part 8: Stranded hauling and carrying-hauling ropes for cableway installations designed to carry persons*

— *Part 9: Locked coil carrying ropes for cableway installations designed to carry persons*

— *Part 10: Spiral ropes for general structural applications*

Part 1 provides the general requirements for Parts 4 to 10.

Annexes A, B and C are normative. Annexes D and E are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

During the preparation of this standard, it was assumed that negotiations would take place between the purchaser and the manufacturer concerning the intended purpose of the rope.

Customers, purchasers and users should recognize that ropes for mine shafts are, more often than not, specially designed by the rope manufacturer to meet particular hoisting machinery conditions, and particular attention should be given to the selection of the correct dimension(s) of rope and associated tolerance.

Although tables with factors for the calculation of breaking forces, nominal rope length masses and outer wire diameters for a number of the more common classes of ropes and tables with physical properties of flat ropes are provided, this part of the standard is not limited to those given, providing all the other requirements are met.

1 Scope

This European Standard specifies the special material, manufacturing and testing requirements for stranded ropes (with round and/or shaped strands) and flat ropes for use as hoist ropes, stage ropes and balance ropes in mine shafts.

It is used in conjunction with EN 12385-1 and EN 12385-2.

NOTE This European Standard can also be used for ropes in other mining applications, e.g. surface mining.

The additional hazards covered by this part of EN 12385 are listed in clause 4.

This part of EN 13285 is applicable to ropes for new installations and ropes that have been manufactured after the publication of this standard. It may also be applied to spare ropes for existing installations

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 10264-2, *Steel wire and wire products – Steel wire for ropes – Part 2: Cold drawn non alloy steel wire for ropes for general applications.*

EN 10264-3*, Steel wire and wire products – Steel wire for ropes – Part 3: Round and shaped non alloyed steel wire for high duty applications.*

EN 12385-1:2002, *Steel wire ropes – Safety – Part 1: General requirements.*

EN 12385-2:2002, *Steel wire ropes – Safety – Part 2: Definitions, designation and classification.*

DIN 21258*, Preservative compounds for Koepe friction drive winding ropes in mining – Safety requirements and testing.*

EN ISO 9001, *Quality management systems - Requirements (ISO 9001:2000).*

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

ISO 3156, *Stranded wire ropes for mine hoisting - Impregnation compounds, lubricants and service dressing - Characteristics and tests.*

3 Terms and definitions

For the purpose of this European Standard, the terms and definitions in EN 12385-2 apply together with the following:

3.1
calculated rope diameter d_c
theoretical diameter of a stranded rope where all outer strands just touch each other

3.2
built-up centre
centre of a strand comprising a number of small wires manufactured in a separate operation instead of a large disproportional centre wire of a parallel or compound lay construction

4 List of hazards

In addition to the hazards listed in clause 4 of EN 12385-1:2002, where applicable, the hazard associated with the uncontrolled relative movements between the rope and the driving sheave shall be taken into account (see 5.2.2, 5.2.3 and 5.3.3 with regard to the associated requirements).

5 Safety requirements and/or measures

5.1 General

In addition to the requirements given in 5.2 to 5.7, the requirements shall also conform to those given in EN 12385-1.

5.2 Materials

5.2.1 Wire

5.2.1.1 Before ropemaking

Round wires, except those which form a built-up centre shall conform to:

a) EN 10264-3 for hoist ropes and stage ropes; and

b) EN 10264-2 for balance ropes and the stitching wires of flat hoist ropes.

For a given rope grade, the tensile strength grades of the wires of stranded round ropes and flat ropes shall not exceed the limits given in Table 1.

Table 1 — Tensile strength grades of wires in stranded round ropes and flat ropes for a given rope grade

Rope grade	Tensile strength grade in N/mm²	
	minimum	maximum
1180	1180	1370
1270	1180	1370
1370	1180	1570
1570	1370	1770
1670	1570	1860
1770	1570	1960
1860	1670	1960
1960	1770	1960 outer wires; 2160 inner wires

For shaped wires as centre wires, the tensile strength grade shall be less than or equal to 900 N/mm², with a tolerance not greater than that of the round wires of the same nominal metallic cross-section.

The tensile strength grades of round and shaped wires used to form built-up centres shall be at least 300 N/mm^2.

For flat ropes, all loadbearing wires shall be of the same tensile strength grade.

For outer wires the maximum tensile strength grade shall be 1960 N/mm² for bright and class B zinc-coated wires and 1770 N/mm² for class A zinc-coated wires.

For inner wires the maximum tensile strength grade shall be 2160 N/mm² for bright and class B zinc-coated wires and 1770 N/mm² for class A zinc-coated wires.

The minimum tensile strength grade of stitching wires for flat hoist ropes shall be 1150 N/mm².

The maximum tensile strength grade of the stitching wires for all flat ropes shall be limited to 75 % of the tensile strength grade of the loadbearing wires. The tensile strength range shall be 300 N/mm².

Reverse bend and torsion requirements are not applicable to stitching wires.

The minimum diameter of the wires, excluding any filler wires and round wires for built-up centres, shall conform to Table 2.

NOTE The approximate outer wire diameters of round-strand round ropes can be calculated with the formulae and factors given in Annex D.

Table 2 — Minimum wire diameters, excluding round wires for built-up centres and filler wires

Dimensions in millimetres

Rope type	Rope diameter *d*	Minimum wire diameter
Stranded round ropes	$d \leq 18$	0,5
	$18 < d \leq 25$	0,8
	$d > 25$	1,0
	Minimum wire diameter for stranded round mine hoist ropes: 0,8 mm	
Flat ropes	-	1,0

5.2.1.2 After ropemaking

Test methods and acceptance criteria for wires taken from the rope shall meet the requirements for stranded ropes in annex B of EN 12385-1:2002 with the addition that at least 90% of all of the wires tested shall be within the specified values. Filler and centre wires shall also be tested. In the case of built-up centres, either the individual wires or the centre as a whole shall be tested only for tensile strength.

The tensile strength of wires from strands that have been compacted shall be calculated on the basis of their respective nominal diameters before stranding and compacting.

The scope of the sampling depends on whether or not the rope manufacturer operates an independently verified quality management system:

a) rope manufacturers operating a quality management system in accordance with EN ISO 9001 certified by an accredited third party certification body shall test the number of specimens given in annex B of EN 12385-1:2002 when the breaking force of the rope is specified as the minimum aggregate breaking force $F_{e.min}$. For flat ropes, the wires of one left-hand and one right-hand unit rope shall be tested;

b) rope manufacturers NOT operating a quality management system in accordance with EN ISO 9001 certified by an accredited third party certification body shall test all loadbearing wires except those forming the built-up centre for: dimensions, tensile strength, reverse bend and torsion. Built-up centres shall be tested only for tensile strength. A test of the zinc coating shall be carried out on at least 20 % of wires of the same diameter in the same wire layer.

5.2.2 Core

Cores shall be one of the following types:

a) fibre;

b) fibre, reinforced by non-loadbearing wires;

c) independent steel wire rope covered with fibre or solid polymer;

d) independent steel wire rope with fibre or solid polymer covered outer strands, or;

e) independent steel wire rope with or without fibre or solid polymer inserts.

Fibre cores and fibre inserts shall be free of water-soluble aggressive acids and be made of either new hard fibre (sisal or manila) or man-made fibres. They shall meet the requirements of ISO 3155.

Fibre cores, inserts and coverings shall be impregnated to resist corrosion and rot. If the impregnating agent has to be heated for workability purposes, the temperature shall not reach a value that is liable to damage the fibre.

The new fibrous material for friction hoist ropes shall have an extractable content, including the batch, of a maximum of 5 % of the mass of the dry fibre before ropemaking. The extractable content of the impregnated or lubricated fibrous material before ropemaking shall have a maximum of 25 % of the mass of the dry fibre.

5.2.3 Lubricants and impregnating compounds

The lubricant and any impregnating compounds for hoist ropes shall conform to ISO 3156.

For friction hoist ropes, DIN 21258 also applies**.**

The properties of the friction hoist rope lubricant shall take account of:

- the coefficient of friction between the rope and the drive sheave, and;
- the chemical compatibility of the lubricant with the respective sheave linings.

5.3 Rope manufacture

5.3.1 Wire joints

The minimum distance between planned wire joints for hoist ropes shall be 36 x nominal rope diameter.

5.3.2 Wire finish

Within a rope with zinc-coated wires, wires with both class A and class B finishes may be used provided that wires within the same layer are of the same class of finish. This is valid also for the filler and centre wires of round ropes, as well as for the stitching wires of flat ropes.

NOTE The purchaser should specify any special wire finish requirements.

5.3.3 Lubrication

Drum hoist ropes shall be lubricated during the stranding and closing processes.

If the outer strand or the outer wire layer of the strands are not lubricated, all the wires shall be zinc coated.

NOTE The purchaser should specify any special lubrication requirements.

5.3.4 Construction

The rope construction shall be either one of those covered by the respective classes for stranded round and flat ropes as given in clause 5 of EN 12385-2:2002 or another construction as specified by the manufacturer.

NOTE 1 Where another construction is specified by the manufacturer, this should be agreed with the purchaser.

NOTE 2 Strands can be compacted.

5.3.5 Rope grade

The rope grade shall not be less than 1270 or greater than 1960 for ropes with bright and class B zinc-coated wires and not less than 1270 or greater than 1770 for ropes with class A zinc-coated wires. The common rope grades for hoist ropes are 1570, 1670, 1770, 1860 and 1960, for flat balance ropes 1370 and 1570 and for round balance ropes 1180, 1270, 1370, 1570 and 1960.

The rope grade shall be used in the calculation of minimum breaking force and minimum aggregate breaking force according to annex B.

5.3.6 Stitching of flat ropes

Flat hoist ropes shall be single stitched. Flat balance ropes shall be single stitched, double stitched or riveted.

5.3.7 Ropes for multi-rope friction hoists

Apart from the directions of lays, the rope designs shall be the same for all ropes manufactured as a set for a particular installation.

5.4 Physical dimensions

5.4.1 Diameter

In the case of 6- to 8-strand round strand hoist ropes with a fibre core according to 5.2.2 a) or reinforced fibre core according to 5.2.2 b), the nominal rope diameter d shall be equivalent to the calculated rope diameter, d_c.

5.4.2 Tolerances

When measured in accordance with 6.3.1 of EN 12385-1:2002, the rope diameter shall not vary from the nominal diameter d by more than the values given in Table 3.

When measured in accordance with 6.3.2 of EN 12385-1:200, the width and thickness of flat ropes shall not vary from the nominal width and thickness by more than the values given in Table 3.

Table 3 — Tolerances

Rope type	Rope dimension	Tolerance %
6- to 8-strand round strand hoist rope with FC according to 5.2.2 a) or 5.2.2 b)	$d = d_c$	+ 2 to + 5
6- or 8-strand round strand hoist rope with IWRC	d	0 to + 5
6-strand triangular strand hoist rope with FC	d	+ 2 to + 5
Rotation-resistant round strand hoist rope	d	0 to + 5
Rotation-resistant oval strand hoist rope	d	0 to + 7
Round balance rope	d	0 to + 5
Flat hoist rope	Width (including stitching)	- 5 to + 5
	Thickness	- 10 to +10
Flat balance rope	Width (including stitching/rivets)	- 10 to +10
	Thickness	-10 to +10
NOTE 1 Purchasers or users should take the above tolerances into account, particularly when ordering or selecting a replacement hoist rope in order to assure themselves that the rope is compatible with the equipment (hoist and end attachments) with which it is intended to be used. NOTE 2 A reduced tolerance may be necessary for drum hoist ropes.		

5.4.3 Permissible differences between diameter measurements

The difference between any two of the four measurements referred to in 6.3.1 of EN 12385-1 shall not exceed 4 % of the nominal rope diameter.

The difference between the average of the two measurements taken at each of the two positions referred to in 6.3.1 of EN 12385-1, shall not exceed 3% of the nominal rope diameter.

5.5 Breaking force

The breaking force shall be specified as either the minimum aggregate breaking force $F_{e.min}$ or, with the exception of flat ropes, the minimum breaking force F_{min} .

The minimum breaking force values of the more common rope classes, with the exception of the flat ropes, shall be calculated using the formulae of Annex B on the basis of the factors given in Annex A.

When calculating the aggregate breaking force $F_{e.c.min}$ of ropes with fibre cores reinforced by non-loadbearing wires, these wires are not included in the calculation. In this case, note 2 of this subclause does not apply.

The minimum aggregate breaking forces for the more common classes of flat hoist ropes and flat balance ropes are given in the tables of Annex C.

NOTE 1 Depending on the actual rope design, higher values of breaking force than those calculated in accordance with annex B or given in the Tables C.1 and C.2 can be specified.

NOTE 2 Certain elements of a rope can be disregarded when calculating the aggregate breaking force. The value in this case is referred to as the reduced aggregate breaking force $F_{e.red.min}$.

The manufacturer shall carry out a breaking force test in accordance with 6.5 on a sample of rope from each production length.

When tested in accordance with 6.5, the measured breaking force shall be equal to or greater than the specified breaking force value.

NOTE 3 When regulations require either the measured aggregate breaking force or the measured breaking force as verification of the safety requirements, the particular verification requirements should be specified by the purchaser in the enquiry or order.

5.6 Rope length mass

The nominal rope length mass *M* of the more common rope classes, with the exception of flat ropes and round balance ropes, shall be calculated with the formulae in annex B and the factors in annex A.

For round balance ropes and those rope classes not contained in annex A, the manufacturer shall specify the nominal rope length mass.

NOTE The rope length mass factors in Table A.1 for round balance rope are for information only.

For flat ropes, the nominal rope length mass values given in Tables C.1 and C.2 shall be used.

The manufacturer shall carry out a test for rope length mass as described in 6.6

When measured as described in 6.6, the actual rope length mass shall be subject to a tolerance of - 2 % to + 5 % for stranded round ropes and - 5 % to + 5 % for flat ropes.

5.7 Designation and classification

Rope designation and classification shall conform to EN 12385-2.

6 Verification of the safety requirements and/or measures

6.1 General

The safety requirements and/or measures shall be verified in accordance with clause 6 of EN 12385-1:2002 and the other characteristics in accordance with 6.2 to 6.6 below.

6.2 Lubricants

A visual check of the test documents supplied with the lubricants shall be carried out to verify that the lubricants meet the relevant requirements.

6.3 Lubrication

A visual check shall be carried out to verify that the lubrication requirements have been met.

6.4 Construction

A visual check shall be carried out to verify that the construction requirements have been met.

6.5 Test on rope for breaking force

6.5.1 Measured breaking force F_m (method 1)

If the breaking force of the rope is specified as minimum breaking force F_{min} it shall be verified by the measured breaking force F_m.

If the manufacturer is NOT operating an independently verified quality management system in accordance with EN ISO 9001, the method of test for determination of the measured breaking force F_m shall be in accordance with 6.4.1 of EN 12385-1:2002.

If the manufacturer is operating an independently verified quality management system in accordance with EN ISO 9001, the method of test for determination of the measured breaking force shall be either

a) in accordance with 6.4.1 of EN 12385-1:2002, or

b) in accordance with 6.4.3 (method 3) of EN 12385-1:2002.

6.5.2 Measured aggregate breaking force, $F_{e.m}$ (method 2)

If the breaking force of the rope is specified as the minimum aggregate breaking force $F_{e.min}$, it shall be verified by the measured aggregate breaking force, $F_{e.m}$.

If wires of fibre cores reinforced with wires are tested, these test results shall not be used when determining the measured aggregate breaking force of the rope

If the manufacturer is NOT operating a quality management system in accordance with EN ISO 9001 certified by an accredited third party certification body, the method of test for determination of the measured aggregate breaking force $F_{e.m}$, based on tests of all loadbearing wires, shall be in accordance with 6.4.2 of EN 12385-1:2002.

If the manufacturer is operating a quality management system in accordance with EN ISO 9001 certified by an accredited third party certification body, the measured aggregate breaking force $F_{e.m}$ shall be determined in accordance with 6.4.2 of EN 12385-1:2002. Sampling of the wires shall be in accordance with B.2.1 of EN 12385-1:2002 except that samples of filler wires and centre wires (or built-up centres as a whole) shall also be tested. Centre wires or centres of at least 3 different strands shall be tested. The results of the breaking forces of the tested wires may be taken to calculate the measured aggregate breaking force $F_{e.m}$.

In the case of ropes having shaped strands with built-up centres, the manufacturer shall have the option of testing either each centre as one element or separating the wires and testing each wire individually. Whichever option has been selected, the results of these tests shall be included in the measured aggregate breaking force $F_{e.m}$.

6.6 Measurement of rope length mass

The measured rope length mass M_m shall be determined by one of the following methods:

a) the gross mass of the rope, reel and ancillary items shall be measured. The mass of reel and ancillary items shall be subtracted from this value to give the rope mass. The rope mass shall be divided by the measured rope length on the closing machine; or

b) a sample of rope shall be weighed without any servings and the value of the mass shall be divided by the measured length of the rope sample.

7 Information for use

In addition to the information listed in 7.2.1 and 7.2.2 of EN 12385-1:2002, the certificate shall also give:

a) measured rope length mass;

b) nominal rope length mass;

c) measured rope dimensions (diameter or width and thickness);

d) reel dimensions (flange diameter, width and diameter of borehole);

e) amount of impregnating agent of fibre core (in % by mass of dry core);

and,

f) if the manufacturer is NOT operating a quality management system in accordance with EN ISO 9001 certified by an accredited third party certification body:
test results of the wires (diameter, tensile strength, reverse bends and torsion) and, where applicable, zinc coating;

g) if the manufacturer is operating a quality management system in accordance with EN ISO 9001 certified by an accredited third party certification body:
test results according to annex B of EN 12385-1:2002 when the breaking force of the rope is specified as minimum aggregate breaking force $F_{e.min}$.

Annex A
(normative)

Factors for stranded round ropes

Table A. 1 shows the minimum breaking force factors *K*, rope length mass factors *W*, nominal metallic cross-sectional area factors *C* and spinning loss factors *k* for the more common rope classes and constructions of stranded round ropes.

These factors shall be used in the calculation of breaking forces and the nominal rope length mass of the rope classes given.

The rope length mass factors for round balance ropes are only for information.

The rope length mass factors in Table A.1 apply to ropes that have been lubricated during stranding. For ropes that have been lubricated during both stranding and twisting, the rope length mass factors in Table A.1 shall be increased by 2 %.

Table A.1 — Factors for stranded round ropes

Rope construction	Rope class	Metallic cross-sectional area factor			Minimum breaking force factor			Rope length mass factor[d]			Spinning loss factor		
		FC	IWRC or WSC	FC reinforced	FC	IWRC or WSC	FC reinforced	FC	IWRC or WSC	FC reinforced	FC	IWRC or WSC	FC reinforced
		C_1[a]	C_2[b]	C_3[c]	K_1[a]	K_2[b]	K_3[c]	W_1[a]	W_2[b]	W_3[c]	k_1[a]	k_2[b]	K_3[a]
Single layer round strand ropes	6 x 19 M	0,365	—	—	0,314	—	—	0,343	—	—	0,86	—	—
	6 x 19	0,400	—	—	0,348	—	—	0,360	—	—	0,87	—	—
	6 x 37 M	0,370		0,370	0,307		0,307	0,343		0,355	0,83		0,83
	6 x 36	0,405		0,405	0,344		0,344	0,370		0,384	0,85		0,85
	7 x 36	—	—	0,390	—	—	0,324	—	—	0,397	—	—	0,83
	8 x 36	—		0,420	—		0,344	—		0,389	—		0,82
	6 x 35 N	0,382		0,382	0,321		0,321	0,351		0,368	0,84		0,84
	7 x 35 N	0,367		0,367	0,301		0,301	0,343		0,364	0,82		0,82
	8 x 35 N	—	—	0,334	—	—	0,271	—	—	0,366	—	—	0,81
Single layer triangular strand ropes	6 x V 8	0,414		—	0,362		—	0,410		—	0,875		—
	6 x V 25	0,413		—	0,351		—	0,410		—	0,85		—
Rotation-resistant ropes	18 x 7	0,412	0,426	—	0,321	0,324	—	0,394	0,402	—	0,78	0,76	—
	34 (M) x 7	0,420	0,433	—	0,315	0,320	—	0,394	0,403	—	0,75	0,74	—
	34 (M) x 19	0,463		—	0,347		—	0,435		—	0,75		—
	34 (W) x K 7	—	0,593	—	—	0,445	—	—	0,516	—	—	0,75	—
	34 (W) x K 19	—	0,574	—	—	0,430	—	—	0,510	—	—	0,75	—
	10 x Q 10	0,340	—	—	0,293	—	—	0,354	—	—	0,86	—	—
	19 x Q 12	0,311		—	0,243		—	0,296		—	0,78		—
	19 x Q 26	0,401		—	0,313		—	0,377		—	0,78		—
Round balance ropes	25 x 6 – 4 x 19	0,422	—	—	0,316	—	—	0,390	—	—	0,75	—	—
	30 x 6 – 6 x 19	0,385	—	—	0,289	—	—	0,385	—	—	0,75	—	—
	50 x 6 – 6 x 19	0,390	—	—	0,293	—	—	0,380	—	—	0,75	—	—

NOTE See also B.1.

[a] These factors apply only to ropes with a fibre core (FC).
[b] These factors apply only to ropes with a steel core (IWRC or WSC).
[c] These factors apply only to ropes with a fibre core reinforced by non-loadbearing steel wires.
[d] Rope length mass factors for round balance ropes are only for information.

Annex B
(normative)

Calculation of breaking forces and nominal rope length masses for the more common rope classes and constructions of stranded round ropes

B.1 General

Breaking forces and nominal rope length masses shall be calculated with the formulae given in B.2 to B.7 on the basis of the factors given in annex A and partly, where applicable, by means of test results.

The following symbols are used in these calculations:

d nominal diameter, in mm

K empirical factor used in the determination of minimum breaking force of a given rope class or construction

- K_1 factor for rope with fibre core
- K_2 factor for rope with loadbearing steel core
- K_3 factor for rope with fibre core reinforced by non-loadbearing steel wires.

R_r rope grade in N/mm²

k empirical factor based on the spinning loss of a given rope class or construction

- k_1 factor for rope with fibre core
- k_2 factor for rope with steel core
- k_3 factor for rope with fibre core reinforced by steel wires.

Σ sum of the breaking forces of the individual wires from a same kind of strand, in kN

n number of same kind of strands in a given strand layer. The following indices are used:

- 0 for the centre strand
- 1 for the first of the same kind of strand
- 2 for the second of the same kind of strand, etc.

W empirical factor taking into account the mass of core and lubricant as well as the metallic elements used in the calculation of the nominal rope length mass M

- W_1 factor for rope with fibre core
- W_2 factor for rope with steel core
- W_3 factor for rope with fibre core reinforced by steel wires.

C factor used in the determination of nominal metallic cross-sectional area of a given class or construction

- C_1 factor for rope with fibre core,
- C_2 factor for rope with loadbearing steel core
- C_3 factor for rope with fibre core reinforced by non-loadbearing steel wires.

NOTE For the derivation of the formulae for the minimum breaking force and the minimum aggregate breaking force, refer to EN 12385-2.

B.2 Minimum breaking force F_{min}

The minimum breaking force F_{min}, expressed in kilonewtons, shall be calculated as follows:

$$F_{min} = \frac{d^2 \cdot R_r \cdot K}{1000}$$

B.3 Minimum aggregate breaking force $F_{e.min}$

The minimum aggregate breaking force of the rope $F_{e.min}$, expressed in kilonewtons, shall be calculated as follows:

a) based on the metallic cross-sectional area factor C

$$F_{e.min} = \frac{d^2 \cdot C \cdot R_r}{1000} \quad \text{or}$$

b) based on the breaking force factor K and spinning loss factor k

$$F_{e.min} = \frac{d^{2\cdot} \cdot R_r \cdot K}{1000} \cdot \frac{1}{k}$$

Using this formula and a given breaking force, the approximate nominal rope diameter is calculable.

B.4 Measured aggregate breaking force $F_{e.m}$

When all the loadbearing wires from the rope have been tested, the measured aggregate breaking force, $F_{e.m}$ expressed in kilonewtons **,** shall be the sum of all the individual wire breaking forces.

If only the wires of one kind of strand in a given layer have been tested, the measured aggregate breaking force of the whole rope, $F_{e.m}$ expressed in kN, shall be calculated as follows:

$$F_{e.m} = \Sigma_o + \Sigma_1 \cdot n_1 + \Sigma_2 \cdot n_2 + \cdots$$

B.5 Calculated measured aggregate breaking force $F_{e.m.c}$

The calculated measured aggregate breaking force $F_{e.m.c}$ shall be calculated as follows:

$$F_{e.m.c} = F_m \cdot \frac{1}{k}$$

B.6 Calculated measured breaking force $F_{m.c}$

The calculated measured breaking force $F_{m.c}$, based on the results from the wire tensile strength tests and the spinning loss factor k shall be calculated as follows:

$$F_{m.c} = F_{e.m} \cdot k$$

B.7 Nominal rope length mass M

The nominal rope length mass M expressed in kilograms per 100 meters, shall be calculated as follows:

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

Annex C
(normative)

Tables of breaking forces and nominal rope length masses for the more common rope classes of flat ropes

Table C.1 — Flat hoist ropes

Nominal values width *w* x thickness *s*	Nominal diameter of loadbearing wires	Sum of nominal cross-sectional area of loadbearing wires	Nominal rope length mass of lubricated rope	Minimum aggregate breaking force $F_{e.min}$		
				Rope grade		
				1770	1860	1960
mm	mm	Mm^2	Kg/100 m	KN	kN	kN
Rope class: 6 x 4 x 7 = 6 unit ropes each of 4 strands each of 1+6 wires = 168 wires						
52 x 11	1,2	190	184	336	353	372
56 x 12	1,3	223	216	395	415	437
60 x 13	1,4	259	251	458	481	507
65 x 14	1,5	297	288	525	552	582
70 x 15	1,6	338	328	598	629	662
74 x 16	1,7	381	370	674	709	747
78 x 17	1,8	428	416	758	796	839
82 x 18	1,9	476	462	843	885	933
87 x 19	2,0	528	513	935	982	1035
91 x 20	2,1	582	565	1030	1083	1141
95 x 21	2,2	639	620	1131	1189	1252
Rope class: 8 x 4 x 7 = 8 unit ropes each of 4 strands each of 1+6 wires = 224 wires						
70 x 11	1,2	253	245	448	471	497
75 x 12	1,3	297	288	526	553	583
80 x 13	1,4	345	335	610	641	676
86 x 14	1,5	396	384	701	736	776
92 x 15	1,6	450	437	797	838	883
98 x 16	1,7	508	493	900	946	997
104 x 17	1,8	570	553	1009	1060	1117
110 x 18	1,9	635	616	1124	1181	1245
116 x 19	2,0	704	683	1246	1309	1379
122 x 20	2,1	776	753	1373	1443	1521
128 x 21	2,2	851	825	1507	1584	1669
Rope class: 8 x 4 x 12 M = 8 unit ropes each of 4 strands each of 3+9 wires = 384 wires						
130 x 21	1,7	872	850	1543	1621	1708
139 x 22	1,8	977	950	1730	1818	1915
146 x 23	1,9	1089	1060	1927	2025	2134
154 x 24	2,0	1206	1170	2135	2244	2364
160 x 25	2,1	1330	1290	2354	2474	2607
168 x 26	2,2	1460	1420	2584	2715	2861

Table C.1 — Flat hoist ropes *(continued)*

Nominal values width *w* x thickness *s*	Nominal diameter of loadbearing wires	Sum of nominal cross-sectional area of loadbearing wires	Nominal rope length mass of lubricated rope	Minimum aggregate breaking force $F_{e.min}$		
				Rope grade		
				1770	1860	1960
mm	mm	mm^2	kg/100 m	kN	kN	kN
Rope class: 8 x 4 x 14 M = 8 unit ropes each of 4 strands each of 4+10 wires = 448 wires						
162 x 24	1,9	1270	1230	2248	2363	2490
168 x 25	2,0	1407	1370	2491	2618	2759
176 x 26	2,1	1552	1510	2747	2886	3041
184 x 27	2,2	1703	1650	3014	3168	3338
Rope class: 8 x 4 x 19 M = 8 unit ropes each of 4 strands each of 1+6+12 wires = 608 wires						
176 x 26	1,8	1547	1500	2738	2878	3032
186 x 28	1,9	1724	1670	3051	3206	3379
194 x 30	2,0	1910	1850	3381	3553	3744
Rope class: 8 x 4 x 19 W = 8 unit ropes each of 4 strands 1+6+6+6 wires = 608 wires						
170 x 25	1,95/1,5	1597	1550	2827	2970	3130
179 x 27	2,05/1,6	1775	1720	3142	3302	3479
188 x 29	2,15/1,7	1963	1900	3474	3651	3847

Table C.2 — Flat balance ropes

Nominal values width *w* x thickness *s* mm		Nominal diameter of load-bearing wires	Sum of nominal cross sectional area of load-bearing wires	Nominal rope length mass of lubricated rope			Minimum aggregate breaking force $F_{e.min}$	
double stitched	single stitched or riveted			double stitched	single stitched	riveted	Rope grade	
							1370	1570
mm	mm	mm	mm^2	kg/100 m	kg/100 m	kg/100 m	kN	kN
Rope class: 6 x 4 x 7 = 6 unit rope each of 4 strands each of 1+6 wires = 168 wires								
70 x 17	70 x 15	1,6	338	342	328	322	463	531
74 x 18	74 x 16	1,7	381	385	370	362	522	598
78 x 19	78 x 17	1,8	428	433	416	407	586	672
82 x 20	82 x 18	1,9	476	481	462	453	652	747
87 x 21	87 x 19	2,0	526	534	513	502	723	829
91 x 22	91 x 20	2,1	582	588	565	553	797	914
95 x 23	95 x 21	2,2	639	646	620	607	875	1003
Rope class: 8 x 4 x 7 = 8 unit ropes each of 4 strands each of 1+6 wires = 224 wires								
110 x 20	110 x 18	1,9	635	642	616	604	870	997
113 x 20	113 x 18	1,95	669	676	649	636	917	1050
116 x 21	116 x 19	2,0	704	711	683	669	964	1105
119 x 21	119 x 19	2,05	739	747	717	702	1010	1160
122 x 22	122 x 20	2,1	776	784	753	738	1060	1220
125 x 22	125 x 20	2,15	813	822	789	773	1110	1280
128 x 23	128 x 21	2,2	851	860	826	809	1170	1340

Table C.2 — Flat balance ropes *(continued)*

Nominal values width *w* x thickness *s* mm		Nominal diameter of load-bearing wires	Sum of nominal cross sectional area of loadbearing wires	Nominal rope length mass of lubricated rope			Minimum aggregate breaking force $F_{e.min}$	
double stitched	single stitched or riveted			double stitched	single stitched	riveted	Rope grade	
							1370	1570
mm	mm	mm	mm^2	Kg/100 m	kg/100 m	kg/100 m	kN	kN
Rope class: 6 x 4 x 12 = 6 unit ropes each of 4 strands each of 3+9 wires = 288 wires								
112 x 26	112 x 23	1,9	817	826	793	768	1120	1280
115 x 26	115 x 23	1,95	860	869	835	809	1180	1350
118 x 27	118 x 24	2,0	905	914	878	851	1240	1420
121 x 27	121 x 24	2,05	951	961	923	894	1300	1490
124 x 28	124 x 25	2,1	998	1010	968	939	1370	1570
127 x 28	127 x 25	2,15	1046	1060	1020	984	1430	1640
130 x 29	130 x 26	2,2	1095	1110	1070	1030	1500	1720
Rope class: 8 x 4 x 12 M = 8 unit ropes each of 4 strands each of 3+9 wires = 384 wires								
146 x 25	146 x 23	1,9	1089	1100	1060	1030	1490	1710
149 x 26	149 x 23	1,95	1147	1160	1120	1080	1570	1800
154 x 27	154 x 24	2,0	1206	1220	1170	1140	1650	1890
157 x 27	157 x 24	2,05	1267	1280	1230	1190	1740	1990
160 x 28	160 x 25	2,1	1330	1350	1290	1250	1820	2090
165 x 28	165 x 25	2,15	1394	1410	1360	1310	1910	2190
168 x 29	168 x 26	2,2	1460	1480	1420	1380	2000	2290
Rope class: 8 x 4 x 14 M = 8 unit ropes each of 4 strands each of 4+10 wires = 448 wires								
168 x 28	168 x 25	2,0	1407	1430	1370	1330	1930	2210
172 x 29	172 x 26	2,05	1479	1500	1440	1390	2030	2320
176 x 29	176 x 26	2,1	1552	1570	1510	1460	2130	2440
180 x 30	180 x 27	2,15	1626	1650	1580	1530	2230	2550
184 x 30	184 x 27	2,2	1703	1720	1660	1600	2330	2670
Rope class: 8 x 4 x 19 M = 8 unit ropes each of 4 strands each of 1+6+12 wires = 608 wires								
186 x 31	186 x 28	1,9	1724	1750	1680	1620	2360	2710
190 x 32	190 x 29	1,95	1816	1840	1780	1700	2490	2850
194 x 33	194 x 30	2,0	1910	1930	1860	1800	2620	3000
200 x 34	200 x 31	2,05	2007	2030	1950	1890	2750	3150
204 x 34	204 x 31	2,1	2106	2130	2040	1980	2890	3310
210 x 36	210 x 32	2,15	2207	2230	2140	2080	3020	3460
216 x 37	216 x 33	2,2	2311	2330	2240	2180	3170	3630

Annex D
(informative)

Factors for the calculation of the approximate outer wire diameters for the more common rope constructions of stranded round ropes

The approximate nominal diameter of the outer wire δ_a in the outer strand layer, expressed in mm, is calculated by means of the outer wire factor *a* given in Table D.1, according to EN 12385-2, as follows:

$$\delta_a = a \cdot d$$

where

d is the nominal rope diameter in mm

a is the empirical factor for the approximate nominal diameter of the outer wire for a given rope construction (see Table D.1)

Table D.1 — Outer wire factors

Rope class	Number of outer wires per strand	Approximate outer wire factor *a*	
6 x 19 M	10	0,0740	
	11	0,0690	
	12	0,0630	
6 x 19	10	0,074	
	12	0,065	
	14	0,056	
	7	0,095	
	8	0,087	
	9	0,080	
	5 + 5 Warr.	0,084	0,064
	6 + 6 Warr.	0,073	0,055
	7 + 7 Warr.	0,065	0,048
7 x 19	10	0,067	
	12	0,058	
	14	0,051	
	7	0,087	
	8	0,079	
	9	0,072	
	5 + 5 Warr.	0,076	0,058
	6 + 6 Warr.	0,066	0,050
	7 + 7 Warr.	0,059	0,044
6 x 37 M	16	0,0505	
	17	0,0474	
	18	0,0454	
6 x 36	12	0,0630	
	14	0,0560	
	16	0,0500	
	18	0,0454	
6 x 35 N	12	0,0630	
	13	0,0600	
	14	0,0560	
	15	0,0530	
	16	0,0500	
	18	0,0454	

Table D.1 — Outer wire factors *(continued)*

Rope class	Number of outer wires per strand		Approximate outer wire factor *a*
7 x 35 N		12	0,0572
		13	0,0550
		14	0,0510
		15	0,0480
		16	0,0455
		18	0,0410
7 x 36		12	0,0575
		14	0,0510
		16	0,0454
		18	0,0410
8 x 36		12	0,0515
		14	0,0454
		16	0,0410
		18	0,0371
8 x 35 N		12	0,0518
		13	0,0487
		14	0,0460
		15	0,0430
		16	0,0410
		18	0,0370
6 x V8		7	0,105
		8	0,088
6 x V25		9	0,087
		10	0,082
		12	0,070
		15	0,059
18 x 7	17 strands	5	0,072
		6	0,067
	18 strands	5	0,0690
		6	0,0625
34 (M) x 7	34 strands	5	0,052
		6	0,047
	36 strands	5	0,050
		6	0,046
34 (M) x 19 S		9	0,0366
10 x Q 10		10	0,0660
		8	0,0630
19 x Q 12		12	0,0450
		11	0,0470
		10	0,0490
19 x Q 26		14	0,0432
		15	0,0425
		16	0,0402

Annex E
(informative)

Information which should be provided with an enquiry or order

At least the following information should be provided with an enquiry or order.

E.1 Details of rope

a) reference to this part of this standard, i.e. EN 12385-6;
b) rope duty;
c) in the case of hoist ropes, whether friction or drum;
d) quantity and length;
e) single- or multi-rope hoisting;
f) dimension(s) with tolerances, where applicable;
g) construction;
h) wire finish;
i) lay direction and type;
j) any particular lubricant or impregnating compound requirements and any particular lubrication requirements;
k) minimum breaking force or minimum aggregate breaking force and any particular verification requirements;
l) nominal rope length mass;
m) any limiting reel dimensions.

E.2 Details of installation

E.2.1 Particulars of the shaft

a) depth from lowest working level in shaft to bank, vertical distance from bank to head pulley;
b) whether upcast, downcast, or both;
c) whether wet or dry and approximate range of temperature variation;
d) whether shaft water is known to have noxious properties and whether its pH value and chloride content are available;
e) whether or not intermediate level hoisting is installed.

E.2.2 Particulars of friction hoist driving sheave

a) diameter;
b) material of rope groove lining;
c) contact pressure.

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