BRITISH STANDARD

BS EN 12385-4:2002

Steel wire ropes — Safety —

Part 4: Stranded ropes for general lifting applications

The European Standard EN 12385-4:2002 has the status of a British Standard

ICS 77.140.65

BSI British Standards

National foreword

This British Standard is the official English language version of EN 12385-4:2002. It supersedes BS 302-2:1987 which is withdrawn.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.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 30 October 2002

Summary of pages

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EUROPEAN STANDARD

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Steel wire ropes - Safety - Part 4: Stranded ropes for general lifting applications

Câbles en acier - Sécurité - Partie 4: Câbles à torons pour applications de levage générales

Drahtseile aus Stahldraht - Sicherheit - Teil 4: Litzenseile für allgemeine Hebezwecke

This European Standard was approved by CEN on 12 November 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 12385-4:2002 E

Contents

Foreword

This document (EN 12385-4:2002) has been prepared by Technical Committee CEN/TC 168, "Chains, ropes, webbing, slings 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 April 2003, and conflicting national standards shall be withdrawn at the latest by April 2003.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directive(s), see informative annex ZA, which is an integral Part of this document.

The other Parts of EN 12385 are:

- Part 1: General requirements
- Part 2: Definitions, designation and classification
- Part 3: Information for use and maintenance
- Part 5: Stranded ropes for lifts
- Part 6: Stranded ropes for mine shafts
- 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 of Parts 4 to 10.

This is the first edition of this Part.

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

Introduction

This Part of this European Standard has been prepared to be a harmonized standard to provide one means of complying with the essential safety requirements of the Machinery Directive.

This Part of this European Standard is a type C standard as stated in EN 292.

For the purposes of the Certificate referred to in clause 7, this Part assumes a working load limit based on a safety factor of 5. The safety factor and the required minimum breaking force of the rope for a given application is the responsibility of the manufacturer of the machine of which the rope forms a part.

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

Although tables of breaking forces and masses are provided for a number of the more common classes, diameters and rope grades, this Part of this standard is not limited to those given, providing all of the other requirements are met.

Specifiers, purchasers and users should recognise that some ropes are specially designed by the manufacturer to meet particular lifting machinery requirements.

1 Scope

This Part of this European Standard specifies the particular materials, manufacturing and testing requirements for ropes for general lifting applications.

The particular hazards covered by this Part are identified in Clause 4.

This Part of this European Standard does not establish requirements for information for use other than those given in clause 7 of Part 1. Neither does it cover the requirements for ropes fitted with terminations.

Minimum breaking force values for the more common classes, sizes and grades of rope are provided in tables 5 to 17.

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-alloyed steel wire for ropes for general 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.*

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

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions in EN 12385-2 apply.

4 Hazards

In addition to the general hazards identified in clause 4 of Part 1, Table 1 contains all the particular hazards which require action to reduce risk as being specific and significant for steel wire ropes for general lifting applications.

Table 1- Hazards and associated requirements

Hazards identified in annex A of EN 1050:1996		Relevant clause of annex A of EN 292-2:1991/A1:1995	Relevant clause of this standard
27.4	Mechanical hazard from insufficient strength of parts	4.1.2.3	5 and 6
27.6	Mechanical hazard from inadequate selection of ropes and their inadequate integration into the machine	4.3.1	7

NOTE For the purposes of this Part of EN 12385, insufficient strength of parts means failure to achieve the minimum breaking force of the rope.

5 Safety requirements and/or measures

5.1 General

In addition to the requirements given 5.2 to 5.5, the requirements shall also conform to those given in EN 12385-1.

5.2 Materials

5.2.1 Wire

Wires, before ropemaking, shall conform to EN 10264-2.

For those ropes where a rope grade is applicable, e.g. Tables 5 to 16, the tensile strength grades of the wires shall be subject to the limits given in Table 2.

For those ropes where a rope grade is not applicable, e.g. large diameter ropes, the tensile strength grades of the wires shall be one or a combination of those given in EN 10264-2.

Table 2 — Wire tensile strength grades excluding centre and filler wires for given rope grades

Rope Grade	Wire tensile strength grades N/mm^2	
	Minimum	Maximum
1770	1570	1960
1960	1770	2160
2160	1960	2160

5.2.2 Core

The core shall be one of the following types:

a) fibre;

b) steel, as an independent wire rope (IWRC) or wire strand (WSC);

c) composite (e.g. steel and fibre or steel and solid polymer);

d) cushion core; or

e) solid polymer.

5.2.3 Lubricant

The lubricant shall comply with ISO 4346.

5.3 Rope manufacture

5.3.1 Lubrication

At least the strands shall be lubricated.

5.3.2 Construction

The rope construction shall be either:

a) one of those covered by Tables 5 to 17; or

b) another single layer or parallel-closed or rotation-resistant rope construction as specified by the manufacturer and covered by the respective classes in EN 12385-2.

5.3.3 Rope grade

For rope sizes up to and including 60 mm diameter, the rope grade shall be 1770, 1960 or 2160 or an intermediate grade as specified by the manufacturer, but not exceeding 2160.

NOTE Ropes larger than 60mm diameter may not have a rope grade.

5.4 Diameter

5.4.1 Tolerances

When measured in accordance with 6.3.1 of EN 12385-1:2002, the measured diameter shall not vary from the nominal diameter by more than the values given in Table 3. For ropes with diameters from 2 mm to 5 mm inclusive, the tolerance shall be rounded up to the nearest 0,05 mm.

Table 3 — Tolerances on rope diameter

Nominal rope diameter mm	Tolerance as percentage of nominal rope diameter
From 2 to < 4	$^{+8}_{0}$
From 4 to < 6	$^{+7}_{0}$
From 6 to < 8	$^{+6}_{0}$
8 and greater	$^{+5}_{0}$

5.4.2 Differences between diameter measurements

The difference between any two of the four measurements taken in accordance with 6.3.1 of EN 12385-1:2002 and expressed as a percentage of the nominal rope diameter, shall not exceed the values given in Table 4.

Table 4 — Differences between diameter measurements

Nominal rope diameter mm	Difference between measurements as percentage of nominal rope diameter	
	Rope with strands that are exclusively of wire or incorporate solid polymer	Ropes with strands that incorporate fibre centres
From 2 to < 4	7	-
From 4 to < 6	6	8
From 6 to < 8	5	7
8 and greater	4	6

NOTE The values in the table apply irrespective of the type of core in the rope.

5.5 Breaking force

The breaking force shall be specified only as minimum breaking force.

The values of minimum breaking force for the more common classes and grades of ropes shall be not less than those given in Tables 5 to 16. For intermediate rope diameters, the values shall be not less than those obtained using the formula in annex A with the factors given in annex B.

The values of minimum breaking force for large diameter ropes are given in Table 17. For intermediate rope diameters, the values shall be not less than those obtained using the formula in annex A.

NOTE Refer to the definitions given in EN 12385-2 for derivation of the formula for calculation of minimum breaking force.

5.6 Designation and classification

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

6 Verification of safety requirements and/or measures

6.1 General

Verification of safety requirements and/or measures shall be in accordance with that given in clause 6 of EN 12385-1 and the additional verification given in 6.2 to 6.5 below.

6.2 Lubricant

Compliance with the lubricant requirements shall be through a visual verification of the inspection documents supplied with the lubricant.

6.3 Lubrication

Compliance with the lubrication requirements shall be through a visual verification.

6.4 Construction

Compliance with the construction requirements shall be through a visual verification.

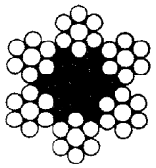
6.5 Rope grade

Compliance with the rope grade requirements shall be through a visual verification of the inspection documents supplied with the wire in relation to the minimum breaking force value of the rope.

7 Information for use

In addition to conforming to clause 7 of Part 1, the Certificate (see 7.2.1 of Part 1) shall also include either an example of the maximum working load to which the rope shall be subjected in service at a given factor of safety or the working load limit when the intended use is known.

Table 5 — Class 6x7

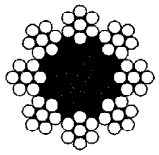
Construction cross section example	Construction of rope		Construction of strand		
 6x7-FC	Item	Quantity	Item		Quantity
	Strands outer strands layers of strands Wires in rope (excluding metallic core)	6 6 1 30 to 54	Wires Outer wires Layers of wires		5 to 9 4 to 8 1
	Typical example		No. of outer wires		Outer wire factor[1]
	Rope	Strand	Total	per strand	
	6×7	1-6	36	6	0,106
	Min. breaking force factor: Nominal length mass factor[1]: Nominal metallic cross-sectional area factor[1]		K_1 = 0,332 W_1 = 0,345 C_1 = 0,369	K_2 = 0,359 W_2 = 0,384 C_2 = 0,432	K_3 = 0,388

Nominal rope diameter	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN			
	Fibre core	Steel core	Rope grade 1770		Rope grade 1960	
mm			Fibre core	Steel core	Fibre core	Steel core
1	2	3	4	5[2]	6	7[2]
2	1,38	1,54	2,35	2,54	2,60	2,81
3	3,11	3,46	5,29	5,72	5,86	6,33
4	5,52	6,14	9,40	10,2	10,40	11,3
5	8,63	9,60	14,7	15,9	16,3	17,6
6	12,4	13,8	21,2	22,9	23,4	25,3
7	16,9	18,8	28,8	31,1	31,9	34,5
8	22,1	24,6	37,6	40,7	41,6	45,0
9	27,9	31,1	47,6	51,5	52,7	57,0
10	34,5	38,4	58,8	63,5	65,1	70,4
11	41,7	46,5	71,1	76,9	78,7	85,1
12	49,7	55,3	84,6	91,5	93,7	101
13	58,3	64,9	99,3	107	110	119
14	67,6	75,3	115	125	128	138
16	88,3	98,3	150	163	167	180
18	112	124	190	206	211	228
20	138	154	235	254	260	281
22	167	186	284	308	315	341
24	199	221	338	366	375	405
26	233	260	397	430	440	476
28	270	301	461	498	510	552
32	353	393	602	651	666	721
36	447	498	762	824	843	912
40	552	614	940	1 020	1 040	1 130

[1] Informative only

[2] For small diameter ropes (2 mm to 7 mm) with wire strand core (WSC), K_3 may be used for the calculation of breaking forces. The values given in columns 5 and 7 are based on ropes with independent wire rope cores (IWRC).

Table 6 — Class 8x7

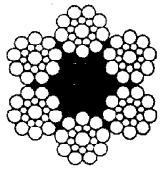
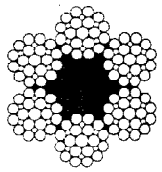
Construction cross section example	Construction of rope		Construction of strand		
	Item	Quantity	Item		Quantity
	Strands outer strands layers of strands Wires in rope (excluding steel core)	8 8 1 40 to 72	Wires Outer wires Layers of wires		5 to 9 4 to 8 1
8x7-FC	Typical example		No. of outer wires		Outer wire factor[1]
	Rope	Strand	Total	per strand	
	8×7	1-6	48	6	0,087
	Min. breaking force factor Nominal length mass factor[1]: Nominal metallic cross-sectional area factor[1]		K_1 = 0,291 W_1 = 0,327 C_1 = 0,335	K_2 = 0,359 W_2 = 0,391 C_2 = 0,439	K_3 = 0,404 W_3 = 0,464 C_3 = 0,379

Nominal rope diameter	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN			
	Fibre core	Steel core	Rope grade 1770		Rope grade 1960	
mm			Fibre core	Steel core	Fibre core	Steel core
1	2	3	4	5[2]	6	7[2]
2	1,31	1,56	2,06	2,54	2,28	2,81
3	2,94	3,52	4,64	5,72	5,13	6,33
4	5,23	6,26	8,24	10,2	9,13	11,3
5	8,18	9,78	12,9	15,9	14,3	17,6
6	11,8	14,1	18,5	22,9	20,5	25,3
7	16,0	19,2	25,5	31,1	27,9	34,5
8	20,9	25,0	33,0	40,7	38,6	45,0
9	26,5	31,7	41,7	51,5	46,2	57,0
10	32,7	39,1	51,5	63,5	57,0	70,4
11	39,6	47,3	62,3	76,9	69,0	85,1
12	47,1	56,3	74,2	91,5	82,1	101
13	55,3	66,1	87,0	107	96,4	119
14	64,1	76,6	101	125	112	138
16	83,7	100	132	163	146	180
18	106	127	167	206	185	228
20	131	156	206	254	228	281
22	158	189	249	308	276	341
24	188	225	297	366	329	405
26	221	264	348	430	386	476
28	256	307	404	498	447	552
32	335	400	527	651	584	721
36	424	507	668	824	739	912
40	523	626	824	1 020	913	1 130

[1] Informative only

[2] For small diameter ropes (2 mm to 7 mm) with wire strand core (WSC), K_3 may be used for the calculation of breaking forces. The values given in columns 5 and 7 are based on ropes with independent wire rope cores (IWRC).

Table 7 — Class: 6x19

Construction cross section examples	Construction of rope		Construction of strand		
	Item	Quantity	Item		Quantity
	Strands outer strands layers of strands Wires in rope (excluding steel core)	6 6 1 90 to 156	Wires Outer wires Layers of wires		15 to 26 7 to 12 2 to 3
6×19S-FC	Typical example		No. of outer wires		Outer wire factor[1]
	Rope	Strand	Total	per strand	
	6×19S	1-9-9	54	9	0,080
	6×25F	1-6-6F-12	72	12	0,064
	6×19W	1-6-6+6	72	12 6	0,073 0,055
	6×26WS	1-5-5+5-10	60	10	0,074
6×25F-FC	Min. breaking force factor: Nominal length mass factor[1] Nominal metallic cross-sectional area factor[1]:		K_1 = 0,330 W_1 = 0,359 C_1 = 0,384	K_2 = 0,356 W_2 = 0,400 C_2 = 0,449	

Nominal rope diameter mm	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN				
			Rope Grade				
			1770		1960		2160
	Fibre core	Steel core	Fibre core	Steel core	Fibre core	Steel core	Steel core
1	2	3	4	5	6	7	8
6	12,9	14,4	21,0	22,7	23,3	25,1	27,7
7	17,6	19,6	28,6	30,9	31,7	34,2	37,7
8	23,0	25,6	37,4	40,3	41,4	44,7	49,2
9	29,1	32,4	47,3	51,0	52,4	56,5	62,3
10	35,9	40,0	58,4	63,0	64,7	69,8	76,9
11	43,3	48,4	70,7	76,2	78,3	84,4	93,0
12	51,7	57,6	84,1	90,7	93,1	100	111
13	60,7	67,6	98,7	106	109	118	130
14	70,4	78,4	114	124	127	137	151
16	91,9	102	150	161	166	179	197
18	116	130	189	204	210	226	249
20	144	160	234	252	259	279	308
22	174	194	283	305	313	338	372
24	207	230	336	363	373	402	443
26	243	270	395	426	437	472	520
28	281	314	458	494	507	547	603
32	368	410	598	645	662	715	787
36	465	518	757	817	838	904	997
40	574	640	935	1 010	1 040	1 120	1 230
44	695	774	1 130	1 220	1 250	1 350	1 490
48	827	922	1 350	1 450	1 490	1 610	1 770
52	971	1 080	1 580	1 700	1 750	1 890	2 080
56	1 130	1 250	1 830	1 980	2 030	2 190	2 410
60	1 290	1 440	2 100	2 270	2 330	2 510	2 770

[1] Informative only

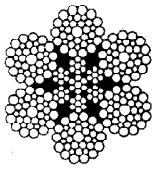
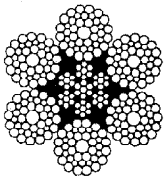
Table 8 — Class 8x19

Construction cross section examples	Construction of rope		Construction of strand		
	Item	Quantity	Item		Quantity
	Strands	8	Wires		15 to 26
	outer strands	8	Outer wires		7 to 12
	layers of strands	1	Layers of wires		2 to 3
	Wires in rope (excluding metallic core)	120 to 208			
8x19S-IWRC	Typical example		No. of outer wires		Outer wire factor[1]
	Rope	Strand	Total	per strand	
	8×19S	1-9-9	72	9	0,065 5
	8×25F	1-6-6F-12	96	12	0,052 5
	8×19W	1-6-6+6	96	12	0,060 6
				6	0,045 0
	8×26WS	1-5-5+5-10	80	10	0,060 0
8×25F-IWRC	Min. breaking force factor:		K_1 = 0,293	K_2 = 0,356	
	Nominal length mass factor[1]		W_1 = 0,340	W_2 = 0,407	
	Nominal metallic cross-sectional area factor[1]		C_1 = 0,349	C_2 = 0,457	

Nominal rope diameter mm	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN				
			Rope Grade				
			1770		1960		2160
	Fibre core	Steel core	Fibre core	Steel core	Fibre core	Steel core	Steel core
1	2	3	4	5	6	7	8
8	21,8	26,0	33,2	40,3	36,8	44,7	49,2
9	27,5	33,0	42,0	51,0	46,5	56,5	62,3
10	34,0	40,7	51,9	63,0	57,4	69,8	76,9
11	41,1	49,2	62,8	76,2	69,5	84,4	93,0
12	49,0	58,6	74,7	90,7	82,7	100	111
13	57,5	68,8	87,6	106	97,1	118	130
14	66,6	79,8	102	124	113	137	151
16	87,0	104	133	161	147	179	197
18	110	132	168	204	186	226	249
20	136	163	207	252	230	279	308
22	165	197	251	305	278	338	372
24	196	234	299	363	331	402	443
26	230	275	351	426	388	472	520
28	267	319	407	494	450	547	603
32	348	417	531	645	588	715	787
36	441	527	672	817	744	904	997
40	544	651	830	1 010	919	1 120	1 230
44	658	788	1 000	1 220	1 110	1 350	1 490
48	783	938	1 200	1 450	1 320	1 610	1 770
52	919	1 100	1 400	1 700	1 550	1 890	2 080
56	1 070	1 280	1 630	1 980	1 800	2 190	2 410
60	1 220	1 470	1 870	2 270	2 070	2 510	2 770

[1] Informative only

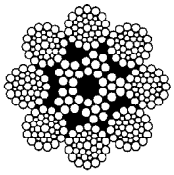
Table 9 — Class 6x36

Construction cross section examples	Construction of rope		Construction of strand		
	Item	Quantity	Item		Quantity
	Strands outer strands layers of strands Wires in rope (excluding steel core)	6 6 1 174 to 342	Wires Outer wires Layers of wires		29 to 57 12 to 18 3 to 4
6×36WS-IWRC	Typical example		No. of outer wires		Outer wire factor[1]
	Rope	Strand	Total	per strand	
	6×31WS	1-6-6+6-12	72	12	0,064
	6×36WS	1-7-7+7-14	84	14	0,056
	6×41WS	1-8-8+8-16	96	16	0,050
	6×49WS	1-8-8-8+8-16	96	16	0,050
6x41WS-IWRC	6×46WS	1-9-9+9-18	108	18	0,045 5
	Min. breaking force factor:		K_1 = 0,330	K_2 = 0,356	
	Nominal length mass factor[1]		W_1 = 0,367	W_2 = 0,409	
	Nominal metallic cross-sectional area factor[1]		C_1 = 0,393	C_2 = 0,460	

Nominal rope diameter mm	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN				
			Rope Grade				
			1770		1960		2160
	Fibre core	Steel core	Fibre core	Steel core	Fibre core	Steel core	Steel core
1	2	3	4	5	6	7	8
8	23,5	26,2	37,4	40,3	41,4	44,7	49,2
9	29,7	33,1	47,3	51,0	52,4	56,5	62,3
10	36,7	40,9	58,4	63,0	64,7	69,8	76,9
11	44,4	49,5	70,7	76,2	78,3	84,4	93,0
12	52,8	58,9	84,1	90,7	93,1	100	111
13	62,0	69,1	98,7	106	109	118	130
14	71,9	80,2	114	124	127	137	151
16	94,0	105	150	161	166	179	197
18	119	133	189	204	210	226	249
20	147	164	234	252	259	279	308
22	178	198	283	305	313	338	372
24	211	236	336	363	373	402	443
26	248	276	395	426	437	472	520
28	288	321	458	494	507	547	603
32	376	419	598	645	662	715	787
36	476	530	757	817	838	904	997
40	587	654	935	1 010	1 040	1 120	1 230
44	711	792	1 130	1 220	1 250	1 350	1 490
48	846	942	1 350	1 450	1 490	1 610	1 770
52	992	1 110	1 580	1 700	1 750	1 890	2 080
56	1 150	1 280	1 830	1 980	2 030	2 190	2 410
60	1 320	1 470	2 100	2 270	2 330	2 510	2 770

[1] Informative only

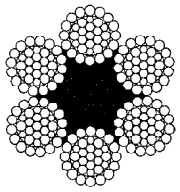
Table 10 — Class 8x36

Construction cross section example	Construction of rope		Construction of strand		
	Item	Quantity	Item	Quantity	
	Strands outer strands layers of strands Wires in rope (excluding steel core)	8 8 1 232 to 456	Wires Outer wires Layers of wires	29 to 57 12 to 18 3 to 4	
8×36WS-IWRC	Typical example		No. of outer wires		Outer wire factor[1]
	Rope	Strand	Total	per strand	
	8×31WS	1-6-6+6-12	96	12	0,052 5
	8×36WS	1-7-7+7-14	112	14	0,046 0
	8×41WS	1-8-8+8-16	128	16	0,041 0
	8×49WS	1-8-8-8+8-16	128	16	0,041 0
	8×46WS	1-9-9+9-18	144	18	0,037 3
	Min. breaking force factor:		K_1 = 0,293	K_2 = 0,356	
	Nominal length mass factor[1]		W_1 = 0,348	W_2 = 0,417	
	Nominal metallic cross-sectional area factor[1]		C_1 = 0,357	C_2 = 0,468	

Nominal rope diameter mm	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN				
			Rope Grade				
			1770		1960		2160
	Fibre core	Steel core	Fibre core	Steel core	Fibre core	Steel core	Steel core
1	2	3	4	5	6	7	8
8	22,3	26,7	33,2	40,3	36,8	44,7	49,2
9	28,2	33,8	42,0	51,0	46,5	56,5	62,3
10	34,8	41,7	51,9	63,0	57,4	69,8	76,9
11	42,1	50,5	62,8	76,2	69,5	84,4	93,0
12	50,1	60,0	74,7	90,7	82,7	100	111
13	58,8	70,5	87,6	106	97,1	118	130
14	68,2	81,7	102	124	113	137	151
16	89,1	107	133	151	147	179	197
18	113	135	168	204	186	226	249
20	139	167	207	252	230	279	308
22	168	202	251	305	278	338	372
24	200	240	299	363	331	402	443
26	235	282	351	426	388	472	520
28	273	327	407	494	450	547	603
32	356	427	531	645	588	715	787
36	451	540	672	817	744	904	997
40	557	667	830	1 010	919	1 120	1 230
44	674	807	1 000	1 220	1 110	1 350	1 490
48	802	961	1 200	1 450	1 320	1 610	1 770
52	941	1 130	1 400	1 700	1 550	1 890	2 080
56	1 090	1 310	1 630	1 980	1 800	2 190	2 410
60	1 250	1 500	1 870	2 270	2 070	2 510	2 770

[1] Informative only

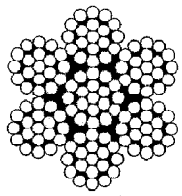
Table 11 — Class 6x35N

Construction cross section example	Construction of rope		Construction of strand			
 6×35NW-FC	Item	Quantity	Item			Quantity
	Strands outer strands layers of strands Wires in rope (excluding steel core)	6 6 1 168 to 288	Wires Outer wires Layers of wires			28 to 48 12 to 18 3
	Typical example		No. of outer wires			Outer wire factor[1]
	Rope	Strand	Total	per strand		
	6×28NW	1-5-5+5/12	72	12		0,064
	6×33NW	1-6-6+6/14	84	14		0,056
	6×34NW	1-6-6+6/15	90	15		0,053
	6×35NW	1-6-6+6/16	96	16		0,050
	Min. breaking force factor: Nominal length mass factor[1]: Nominal metallic cross-sectional area factor[1]:		K_1 = 0,317 W_1 = 0,352 C_1 = 0,377	K_2 = 0,345 W_2 = 0,392 C_2 = 0,441		

Nominal rope diameter mm	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN			
	Fibre core	Steel core	Rope grade 1770		Rope grade 1960	
			Fibre core	Steel core	Fibre core	Steel core
1	2	3	4	5	6	7
8	22,5	25,1	35,9	39,1	39,8	43,3
9	28,5	31,8	45,4	49,5	50,3	54,8
10	36,2	39,2	56,1	61,1	62,1	67,6
11	42,6	47,4	67,9	73,9	75,2	81,8
12	50,7	56,4	80,8	87,9	89,5	97,4
13	59,5	66,2	94,8	103	105	114
14	69,0	76,8	110	120	122	133
16	90,1	100	144	156	159	173
18	114	127	182	198	201	219
20	141	157	224	244	249	270
22	170	190	272	296	301	327
24	203	226	323	352	358	389
26	238	265	379	413	420	457
28	276	307	440	479	487	530
32	360	401	575	625	636	692
36	456	508	727	791	805	876
40	563	626	898	977	994	1 080
44	681	759	1 090	1 180	1 200	1 310
48	811	903	1 290	1 410	1 430	1 560
52	952	1 060	1 520	1 650	1 680	1 830
56	1 100	1 230	1 760	1 920	1 950	2 120
60	1 270	1 410	2 020	2 200	2 240	2 430

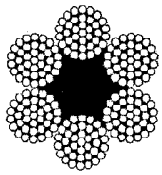
[1] Informative only

Table 12 — Class 6x19M

<table>
<tr><td rowspan="5">Construction cross section example
 
6×19M-WSC</td><td colspan="3">Construction of rope</td><td colspan="3">Construction of strand</td></tr>
<tr><td>Item</td><td>Quantity</td><td colspan="2">Item</td><td>Quantity</td></tr>
<tr><td>Strands
outer strands
layers of strands
Wires in rope
(excluding steel core)</td><td>6
6
1
72 to 114</td><td colspan="2">Wires
Outer wires
Layers of wires</td><td>12 to 19
9 to 12
2</td></tr>
<tr><td colspan="2">Typical example</td><td colspan="2">No. of outer wires</td><td rowspan="2">Outer wire factor[1)]</td></tr>
<tr><td>Rope</td><td>Strand</td><td>Total</td><td>per strand</td></tr>
<tr><td></td><td>6x19M</td><td>1-6/12</td><td>72</td><td>12</td><td>0,064 0</td></tr>
<tr><td></td><td colspan="5">Min. breaking force factor K_1 = 0,307 K_3 = 0,362
Nominal length mass factor[1)] W_1 = 0,346 W_3 = 0,381
Nominal metallic cross-sectional area factor[1)] C_1 = 0,357 C_3 = 0,418</td></tr>
<tr><td rowspan="2">Nominal rope diameter

mm</td><td colspan="2">Approximate nominal length mass[1)] kg/100 m</td><td colspan="3">Minimum breaking force kN</td></tr>
<tr><td>Fibre core</td><td>Steel core</td><td colspan="2">Rope grade 1770</td><td colspan="2">Rope grade 1960</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>3</td><td>3,11</td><td>3,43</td><td>4,89</td><td>5,77</td><td>5,42</td><td>6,39</td></tr>
<tr><td>4</td><td>5,54</td><td>6,10</td><td>8,69</td><td>10,3</td><td>9,63</td><td>11,4</td></tr>
<tr><td>5</td><td>8,65</td><td>9,53</td><td>13,6</td><td>16,0</td><td>15,0</td><td>17,7</td></tr>
<tr><td>6</td><td>12,5</td><td>13,7</td><td>19,6</td><td>23,1</td><td>21,7</td><td>25,5</td></tr>
<tr><td>7</td><td>17,0</td><td>18,7</td><td>26,6</td><td>31,4</td><td>29,5</td><td>34,8</td></tr>
<tr><td colspan="7">[1)] Informative only</td></tr>
</table>

Table 13 — Class 6x37M

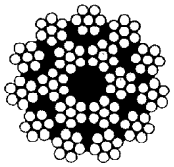
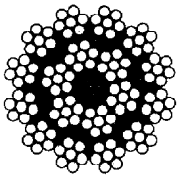
Construction cross section example	Construction of rope		Construction of strand		
 6×37M-FC	Item	Quantity	Item		Quantity
	Strands outer strands layers of strands Wires in rope (excluding steel core)	6 6 1 162 to 222	Wires Outer wires Layers of wires		27 to 37 16 to 18 3
	Typical example		No. of outer wires		Outer wire factor[1]
	Rope	Strand	Total	per strand	
	6x37M	1-6/12/18	108	18	0,0455
	Min. breaking force factor Nominal length mass factor[1] Nominal metallic cross-sectional area factor[1]		K_1 = 0,295 W_1 = 0,346 C_1 = 0,357	K_2 = 0,319 W_2 = 0,381 C_2 = 0,418	K_3 = 0,346 W_3 = 0,381 C_3 = 0,418

Nominal rope diameter mm	Approximate nominal length mass[1] kg/100 m		Minimum breaking force kN			
	Fibre core	Steel core	Rope grade 1770		Rope grade 1960	
			Fibre core	Steel core	Fibre core	Steel core
1	2	3	4	5[2]	6	7[2]
5	8,65	9,53	13,1	15,3	14,5	17,0
6	12,5	13,7	18,8	22,0	20,8	24,4
7	17,0	18,7	25,6	30,0	28,3	33,2
8	22,1	24,4	33,4	39,2	37,0	43,4
9	28,0	30,9	42,3	49,6	46,8	54,9
10	34,6	38,1	52,2	61,2	57,8	67,8
11	41,9	46,1	63,2	74,1	70,0	82,1
12	49,8	54,9	75,2	88,2	83,3	97,7

[1] Informative only

[2] The values shown in columns 5 and 7 are for ropes with wire strand cores (WSC) and based on minimum breaking force factor K_3. The minimum breaking force for ropes with independent wire rope cores (IWRC) shall be based on factor K_2.

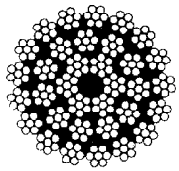
Table 14 — Class 18x7

<table>
<tr><td rowspan="4">Construction cross section example
 
17×7-FC
 
18×7-FC</td><td colspan="3">Construction of rope</td><td colspan="3">Construction of strand</td></tr>
<tr><td>Item</td><td>Quantity</td><td colspan="2">Item</td><td>Quantity</td></tr>
<tr><td>Strands
outer strands
layers of strands
Wires in rope (excluding wire strand centre)</td><td>17 to 18
10 to 12
2
85 to 162</td><td colspan="2">Wires
Outer wires
Layers of wires</td><td>5 to 9
4 to 8
1</td></tr>
<tr><td colspan="3">Typical example</td><td colspan="2">No. of outer wires</td><td>Outer wire factor[1)]</td></tr>
<tr><td>Rope</td><td>Strand</td><td>Total</td><td>per strand</td><td></td></tr>
<tr><td colspan="2">17×7
18x7</td><td>1-6
1-6</td><td>66
72</td><td>6
6</td><td>0,070
0,063 2</td></tr>
<tr><td colspan="2">Min. breaking force factor;
Nominal length mass factor[1)]:
Nominal metallic cross-sectional area factor[1)]:</td><td colspan="4">K_1 = 0,328 K_3 = 0,328
W_1 = 0,382 W_3 = 0,401
C_3 = 0,433</td></tr>
</table>

Nominal rope diameter	Approximate nominal length mass[1)] kg/100 m		Minimum breaking force kN	
	Fibre centre	Steel centre	Rope grade 1770	Rope grade 1960
mm			Fibre or steel centre	Fibre or steel centre
1	2	3	4	5
6	13,8	14,4	20,9	23,1
7	18,7	19,6	28,4	31,5
8	24,4	25,7	37,2	41,1
9	30,9	32,5	47,0	52,1
10	38,2	40,1	58,1	64,3
11	46,2	48,5	70,2	77,8
12	55,0	57,7	83,6	92,6
13	64,6	67,8	98,1	109
14	74,9	78,6	114	126
16	97,8	103	149	165
18	124	130	188	208
20	153	160	232	257
22	185	194	281	311
24	220	231	334	370
26	258	271	392	435
28	299	314	455	504

[1)] Informative only

Table 15 — Class: 34(M)x7

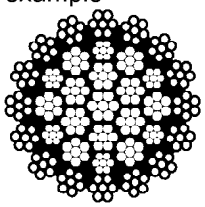
<table>
<tr><td rowspan="6">Construction cross section example
 
34(M)×7-FC</td><td colspan="2">Construction of rope</td><td colspan="3">Construction of strand</td></tr>
<tr><td>Item</td><td>Quantity</td><td>Item</td><td colspan="2">Quantity</td></tr>
<tr><td>Strands
outer strands
layers of strands
Wires in rope - (excluding wire strand centre)</td><td>34 to 36
17 to 18
3

170 to 324</td><td>Wires
Outer wires
Layers of wires</td><td colspan="2">5 to 9
4 to 8
1</td></tr>
<tr><td colspan="2">Typical example</td><td colspan="2">No. of outer wires</td><td>Outer wire factor[1)]</td></tr>
<tr><td>Rope</td><td>Strand</td><td>Total</td><td>per strand</td><td></td></tr>
<tr><td>34(M)x7
36(M)x7</td><td>1-6
1-6</td><td>102
108</td><td>6
6</td><td>0,047 2
0,045</td></tr>
<tr><td colspan="5">Min. breaking force factor K_1 = 0,318 K_3 = 0,318
Nominal length mass factor[1)] W_1 = 0,390 W_3 = 0,401
Nominal metallic cross-sectional area factor[1)] C_3 = 0,428</td></tr>
</table>

Nominal rope diameter mm	Approximate nominal length mass[1)] kg/100 m		Minimum breaking force kN	
	Fibre centre	Steel centre	Rope grade 1770	Rope grade 1960
			Fibre or steel centre	Fibre or steel centre
1	2	3	4	5
10	39,0	40,1	56,3	62,3
11	47,2	48,5	68,1	75,4
12	56,2	57,7	81,1	89,8
13	65,9	67,8	95,1	105
14	76,4	78,6	110	122
16	99,8	103	144	160
18	126	130	182	202
20	156	160	225	249
22	189	194	272	302
24	225	231	324	359
26	264	271	380	421
28	306	314	441	489
32	399	411	576	638
36	505	520	729	808
40	624	642	901	997
44	755	776	1 090	1 210
48	899	924	1 300	1 440
52	1 060	1 080	1 520	1 690
56	1 220	1 260	1 770	1 960
60	1 400	1 440	2 030	2 240

[1)] Informative only

Table 16 — Class 35(W)x7

<table>
<tr><td rowspan="6">Construction cross section example
 
35(W)×7</td><td colspan="2">Construction of rope</td><td colspan="3">Construction of strand</td></tr>
<tr><td>Item</td><td>Quantity</td><td colspan="2">Item</td><td>Quantity</td></tr>
<tr><td>Strands
outer strands
layers of strands
Wires in rope</td><td>28 to 40
15 to 18
3
196 to 280</td><td colspan="2">Wires
Outer wires
Layers of wires</td><td>5 to 9
4 to 8
1</td></tr>
<tr><td colspan="2">Typical example</td><td colspan="2">No. of outer wires</td><td rowspan="2">Outer wire factor[1)]</td></tr>
<tr><td>Rope</td><td>Strand</td><td>Total</td><td>per strand</td></tr>
<tr><td>35(W)x7</td><td>1-6</td><td>96</td><td>6</td><td>0,046 1</td></tr>
<tr><td colspan="5">Min. breaking force factor: K_3 = 0,360[2)] K_3 = 0,350[3)]
Nominal length mass factor[1)] W_3 = 0,454
Nominal metallic cross-sectional area factor[1)] C_3 = 0,480</td></tr>
</table>

Nominal rope diameter mm	Approximate nominal length mass[1)] kg/100 m	Minimum breaking force kN	
		Rope grade 1960	Rope grade 2160
1	2	3	4
8	29,1	45,2	48,4
9	36,8	57,2	61,2
10	45,4	70,6	75,6
11	54,9	85,4	91,5
12	65,4	102	109
13	76,7	119	128
14	89,0	138	148
16	116	181	194
18	147	229	245
20	182	282	302
22	220	342	366
24	262	406	435
26	307	477	511
28	356	553	593
32	465	723	774
36	588	914	980
38	656	1 020	1 090
40	726	1 130	1 210

[1)] Informative only
[2)] Up to and including rope grade 1960
[3)] Greater than rope grade 1960 up to and including rope grade 2160

Table 17 — Large diameter ropes

Class	Number of strands	Outer strands	Layers of strands	Wires in rope[1)]	Wires per strand	Outer wires in one strand	Layer of wires	Typical rope diameter range[2)]
6×19	6	6	1	90 to 156	15 to 26	7 to 12	2 to 3	64 to 70
8×19	8	8	1	120 to 208	15 to 26	7 to 12	2 to 3	64 to 76
6×36	6	6	1	174 to 342	29 to 57	12 to 18	3	64 to 100
8×36	8	8	1	232 to 456	29 to 57	12 to 18	3	80 to 192
6×61	6	6	1	366 to 510	61 to 85	18 to 24	3 to 4	104 to 136
8×61	8	8	1	488 to 680	61 to 85	18 to 24	3 to 4	200 to 264
6×91N	6	6	1	510 to 654	85 to 109	24 to 36	4 to 6	144 to 192
8×91N	8	8	1	680 to 872	85 to 109	24 to 36	4 to 6	> 150

F_{min} = 8,55 d + 0,592 d^2 - 0,000 615 d^3, where d = nominal rope diameter
$M = W.d^2$, where nominal length mass factor (W) = 0,415

Nominal rope diameter mm	Approximate nominal length mass kg/100 m	Minimum breaking force kN
64	1 700	2 800
68	1 900	3 100
72	2 200	3 500
76	2 400	3 800
80	2 700	4 200
84	2 900	4 500
88	3 200	4 900
92	3 500	5 300
96	3 800	5 700
100	4 200	6 200
104	4 500	6 600
112	5 200	7 500
120	6 000	8 500
128	6 800	9 500
136	7 700	10 600
144	8 600	11 700
152	9 600	12 800
160	10 600	14 000
168	11 700	15 200
176	12 900	16 500
184	14 100	17 800
192	15 300	19 100
200	16 600	20 500
208	18 000	21 900
216	19 400	23 300
224	20 800	24 700
232	22 300	26 200
240	23 900	27 700
248	25 500	29 200
256	27 200	30 700
264	28 900	32 200

[1)] Excluding steel core

[2)] Information only.

Annex A
(normative)
Calculation of minimum breaking force for those ropes covered by Tables 5 to 17

A.1 Ropes from 2 mm to 60 mm diameter

The minimum breaking force, F_{min}, expressed in kilonewtons, shall be calculated using the following equation:

$$F_{min} = \frac{K.d^{2}.R_{r}}{1000}$$

where

d is the nominal diameter of the rope, in mm;

R_r is the rope grade intended by the manufacturer, in Newtons per square millimetres; and

K is the empirical factor for the minimum breaking force for a given rope class and core type

K_1 is the factor for stranded ropes with a fibre core (single layer rope) or fibre centre (rotation-resistant rope)
K_2 is the factor for stranded ropes with an independent wire rope core
K_3 is the factor for stranded ropes with a wire strand core (single layer rope) or wire strand centre (rotation-resistant rope)

A.2 Ropes over 60 mm and up to 264 mm diameter

The minimum breaking force, F_{min}, expressed in kilonewtons is calculated using the following equation:

$$F_{min} = 8{,}55\ d + 0{,}592\ d^2 - 0{,}000\ 615\ d^3$$

where

d is the nominal diameter of the rope, in millimetres.

Annex B
(normative)
Summary of factors for calculations

Table B.1 summarises the factors used in the calculation of minimum breaking force, for those ropes covered by Tables 5 to 16.

Table B.1 - Factors for stranded wire ropes for general lifting applications

Type of rope	Class	Ropes with fibre core or fibre centre			Ropes with steel core or wire strand centre					
		Nominal length mass factor (approx.)	Nominal metallic cross-sectional area factor	Minimum breaking force factor	Nominal length mass factor		Nominal metallic cross-sectional area factor		Minimum breaking force factor	
		W_1	C_1	K_1	W_2	W_3	C_2	C_3	K_2	K_3
Single layer round strand rope	6x7	0,345	0,369	0,332	0,384	0,384	0,432	0,432	0,359	0,388
	8x7	0,327	0,335	0,291	0,391		0,439		0,359	
	6x19	0,359	0,384	0,330	0,400		0,449		0,356	
	8x19	0,340	0,349	0,293	0,407		0,457		0,356	
	6x36	0,367	0,393	0,330	0,409		0.460		0,356	
	8x36	0,348	0,357	0,293	0,417		0,468		0,356	
	6x35N	0,352	0,377	0,317	0,392		0,441		0,345	
	6x19M	0,346	0,357	0,307		0,381		0,418	0,332	0,362
	6x37M	0,346	0,357	0,295	0,381	0,381	0,418	0,418	0,319	0,346
Rotation resistant rope	18x7	0,382		0,328		0,401		0,433		0,328
	34(M)x7	0,390		0,318		0,401		0,428		0,318
	35(W)x7					0,454		0,480		0,360[1)] 0,350[2)]

[1)] Up to and including rope grade 1960
[2)] Greater than rope grade 1960 up to and including rope grade 2160

NOTE 1 The nominal length mass factors and nominal cross-sectional area factors are only for information.

NOTE 2 See EN 12385-2 for calculation of nominal length mass, nominal metallic cross sectional area and minimum breaking force using the factors in Table B.1.

Annex C
(informative)
Calculation of approximate nominal length mass of ropes over 60mm diameter

C.1 Length mass of ropes over 60 mm and up to 264 mm diameter

The approximate rope length mass, M, expressed in kilograms per 100 m, should be calculated as follows:

$$M = 0{,}415\ d^2$$

where d is the nominal diameter of the rope, in mm

Annex D
(informative)
Information which should be provided with an enquiry or an order

At least the following information should be supplied with an enquiry or order:

a) reference to this standard, i.e. EN 12385-4;

b) quantity and length;

c) nominal diameter;

d) rope class or construction;

e) core type;

f) rope grade;

g) wire finish;

h) lay direction and type;

NOTE Single layer ropes are normally manufactured right hand ordinary lay unless otherwise stated by the purchaser.

i) preformation;

NOTE The outer strands of single layer and parallel-closed ropes are normally preformed during manufacture. The purchaser should specify any particular preformation requirements.

j) lubrication;

NOTE At least the strands are lubricated during manufacture. The purchaser should specify any particular lubrication requirements.

k) type of inspection document - refer EN 12385-1;

l) any particular marking requirements;

m) any particular packaging requirements;

n) minimum breaking force required.

Annex ZA
(informative)
Relationship of this document with EC Directives

This Part of this European Standard has been prepared under a Mandate given to CEN by the European Commission and the European Free Trade Association, and supports the essential requirements of EC Directives as follows:

Machinery Safety Directive 98/37/EC, amended by Directive 98/79/EC.

Compliance with the listed clauses of this Part provides one means of complying with the specific essential requirements of the Directive concerned and associated EFTA regulations.

WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.

Bibliography

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

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