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Wire ropes

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Wire Products Association (JWPA)/ Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS G 3525:2006** is replaced with this Standard.

However, **JIS G 3525:2006** may be applied in the **JIS** mark certification based on the relevant provisions of Article 19 Clause 1, etc. of the Industrial Standardization Law until November 19, 2014.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

Wire ropes

Introduction

This Japanese Industrial Standard has been prepared based on the third edition of **ISO 2408** published in 2004 and the second edition of **ISO 4344** published in 2004 with some modifications of the technical contents.

The portions with continuous sidelines or dotted underlines are the matters in which the contents of the corresponding International Standards have been modified. A list of modifications with explanations is given in Annex JC.

1 Scope

This Standard specifies general wire ropes used for machines, lifts, construction works, ships, fishery, forestry, mining, ropeways and the like (hereafter referred to as “ropes”).

However, this Standard is not applicable to wire ropes with profile wires, wire ropes for aircraft control, wire ropes for mechanical control and wire ropes for structure.

NOTE : The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 2408:2004 *Steel wire ropes for general purposes—Minimum requirements*

ISO 4344:2004 *Steel wire ropes for lifts—Minimum requirements* (Overall evaluation: MOD)

The symbols which denote the degree of correspondence in the contents between the relevant International Standards and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 3506 *High carbon steel wire rods*

JIS H 0401 *Test methods for hot dip galvanized coatings*

JIS Z 8401 *Guide to the rounding of numbers*

3 Terms and definitions

For the purposes of this Standard, the following terms and definitions apply.

3.1 wire

steel wire constructing a strand

There are bright wires which are not plated and plated wires which are galvanized.

3.2 strand

element of rope consisting of an assembly of wires laid helically

3.3 core

general term of fibre core, independent wire rope core and wire strand core

3.3.1 fibre core

fibre rope centring a rope

There are natural fibre cores and synthetic fibre cores.

3.3.2 independent wire rope core

rope centring a rope, which has 7×7 construction, and the symbol is IWRC

3.3.3 wire strand core

strand centring a rope, which has 1×7 construction

3.4 rope diameter

diameter of circumscribed circle at any cross-section of a rope

There are the nominal diameter and the actual diameter.

3.5 rope lay length

pitch of helix of strand in the outer layer of a rope (see figure 1)

3.6 strand lay length

pitch of helix of wire in the outer layer of a strand

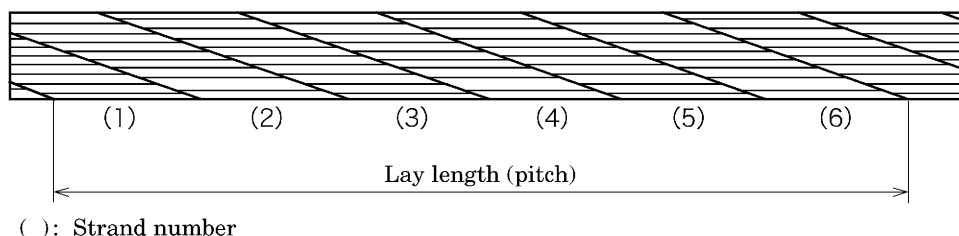


Figure 1 Lay length (informative example: in the case of 6 strand rope)

3.7 lay direction

direction of lay of strand in a rope or direction of lay of wire in a strand (see figure 2)

There are Z-lay and S-lay.

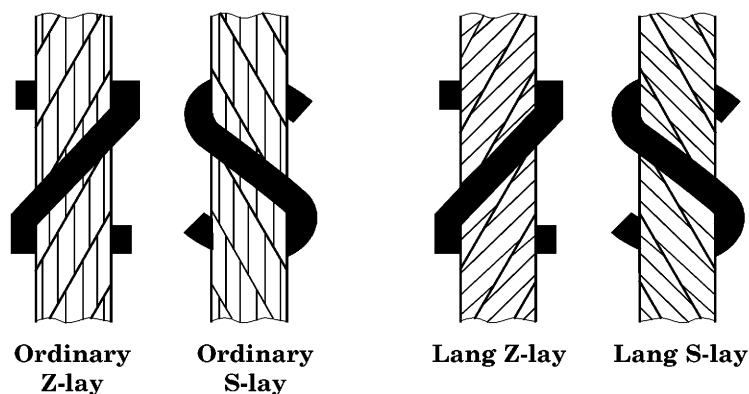


Figure 2 Lay type and lay direction

3.8 lay type of rope

combination of lay direction of rope and lay direction of strand (see figure 2)

3.8.1 ordinary lay

lay type in which lay direction of wire in a strand is opposite to lay direction of strand in a rope

3.8.2 Lang lay

lay type in which lay direction of wire in a strand is the same as lay direction of strand in a rope

3.9 lay type of strand

combination of lay direction of wires in respective layers of a strand

3.9.1 cross-lay

strand in which wires in respective layers make point contacts; however, the designation “7 wires” is classified into cross-lay

3.9.2 parallel-lay

strand in which wires in respective layers make linear contacts

There are types of Seale, Warrington, Filler, Warrington Seale and others according to the combination of wires in respective layers.

3.10 filler-wire

wire used in Filler rope to fill up interstices in a strand between outer and inner layers of wires

3.11 measured breaking force

maximum test force leading to the breakage of a test piece in the measured breaking force test

3.12 aggregate breaking force

sum of measured breaking force of respective wires constructing a rope

3.13 rope grade

categories for breaking force of rope based on the nominal tensile strength of wires constructing a rope

3.14 lot

a series of ropes manufactured consecutively from the same wires by the same machine

3.15 free length between grips

distance between inner ends of test piece grips such as chucks in the measured breaking force test or torsion test for wires, or the measured breaking force test for ropes

4 Classification

Classification of ropes shall be as follows.

- a) **Construction** Ropes shall be classified into 24 categories according to the designation, constructional symbol and cross section as given in table 1.

Table 1 Construction

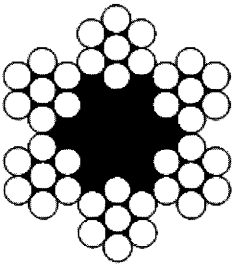
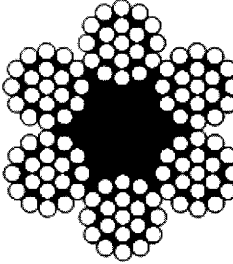
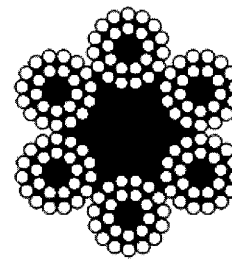
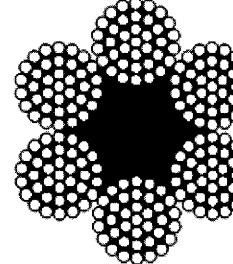
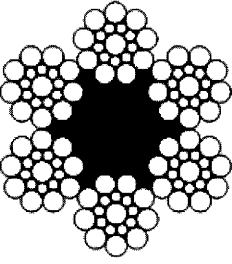
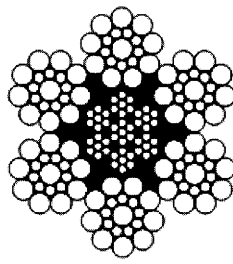
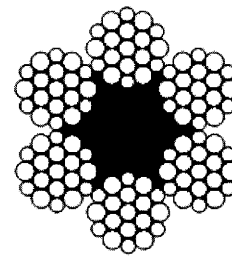
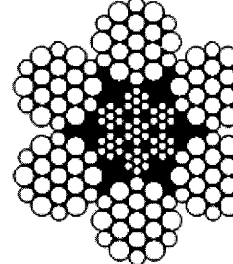
Designation	6 strands of 7 wires	6 strands of 19 wires	6 strands of 24 wires	6 strands of 37 wires
Constructional symbol	6×7	6×19	6×24	6×37
Cross section				
Designation	Seale rope 6 strands of 19 wires	Seale rope with independent wire rope core 6 strands of 19 wires	Warrington rope 6 strands of 19 wires	Warrington rope with independent wire rope core 6 strands of 19 wires
Constructional symbol	$6 \times S (19)$	IWRC $6 \times S (19)$	$6 \times W (19)$	IWRC $6 \times W (19)$
Cross section				

Table 1 (continued)

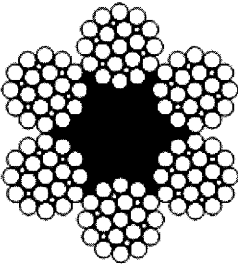
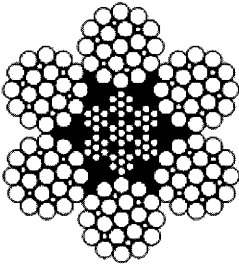
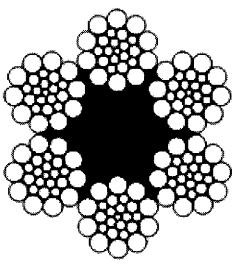
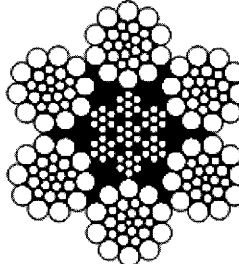
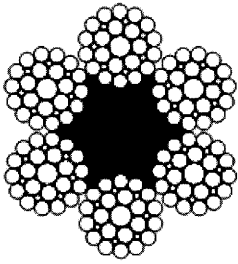
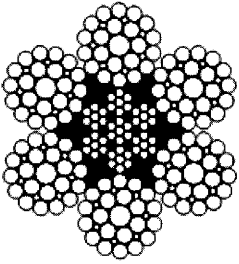
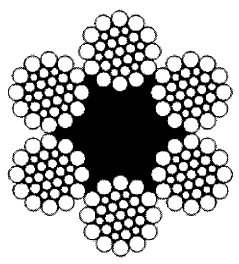
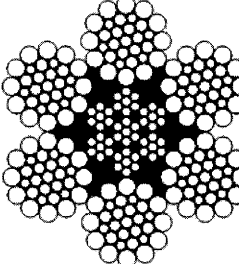
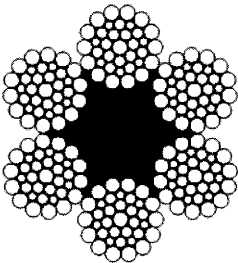
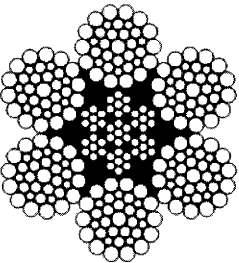
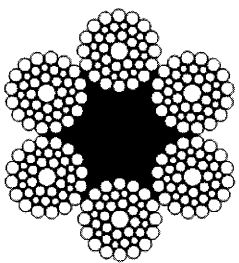
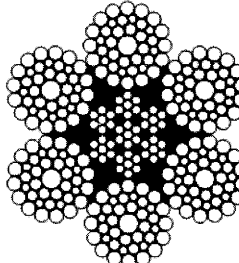
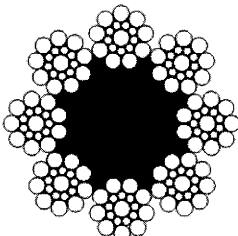
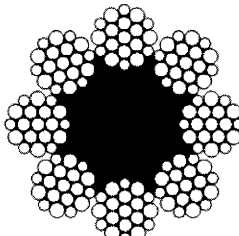
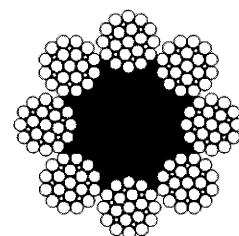
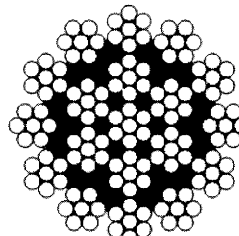
Designation	Filler rope 6 strands of 25 wires	Filler rope with independent wire rope core 6 strands of 25 wires	Warrington Seale rope 6 strands of 26 wires	Warrington Seale rope with independent wire rope core 6 strands of 26 wires
Constructional symbol	$6 \times \text{Fi} (25)$	IWRC $6 \times \text{Fi} (25)$	$6 \times \text{WS} (26)$	IWRC $6 \times \text{WS} (26)$
Cross section				
Designation	Filler rope 6 strands of 29 wires	Filler rope with independent wire rope core 6 strands of 29 wires	Warrington Seale rope 6 strands of 31 wires	Warrington Seale rope with independent wire rope core 6 strands of 31 wires
Constructional symbol	$6 \times \text{Fi} (29)$	IWRC $6 \times \text{Fi} (29)$	$6 \times \text{WS} (31)$	IWRC $6 \times \text{WS} (31)$
Cross section				
Designation	Warrington Seale rope 6 strands of 36 wires	Warrington Seale rope with independent wire rope core 6 strands of 36 wires	Warrington Seale rope 6 strands of 41 wires	Warrington Seale rope with independent wire rope core 6 strands of 41 wires
Constructional symbol	$6 \times \text{WS} (36)$	IWRC $6 \times \text{WS} (36)$	$6 \times \text{WS} (41)$	IWRC $6 \times \text{WS} (41)$
Cross section				

Table 1 (concluded)

Designation	Seale rope 8 strands of 19 wires	Warrington rope 8 strands of 19 wires	Filler rope 8 strands of 25 wires	Hercules rope 19 strands of 7 wires
Constructional symbol	8 × S (19)	8 × W (19)	8 × Fi (25)	19 × 7
Cross section				

- b) **Lay type and lay direction** Ropes shall be classified into ordinary Z-lay, ordinary S-lay, Lang Z-lay and Lang S-lay (see figure 2).
- c) **With/without plating** Ropes shall be classified into bright ropes (hereafter referred to as “bright”) and plated ropes (hereafter referred to as “plated”).
- d) **Rope grade** Ropes shall be classified into Grade E, Grade G, Grade A, Grade B and Grade T according to the nominal tensile strength as given in table 2. The nominal tensile strength herein indicates the tensile strength of wires regarded as calculation basis of breaking force of rope given in table 4 to table 20.

Table 2 Rope grade

Grade	Nominal tensile strength N/mm ²	Application
Grade E ^{a)}	1 320	Bright or plated (including those cold-worked after plating)
Grade G	1 470	Plated (including those cold-worked after plating)
Grade A	1 620	Bright or plated (including those cold-worked after plating)
Grade B	1 770	Bright or plated (including those cold-worked after plating)
Grade T	1 910	Bright
NOTE : 1 N/mm ² = 1 MPa		
Note ^{a)} Indicates dual-tensile ropes whose nominal tensile strength of wires in the most outer layer is lower than that of wires in the inner layer for the strand in the outer layer.		

- e) **Combination** As given in table 3 [except b)].

Table 3 Combination

Strand			Type of core	Constructional symbol	With/without plating							
Number of layers	Lay type	Num-ber			Bright				Plated			
					Grade E	Grade A	Grade B	Grade T	Grade E	Grade G	Grade A	Grade B
Single	Cross-lay	6	Fibre core	6 × 7	—	○	—	—	—	○	—	—
				6 × 19	—	○	—	—	—	○	—	—
				6 × 24	—	○	—	—	—	○	—	—
				6 × 37	—	○	—	—	—	○	—	—
	Parallel-lay	6	Fibre core	6 × S (19)	○	○	○	○	○	—	○	○
				6 × W (19)	○	○	○	○	○	—	○	○
				6 × Fi (25)	○	○	○	○	○	—	○	○
				6 × WS (26)	—	—	○	○	—	—	—	○
				6 × Fi (29)	—	—	○	○	—	—	—	○
				6 × WS (31)	—	—	○	○	—	—	—	○
				6 × WS (36)	—	—	○	○	—	—	—	○
				6 × WS (41)	—	—	○	○	—	—	—	○
			Independent wire rope core	IWRC 6 × S (19)	—	—	○	○	—	—	—	○
				IWRC 6 × W (19)	—	—	○	○	—	—	—	○
				IWRC 6 × Fi (25)	—	—	○	○	—	—	—	○
				IWRC 6 × WS (26)	—	—	○	○	—	—	—	○
				IWRC 6 × Fi (29)	—	—	○	○	—	—	—	○
				IWRC 6 × WS (31)	—	—	○	○	—	—	—	○
				IWRC 6 × WS (36)	—	—	○	○	—	—	—	○
		IWRC 6 × WS (41)	—	—	○	○	—	—	—	○		
		8	Fibre core	8 × S (19)	○	○	○	○	○	—	○	—
				8 × W (19)	○	○	○	○	○	—	○	—
				8 × Fi (25)	○	○	○	○	○	—	○	—
Multiple	Cross-lay	18	Strand core	19 × 7	—	—	—	—	—	—	○	—

5 Materials

5.1 Wire rod

Materials used for the manufacture of wires shall be wire rods which conform to **JIS G 3506** or those at least equivalent, or heat treated (inline patented) materials thereof.

5.2 Fibre core

Fibres used for fibre cores shall be synthetic or natural fibres in good quality. Unless otherwise specified, fibres shall be impregnated with grease appropriately.

5.3 Rope grease

Main components of red grease and black grease for rope or core to be coated or impregnated with (hereafter referred to as “grease”) shall be petrolatum for red grease and asphalt for black grease.

Grease shall not contain harmful acid or alkali.

6 Method for manufacturing

6.1 Wire

The manufacturing method of wires shall be as follows.

- a) Bright wires shall be cold-worked after heat treatment (patenting) as required.
- b) Plated wires shall be either galvanized after cold-work or cold-worked after galvanizing.

6.2 Rope

6.2.1 Spinning

Ropes shall be spun so that the diameter, lay length, etc. are uniform throughout the full length by using wires of **6.1** and fibre cores of **5.2** (except rope with independent wire rope core and rope with wire strand core). The lay direction of rope shall generally be Z-lay, and lay directions of independent wire rope core and wire strand core shall generally be the same as the lay direction of rope. In the spinning process of strands, if wires need joining, welding or splicing may be applied. However, this joining shall not be made otherwise at one point in any 10 m of a strand.

Where the diameter of the core wire of a strand is over 1.3 times the wire diameter in the adjacent covering layer, the core wire may be replaced with a stranded wire. In this case, the designation and constructional symbol shall be as they are.

6.2.2 Lubrication

Ropes shall generally be coated with grease.

7 Mechanical properties

7.1 Measured breaking force

7.1.1 Wire

For post-spin wires of the same type and same diameter group, when tested according to **11.2.3**, the difference between respective measured breaking forces and the mean value thereof shall be within $\pm 8\%$ of the mean value except core wires and filler wires of strand.

7.1.2 Rope

For ropes, when tested according to **11.3.3**, the obtained values shall be not less than the values given in table 4 to table 20.

Table 4 Measured breaking force of 6 × 7

Lay type	With/without plating	Rope grade	Nominal diameter of rope mm	Measured breaking force (min.) kN	Approximate unit mass kg/m (informative)
Ordinary lay	Plated	Grade G	6	19.0	0.134
			8	33.8	0.237
			9	42.8	0.300
			10	52.8	0.371
			12	76.0	0.534
			14	103	0.727
			16	135	0.950
			18	171	1.20
			20	211	1.48
			22	256	1.80
			24	304	2.14
			26	357	2.51
			28	414	2.91
			30	475	3.34
			32	541	3.80
Lang lay	Bright	Grade A	6	21.4	0.134
			8	38.1	0.237
			9	48.2	0.300
			10	59.5	0.371
			12	85.6	0.534
			14	117	0.727
			16	152	0.950
			18	193	1.20
			20	238	1.48
			22	288	1.80
			24	343	2.14
			26	402	2.51
			28	466	2.91
			30	535	3.34
			32	609	3.80

Table 5 Measured breaking force of 6 × 19

Lay type	With/without plating	Rope grade	Nominal diameter of rope mm	Measured breaking force (min.) kN	Approximate unit mass kg/m (informative)
Ordinary lay	Plated	Grade G	6	18.1	0.131
			8	32.1	0.233
			9	40.7	0.295
			10	50.2	0.364
			12	72.3	0.524
			14	98.4	0.713
			16	128	0.932
			18	163	1.18
			20	201	1.46
			22	243	1.76
			24	289	2.10
			26	339	2.46
			28	393	2.85
Ordinary lay	Bright	Grade A	6	19.4	0.131
			8	34.6	0.233
			9	43.8	0.295
			10	54.0	0.364
			12	77.8	0.524
			14	106	0.713
			16	138	0.932
			18	175	1.18
			20	216	1.46
			22	261	1.76
			24	311	2.10
			26	365	2.46
			28	424	2.85

Table 6 Measured breaking force of 6 × 24

Lay type	With/without plating	Rope grade	Nominal diameter of rope mm	Measured breaking force (min.) kN	Approximate unit mass kg/m (informative)
Ordinary lay	Plated	Grade G	6	16.5	0.120
			8	29.3	0.212
			9	37.1	0.269
			10	45.8	0.332
			12	65.9	0.478
			14	89.7	0.651
			16	117	0.850
			18	148	1.08
			20	183	1.33
			22	222	1.61
			24	264	1.91
			26	309	2.24
			28	359	2.60
			30	412	2.99
			32	469	3.40
			36	593	4.30
			40	732	5.31
Ordinary lay	Bright	Grade A	6	17.7	0.120
			8	31.6	0.212
			9	39.9	0.269
			10	49.3	0.332
			12	71.0	0.478
			14	96.6	0.651
			16	126	0.850
			18	160	1.08
			20	197	1.33
			22	239	1.61
			24	284	1.91
			26	333	2.24
			28	387	2.60
			30	444	2.99
			32	505	3.40
			36	639	4.30
			40	789	5.31

Table 7 Measured breaking force of 6 × 37

Lay type	With/without plating	Rope grade	Nominal diameter of rope mm	Measured breaking force (min.) kN	Approximate unit mass kg/m (informative)
Ordinary lay	Plated	Grade G	6	17.8	0.129
			8	31.6	0.230
			9	40.0	0.291
			10	49.4	0.359
			12	71.1	0.517
			14	96.7	0.704
			16	126	0.920
			18	160	1.16
			20	197	1.44
			22	239	1.74
			24	284	2.07
			26	334	2.43
			28	387	2.82
			30	444	3.23
			32	505	3.68
			36	640	4.66
			40	790	5.75
			44	956	6.96
			48	1 140	8.28
			52	1 330	9.72
			56	1 550	11.3
			60	1 780	12.9
Ordinary lay	Bright	Grade A	6	19.1	0.129
			8	34.0	0.230
			9	43.0	0.291
			10	53.1	0.359
			12	76.5	0.517
			14	104	0.704
			16	136	0.920
			18	172	1.16
			20	212	1.44
			22	257	1.74
			24	306	2.07
			26	359	2.43
			28	416	2.82
			30	478	3.23
			32	544	3.68
			36	688	4.66
			40	850	5.75
			44	1 030	6.96
			48	1 220	8.28
			52	1 440	9.72
			56	1 670	11.3
			60	1 910	12.9

Table 8 Measured breaking force of 6 × S (19)

Lay type	With/without plating	Rope grade	Nominal diameter of rope mm	Measured breaking force (min.) kN	Approximate unit mass kg/m (informative)
Ordinary lay	Bright/plated	Grade E	6	16.1	0.139
			6.3	17.8	0.153
			8	28.6	0.247
			9	36.2	0.312
			10	44.7	0.386
			11.2	56.1	0.484
			12	64.4	0.556
			12.5	69.9	0.603
			14	87.7	0.756
			16	115	0.988
			18	145	1.25
			20	179	1.54
			22.4	224	1.94
			25	280	2.41
Ordinary lay/ Lang lay	Bright/plated	Grade A	6	19.6	0.139
			6.3	21.6	0.153
			8	34.9	0.247
			9	44.1	0.312
			10	54.5	0.386
			11.2	68.3	0.484
			12	78.4	0.556
			12.5	85.1	0.603
			14	107	0.756
			16	139	0.988
			18	176	1.25
			20	218	1.54
			22.4	273	1.94
			25	340	2.41

Table 8 (concluded)

Lay type	With/without plating	Rope grade	Nominal diameter of rope mm	Measured breaking force (min.) kN	Approximate unit mass kg/m (informative)
Ordinary lay/ Lang lay	Bright/plated	Grade B	6	20.9	0.139
			6.3	23.0	0.153
			8	37.2	0.247
			9	47.0	0.312
			10	58.1	0.386
			11.2	72.8	0.484
			12	83.6	0.556
			12.5	90.7	0.603
			14	114	0.756
			16	149	0.988
			18	188	1.25
			20	232	1.54
			22.4	291	1.94
			25	363	2.41
			28	455	3.02
			30	523	3.47
			31.5	576	3.83
			33.5	652	4.33
			35.5	732	4.86
			37.5	816	5.43
			40	929	6.17
Ordinary lay/ Lang lay	Bright	Grade T	6	22.0	0.139
			6.3	24.2	0.153
			8	39.1	0.247
			9	49.5	0.312
			10	61.1	0.386
			11.2	76.6	0.484
			12	88.0	0.556
			12.5	95.4	0.603
			14	120	0.756
			16	156	0.988
			18	198	1.25
			20	244	1.54
			22.4	306	1.94
			25	382	2.41
			28	479	3.02
			30	550	3.47
			31.5	606	3.83
			33.5	685	4.33
			35.5	770	4.86
			37.5	859	5.43
			40	977	6.17