Redaelli

Wire Ropes

for Cranes

The sense of safety

Do you know that awkward feeling in your stomach when stepping into an overcrowded cable car? Or those moments driving across a long suspension bridge in a high wind? Whether gliding through a scenic winter landscape or being whisked up to the 31st floor of a skyscraper.

It is in these moments of life that we depend on steel wires and wire ropes. Hopefully the manufacturer of those wires and wire ropes has laid great emphasis on safety aspects.

Our Company, Redaelli, is one of the global leaders in the production of steel wire ropes. We draw on almost 200 years of experience in our field and, as a result, we have established an excellent international reputation for our stringent safety policy.

"The sense of safety" is our mission and we take these words very seriously at every stage of our production and service chain.

Safety does not only mean making products safe.

To us, guaranteeing safety also means calculating the durability of a product in full operation. We want people that enter a cable car, cross a bridge or work under a crane, to feel safe, because they know that safety is our first priority.

Maurizio Prete
Managing Director
Redaelli Tecna S.p.A.

Quality System

Redaelli Company has obtained federal approval of its organizational structure, manufacturing process and inspection guidelines in conformity with the ISO 9001:2008 standard.

This certification shows that a quality control system has been implemented that allows the company to offer products:

- Made of steel with documented origin.
- Manufactured according to standard, accurate and legally binding procedures.
- Delivered in conformity to rigorous technical requirements.
- Documented by manufacturing and test data.

Each product is produced according to a manufacturing and inspection schedule that codifies the following:

- Phases of the work cycle.
- Type and number of inspections for each phase.
- Reference procedures.
- Responsibilities.
- Type of certification issued.

Inspection begins with a preliminary selection of suppliers and a systematic approval process for raw materials. The materials used are inspected during all phases of the manufacturing cycle.

Redaelli uses the most up-to-date quality control equipment. The company has a lab for chemical analyses and a metallurgical lab with the latest equipment for performing mechanical tests.

CISQ is a member of IQNet

IGQ

CERTIFICATO
CERTIFICATE
IGQ 8802B

Si certifica che il sistema di gestione per la qualità di:
We hereby certify that the quality management system operated by:
Redaelli Tecna Spa
nelle seguenti unità operative:
in the following units:

Divisione Operations - Via Matteotti, 323 25063 Gardone Val Trompia BS
Sede - Via A. Volta, 16 20093 Cologno M.se MI
Uffici Commerciali Div. Wire Ropes - Via A. Volta, 16 20093 Cologno M.se MI
Divisione Operations - Riva Alvise Ca' da Mosto, 14 34100 Trieste TS

è conforme alla norma:
is in compliance with the standard:
UNI EN ISO 9001:2008
per le seguenti attività:
for the following activities:
EA:17

Produzione fili trafilati lucidi, zincati o con rivestimenti elettrolitici - Progettazione e produzione funi in acciaio al carbonio e inox - Supervisione alla loro installazione e monitoraggio delle condizioni tecniche e funzionali in servizio

Production of cold drawn steel wires uncoated, zinc coated or with electrolytic coating - Design and production of carbon and stainless steel ropes - Installation and supporting activities and in service condition monitoring

prima emissione / first issued on: 1988-03-07
emissione corrente / last issued on: 2012-11-30
data di scadenza / valid until: 2015-11-30

Il Direttore
Dario Agalbato

ANAB ACCREDIA CISQ

IQNet
THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

IQNet and its partner
CISQ/IGQ
hereby certify that the organization:
Redaelli Tecna Spa

has implemented and maintains a Quality Management System
which fulfills the requirements of the standard
ISO 9001:2008
for the following activities:
Production of cold drawn steel wires uncoated, zinc coated or with electrolytic coating - Design and production of carbon and stainless steel ropes - Installation and supporting activities and in service condition monitoring
issued on: 2012-11-30
valid until: 2015-11-30
CISQ/IGQ certified since: 1988-03-07

Registration Number:
IT-0015 IGQ 8802B

Michael Drechsel
President of IQNET

Ing. Claudio Provetti
President of CISQ

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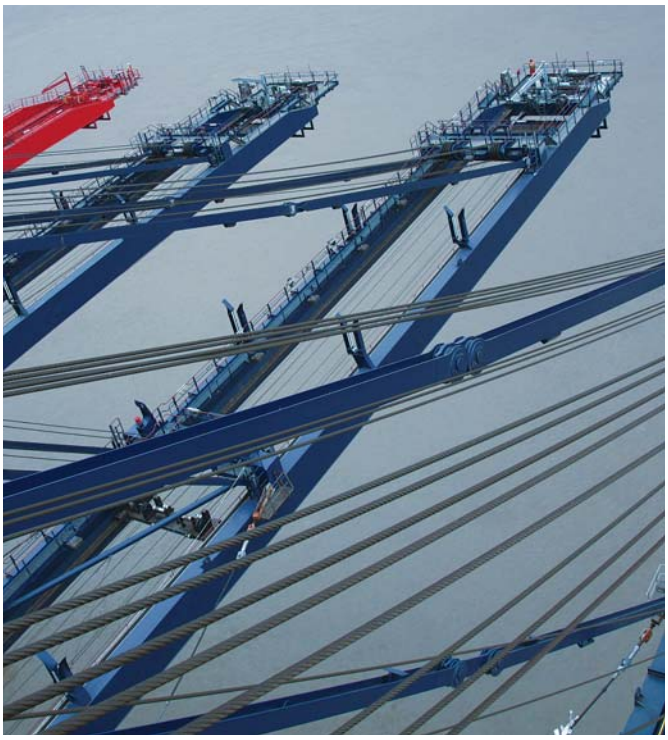

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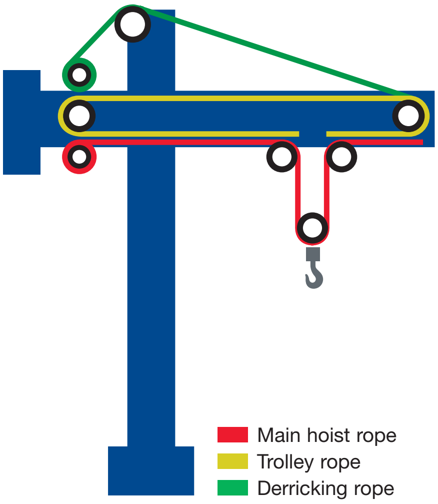
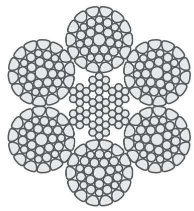
Tower Cranes



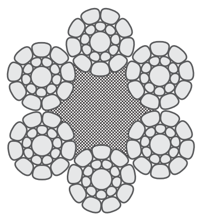
Pack™1

High breaking force, high wear resistance, good handling simplicity.
See page 27




Pack™1T

Good breaking force, high flexibility, high shock resistance, good handling simplicity.
See page 29




Keeport™8K

High breaking force, high wear resistance, high crushing resistance.
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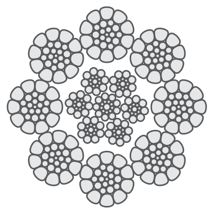


Pack™9

High breaking force, good wear resistance, good crushing resistance.
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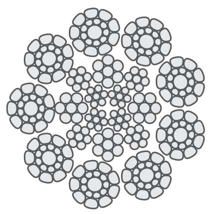
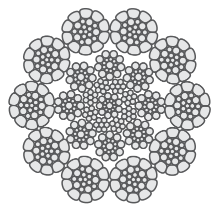


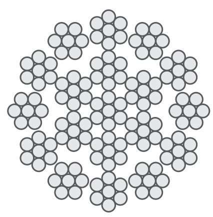
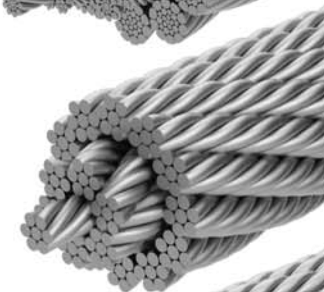

Pack™10

High breaking force, good wear resistance, good crushing resistance.
See page 37



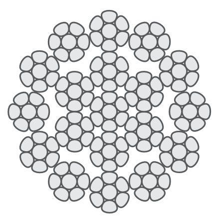
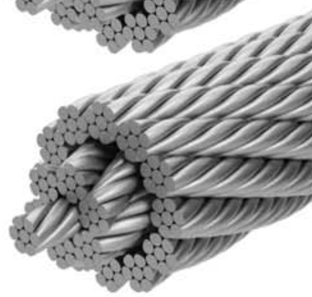

19x7LR

Good wear resistance, good rotational stability, good crushing resistance.
See page 38

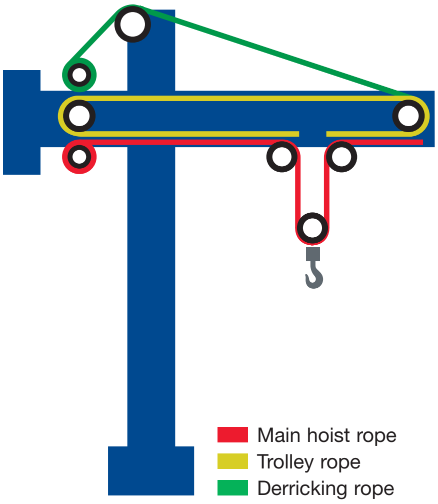
19xK7LR

High breaking force, good wear resistance, good rotational stability, good crushing resistance.
See page 39

Applications

Tower Cranes (continued)



Iperflex™

Good wear resistance, good rotational stability, high crushing resistance.
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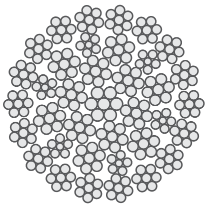

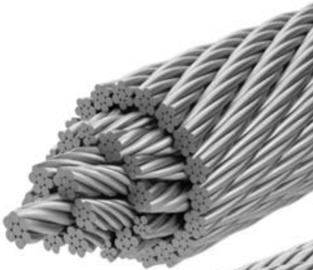

Pack™361

High breaking force, good wear resistance, good flexibility, good rotational stability, good crushing resistance.
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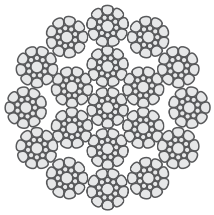

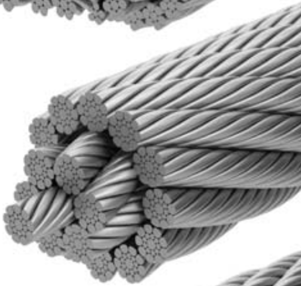

Flexpack™

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
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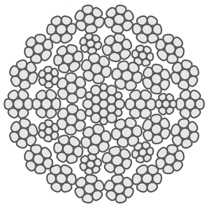
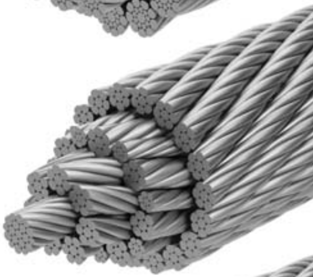
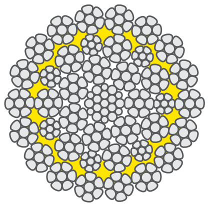




Flexpack™P

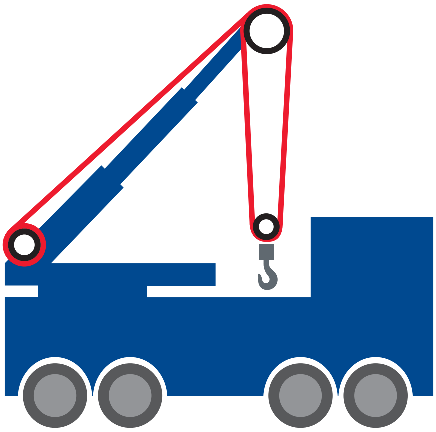
Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



For the applications shown the related rope types refer mainly to compacted ropes. For the same applications uncompacted ropes can also be suitable in the many cases. For more information please contact Redaelli directly.


GROVE
GROVE
GROVE
GROVE
ESTENSIONE INTERMEDIA
ESTENSIONE INTERMEDIA

Mobile Cranes



Main hoist rope

19x7LR

Good wear resistance, good rotational stability, good crushing resistance.
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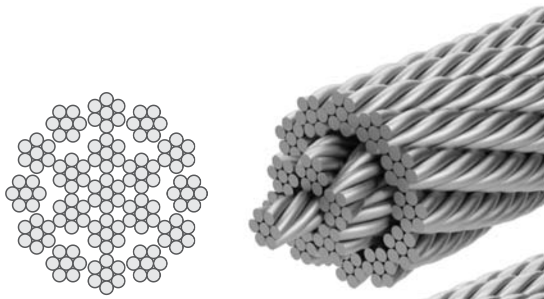

19xK7LR

High breaking force, good wear resistance, good rotational stability, good crushing resistance.
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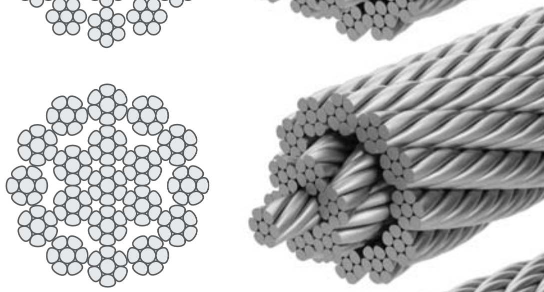
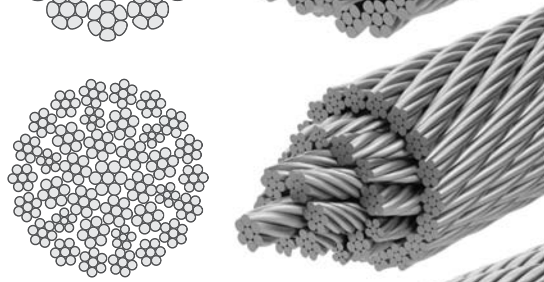


Iperflex™

Good wear resistance, good rotational stability, high crushing resistance.
See page 41



Pack™361

High breaking force, good wear resistance, good flexibility, good rotational stability, good crushing resistance.
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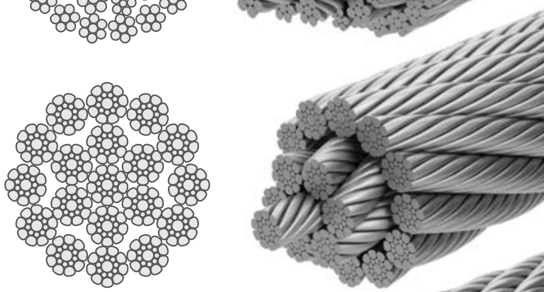
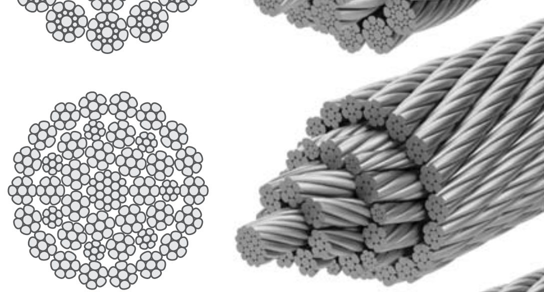


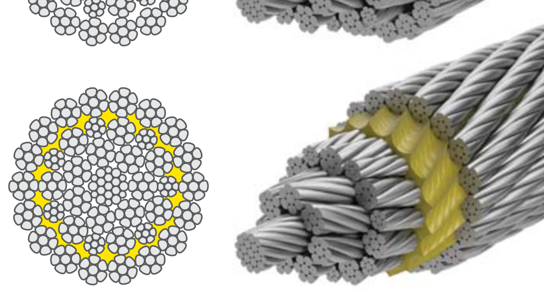
Flexpack™

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



Flexpack™P

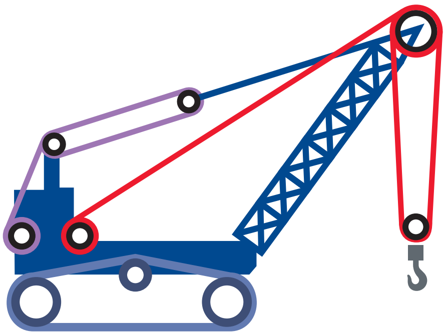
Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



For the applications shown the related rope types refer mainly to compacted ropes. For the same applications uncompacted ropes can also be suitable in the many cases. For more information please contact Redaelli directly.

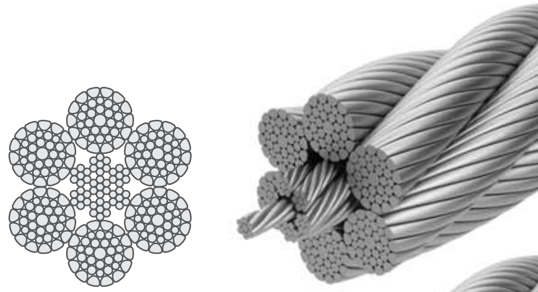
Applications

Crawler Cranes



Main hoist rope
Boom hoist rope

Pack™1



High breaking force, high wear resistance, good handling simplicity.
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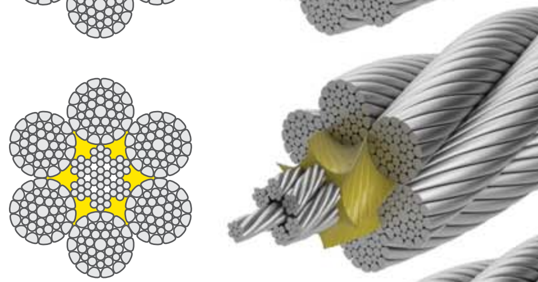
Pack™1P



High breaking force, high wear resistance, good fleet angle resistance, good handling simplicity.
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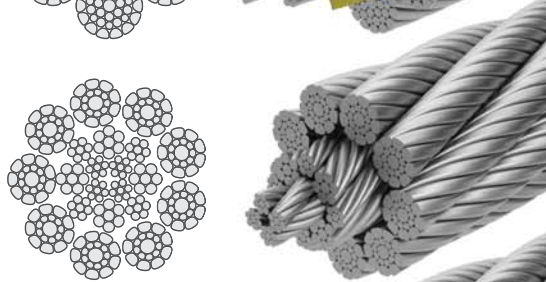
Pack™9



High breaking force, good wear resistance, good crushing resistance.
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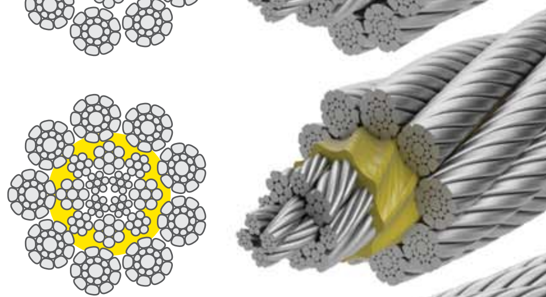
Pack™9P



High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
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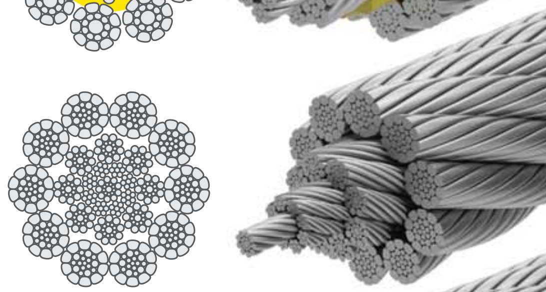
Pack™10



High breaking force, good wear resistance, good crushing resistance.
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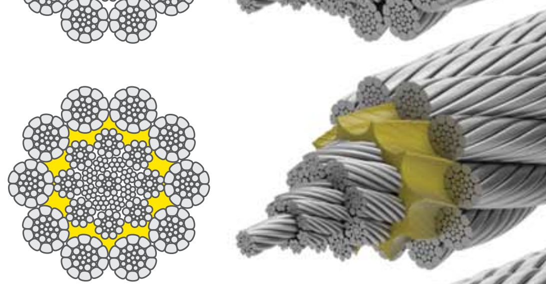
Pack™10P



High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
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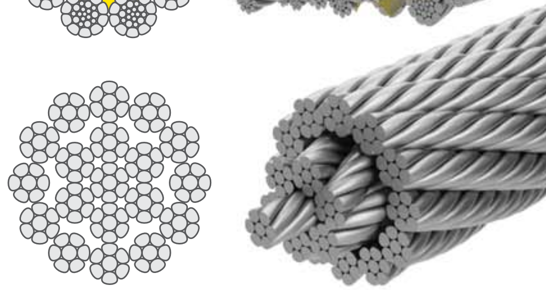
19xK7LR



High breaking force, good wear resistance, good rotational stability, good crushing resistance.
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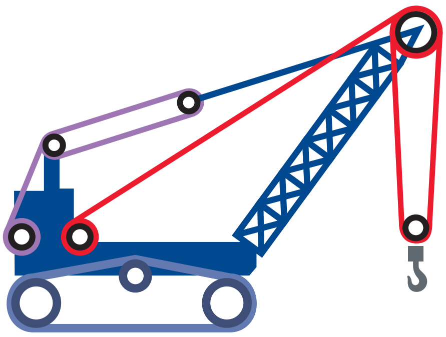
Crawler Cranes (continued)



Main hoist rope
Boom hoist rope

Pack™361

High breaking force, good wear resistance, good flexibility, good rotational stability, good crushing resistance.
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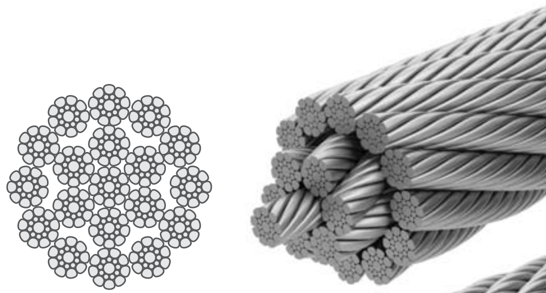

Flexpack™

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
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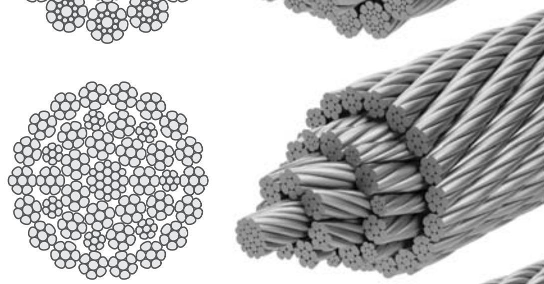
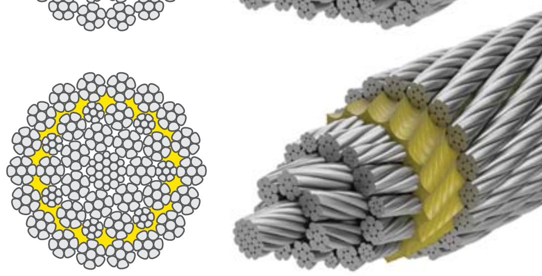


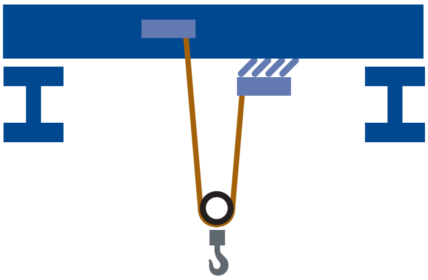
Flexpack™P

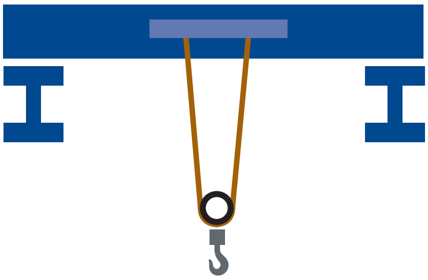
Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45

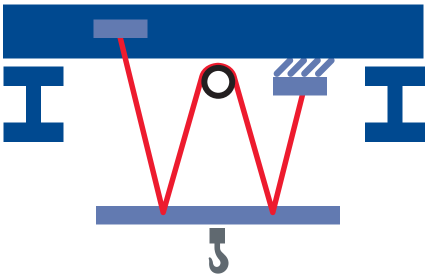


For the applications shown the related rope types refer mainly to compacted ropes. For the same applications uncompacted ropes can also be suitable in the many cases. For more information please contact Redaelli directly.

Overhead Cranes







Main hoist rope
(for bigger overhead cranes)

Main hoist rope
(for small overhead cranes)

Pack™1

High breaking force, high wear resistance, good handling simplicity.

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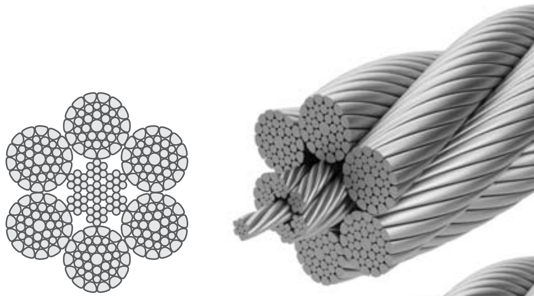

Pack™1P

High breaking force, high wear resistance, good fleet angle resistance, good handling simplicity.

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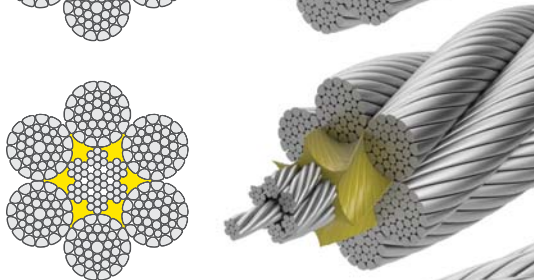

Keeport™8K

High breaking force, high wear resistance, high crushing resistance.

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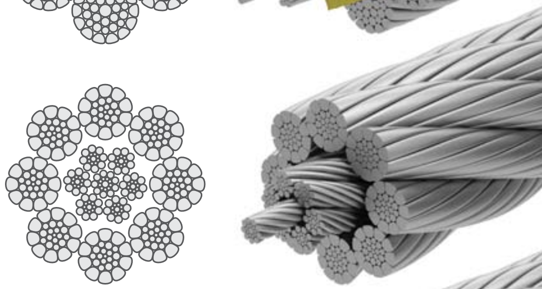
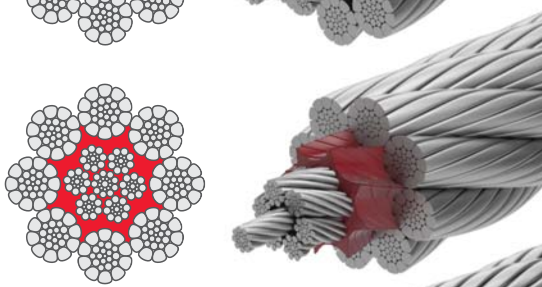


Keeport™8KP

High breaking force, high wear resistance, good fleet angle resistance, high crushing resistance.

See page 31



Pack™8

Excellent breaking force, high wear resistance.

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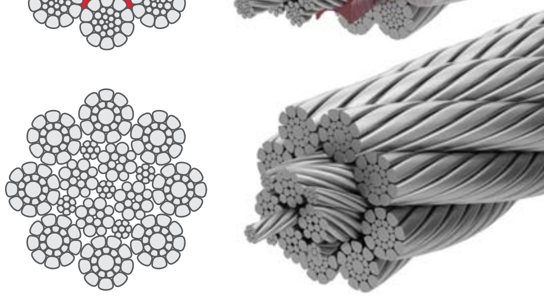
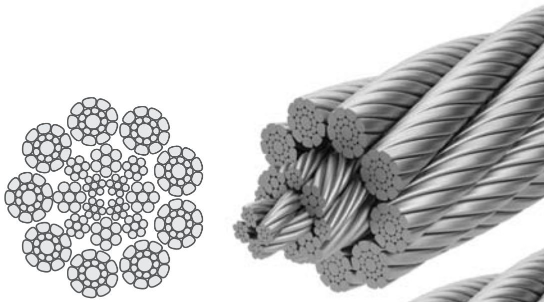


Applications

Overhead Cranes (continued)



Pack™9

High breaking force, good wear resistance, good crushing resistance.
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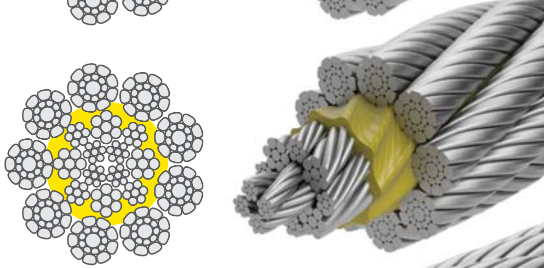
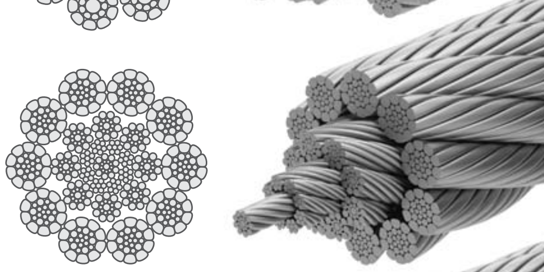


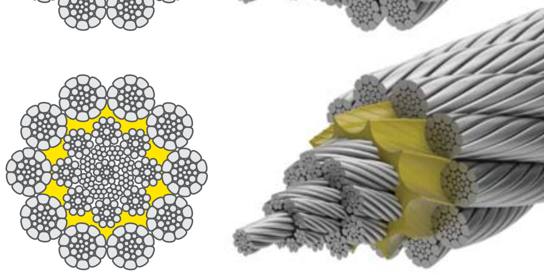
Pack™9P

High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 35



Pack™10

High breaking force, good wear resistance, good crushing resistance.
See page 37



Pack™10P

High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
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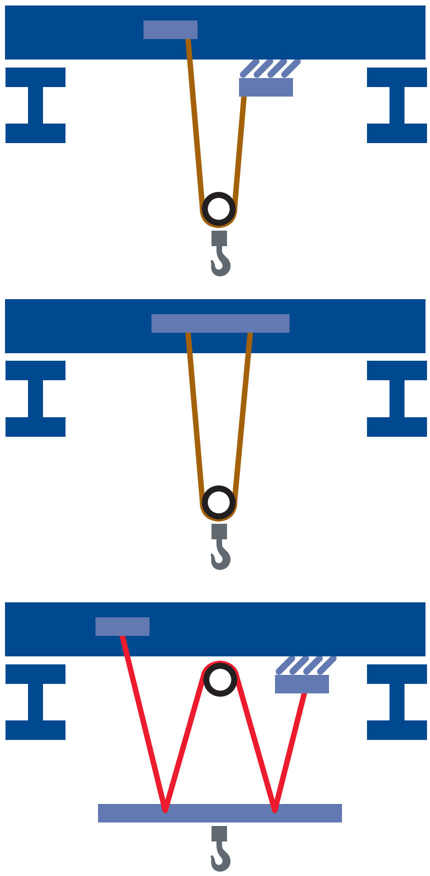

- Main hoist rope (for bigger overhead cranes)
- Main hoist rope (for small overhead cranes)

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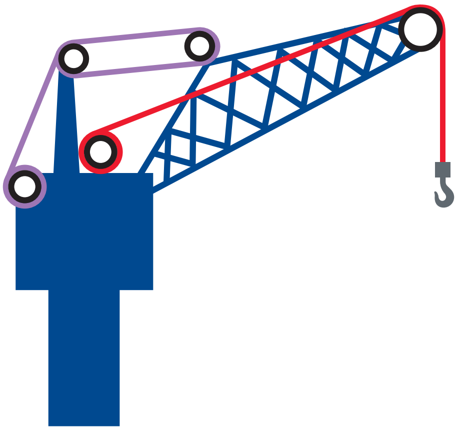
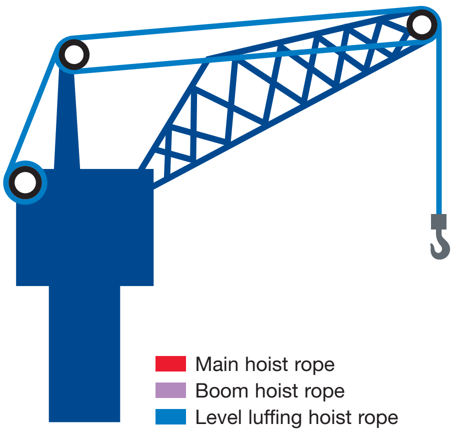
Applications

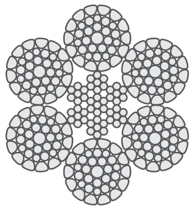
Harbour Cranes





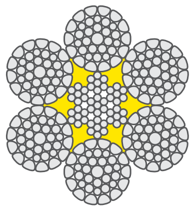
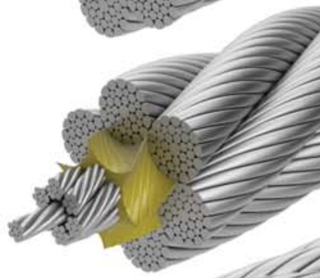
Pack™1

High breaking force, high wear resistance, good handling simplicity.
See page 27



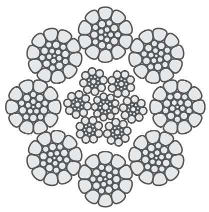

Pack™1P

High breaking force, high wear resistance, good fleet angle resistance, good handling simplicity.
See page 27

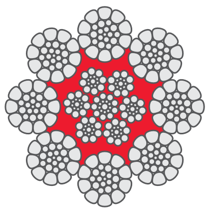
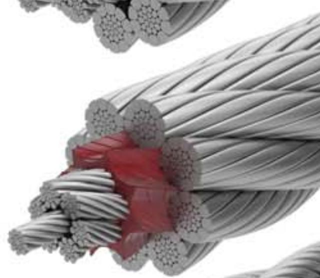
Keeport™8K

High breaking force, high wear resistance, high crushing resistance.
See page 31



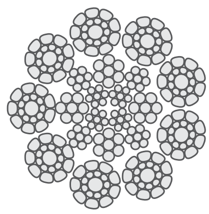

Keeport™8KP

High breaking force, high wear resistance, good fleet angle resistance, high crushing resistance.
See page 31

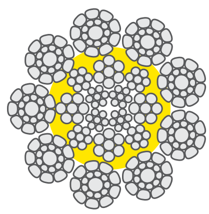
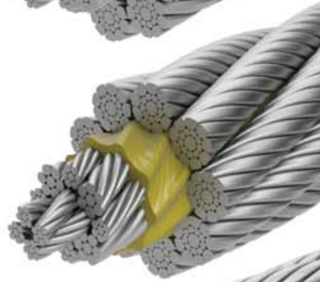
Pack™9

High breaking force, good wear resistance, good crushing resistance.
See page 35



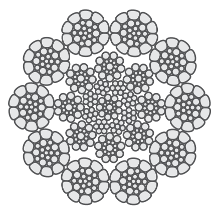
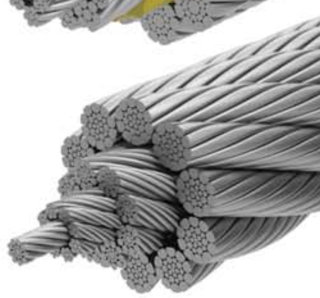

Pack™9P

High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 35

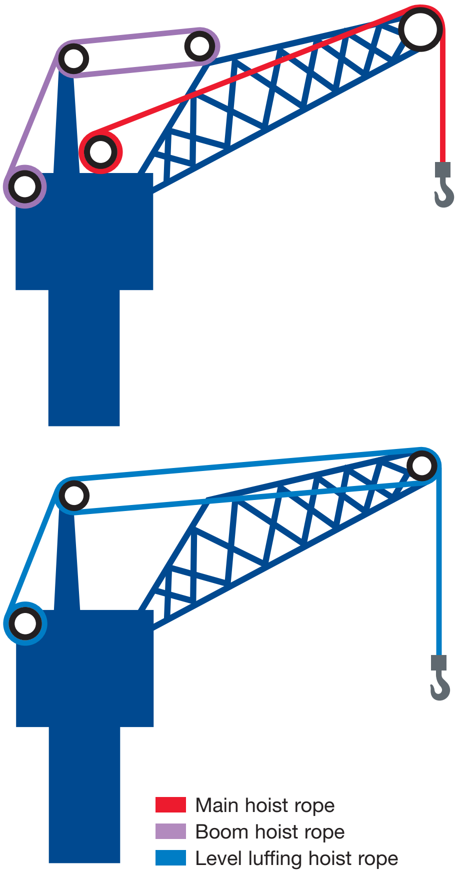
Pack™10

High breaking force, good wear resistance, good crushing resistance.
See page 37

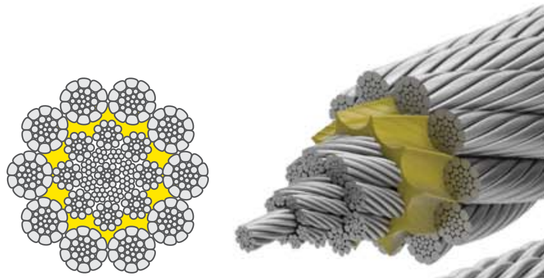
Applications

Harbour Cranes (continued)



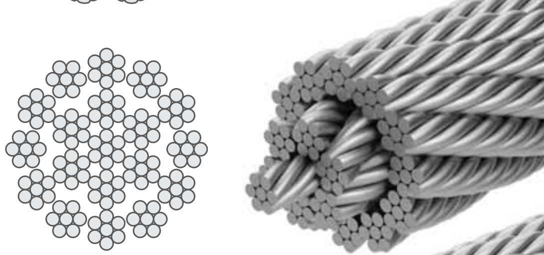
Pack™10P

High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 37



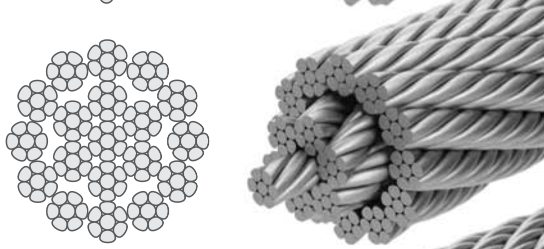
19x7LR

Good wear resistance, good rotational stability, good crushing resistance.
See page 38



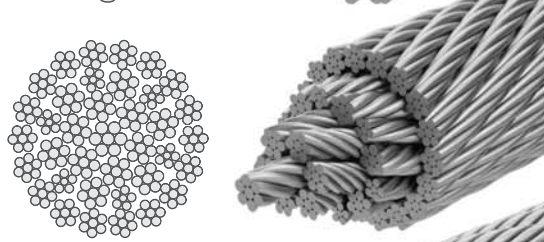
19xK7LR

High breaking force, good wear resistance, good rotational stability, good crushing resistance.
See page 39



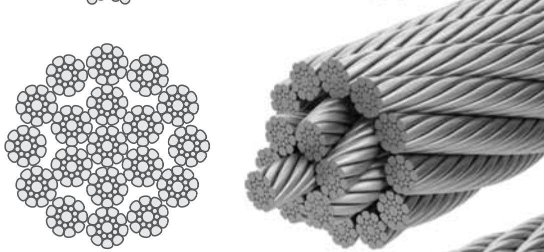
Iperflex™

Good wear resistance, good rotational stability, high crushing resistance.
See page 41



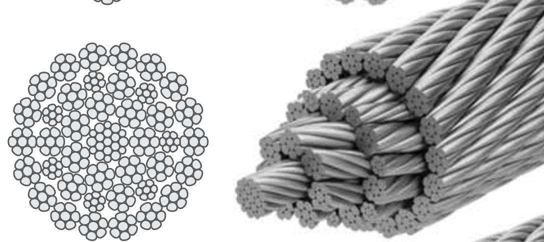
Pack™361

High breaking force, good wear resistance, good flexibility, good rotational stability, good crushing resistance.
See page 43



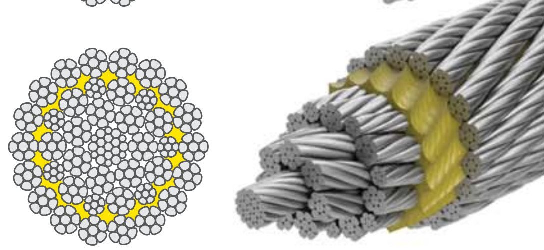
Flexpack™

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



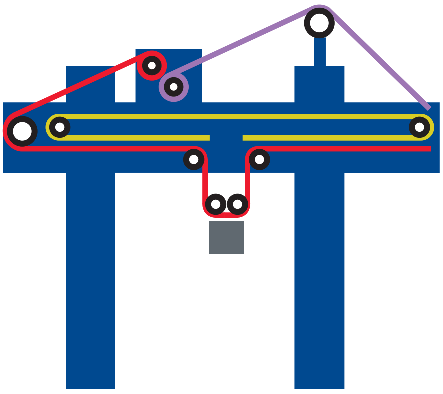
Flexpack™P

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



For the applications shown the related rope types refer mainly to compacted ropes. For the same applications uncompacted ropes can also be suitable in the many cases. For more information please contact Redaelli directly.

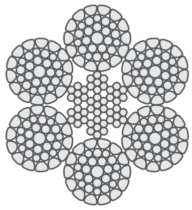
Container Cranes



- Main hoist rope
- Boom hoist rope
- Trolley rope

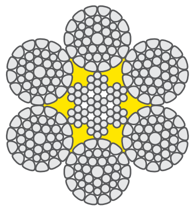
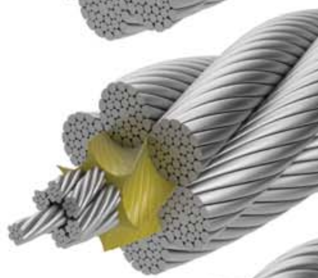
Pack™1

High breaking force, high wear resistance, good handling simplicity.
See page 27



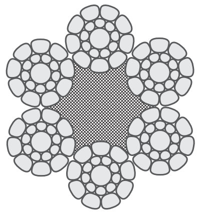

Pack™1P

High breaking force, high wear resistance, good fleet angle resistance, good handling simplicity.
See page 27

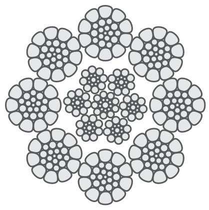
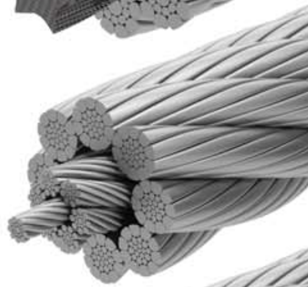
Pack™1T

Good breaking force, high flexibility, high shock resistance, good handling simplicity.
See page 29



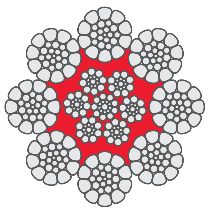
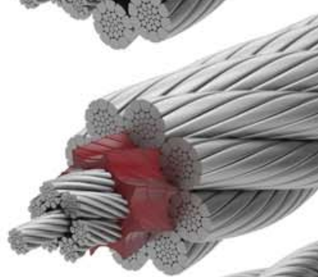

Keeport™8K

High breaking force, high wear resistance, high crushing resistance.
See page 31

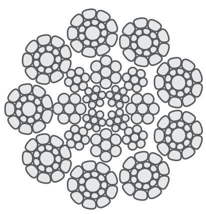
Keeport™8KP

High breaking force, high wear resistance, good fleet angle resistance, high crushing resistance.
See page 31

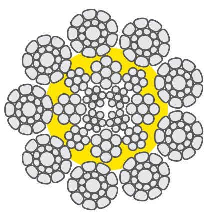
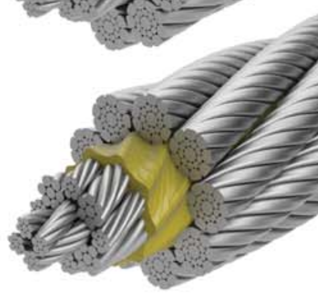
Pack™9

High breaking force, good wear resistance, good crushing resistance.
See page 35

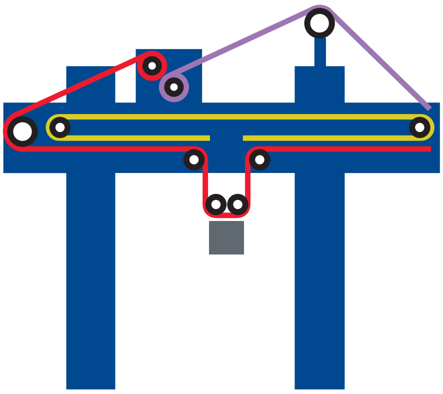



Pack™9P

High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 35

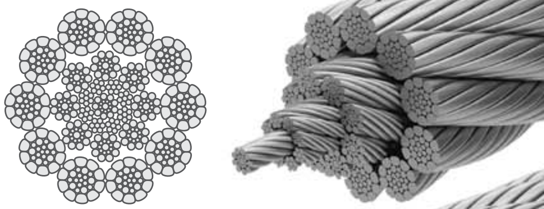
Container Cranes (continued)



Main hoist rope
Boom hoist rope
Trolley rope

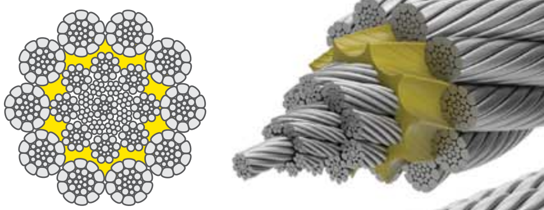
Pack™10

High breaking force, good wear resistance, good crushing resistance.
See page 37



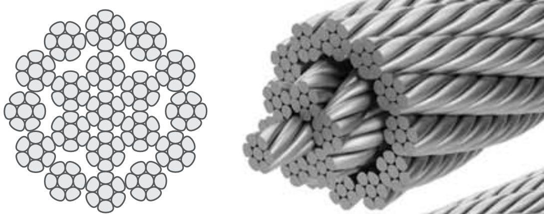
Pack™10P

High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 37



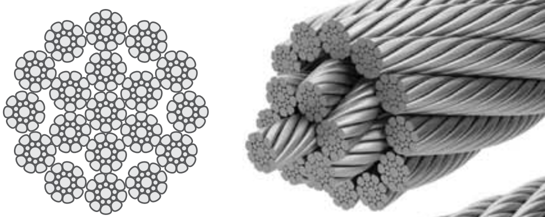
19xK7LR

High breaking force, good wear resistance, good rotational stability, good crushing resistance.
See page 39



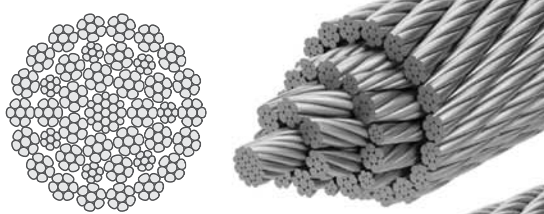
Pack™361

High breaking force, good wear resistance, good flexibility, good rotational stability, good crushing resistance.
See page 43



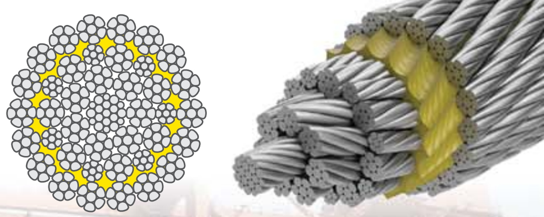
Flexpack™

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



Flexpack™P

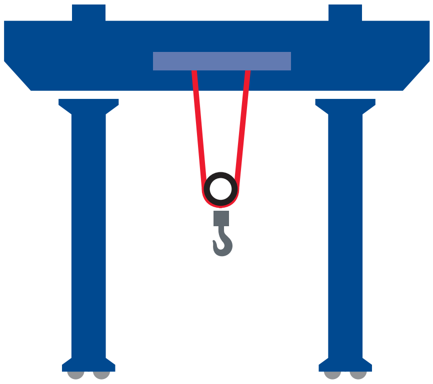
Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



For the applications shown the related rope types refer mainly to compacted ropes. For the same applications uncompacted ropes can also be suitable in the many cases. For more information please contact Redaelli directly.

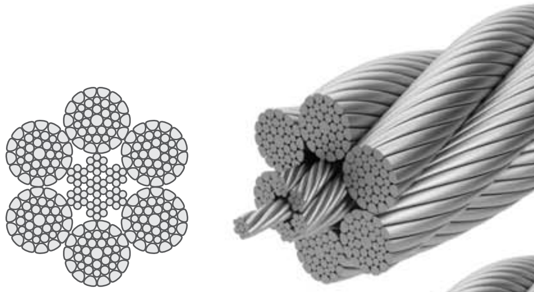
Applications

Gantry Launching Cranes



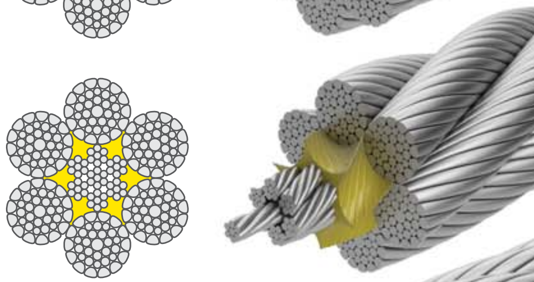
Main hoist rope

Pack™1



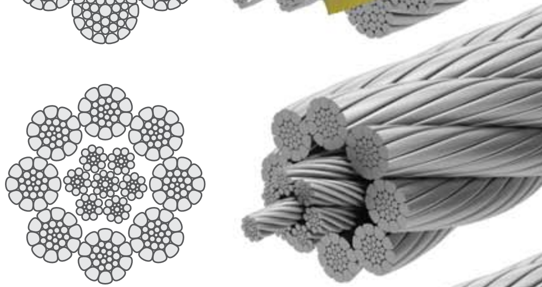
High breaking force, high wear resistance, good handling simplicity.
See page 27

Pack™1P



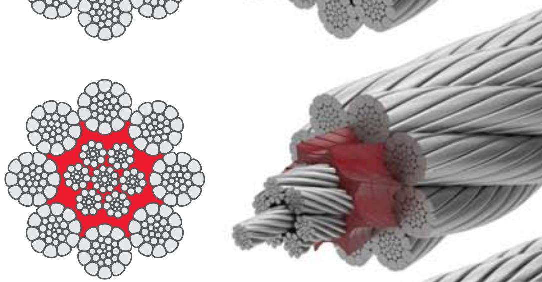
High breaking force, high wear resistance, good fleet angle resistance, good handling simplicity.
See page 27

Keeport™8K



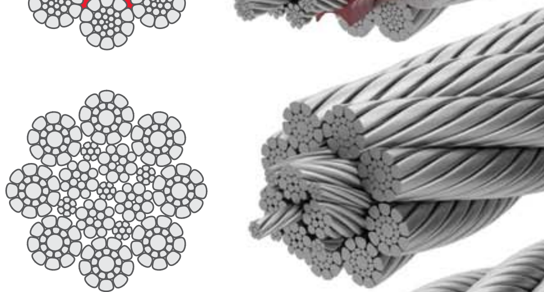
High breaking force, high wear resistance, high crushing resistance.
See page 31

Keeport™8KP



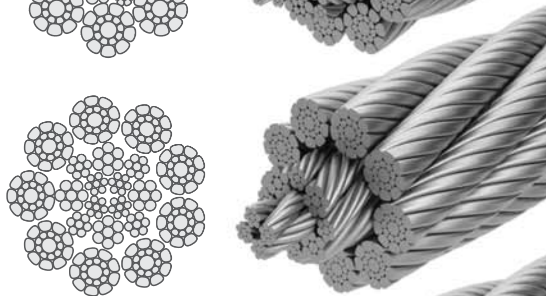
High breaking force, high wear resistance, good fleet angle resistance, high crushing resistance.
See page 31

Pack™8



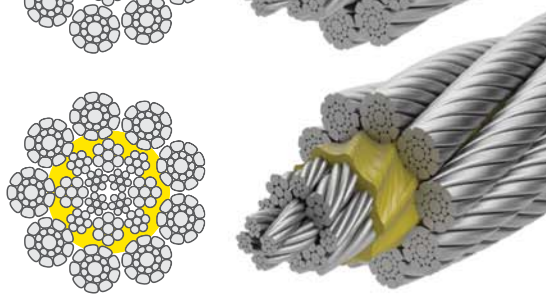
Excellent breaking force, high wear resistance.
See page 33

Pack™9



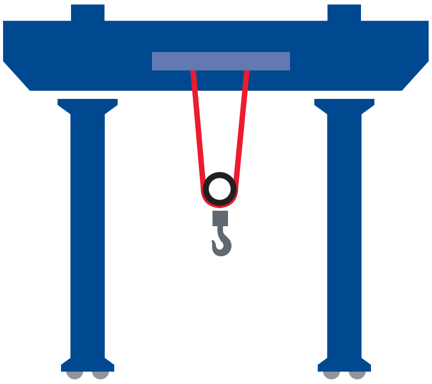
High breaking force, good wear resistance, good crushing resistance.
See page 35

Pack™9P



High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 35

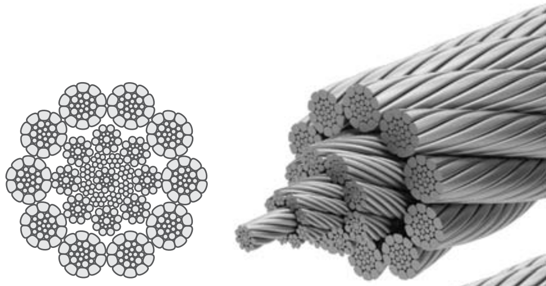
Gantry Launching Cranes (continued)



Main hoist rope

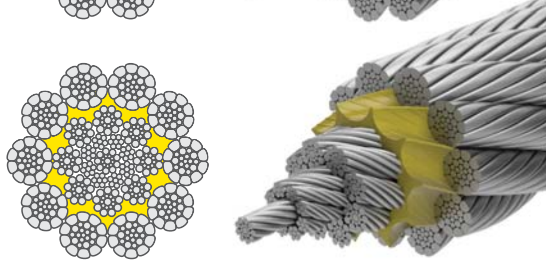
Pack™10

High breaking force, good wear resistance, good crushing resistance.
See page 37



Pack™10P

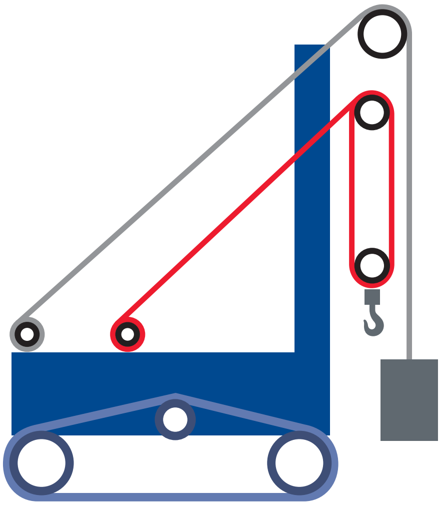
High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 37



For the applications shown the related rope types refer mainly to compacted ropes. For the same applications uncompacted ropes can also be suitable in the many cases. For more information please contact Redaelli directly.


MC 1500
COMACCHIO
Steelco

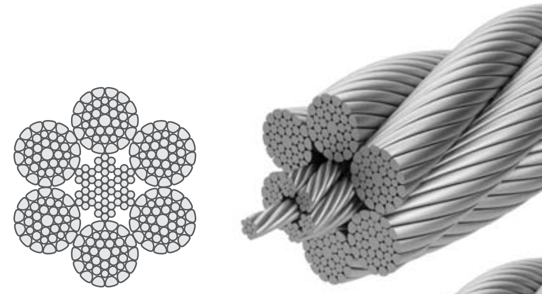
Rotary Drilling Machines



Main hoist rope
Pipe handling rope

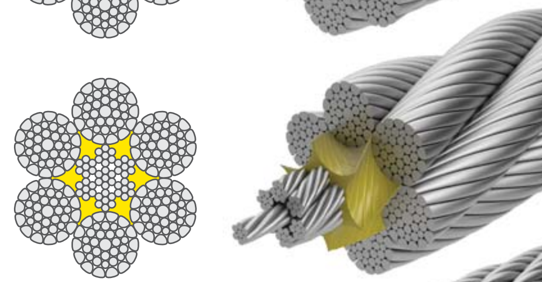
Pack™1

High breaking force, high wear resistance, good handling simplicity.
See page 27



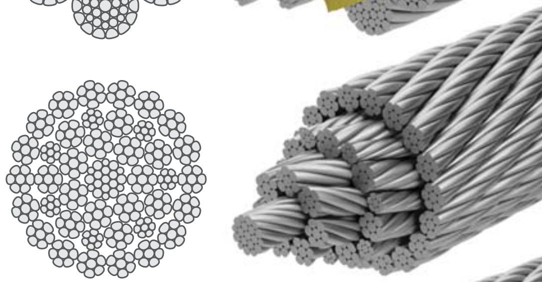
Pack™1P

High breaking force, high wear resistance, good fleet angle resistance, good handling simplicity.
See page 27



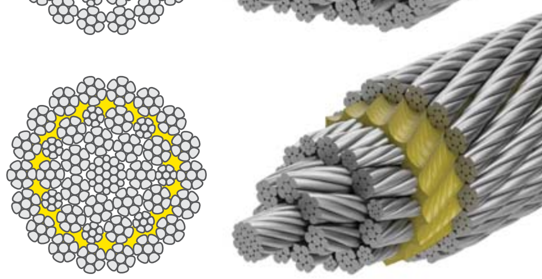
Flexpack™

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



Flexpack™P

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.
See page 45



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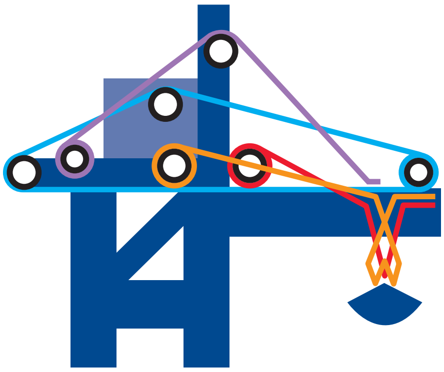
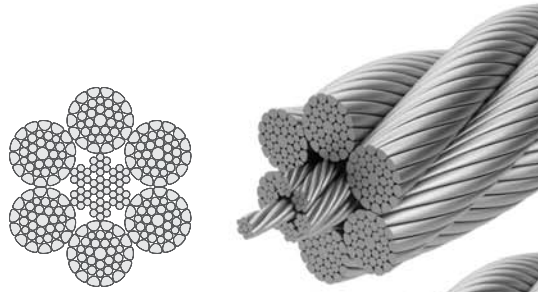
Grab Unloaders



Main hoist rope
Boom hoist rope
Grab closing rope
Racking rope

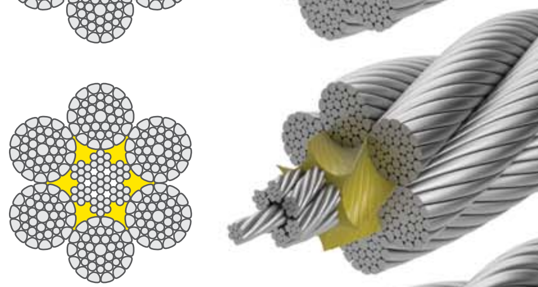
Pack™1

High breaking force, high wear resistance, good handling simplicity.
See page 27



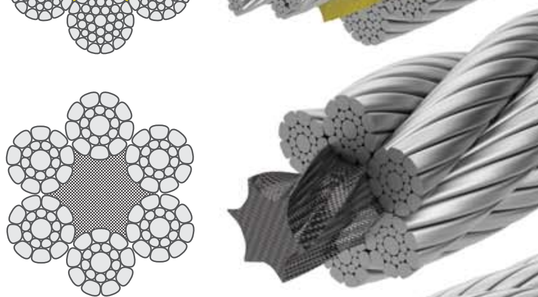
Pack™1P

High breaking force, high wear resistance, good fleet angle resistance, good handling simplicity.
See page 27



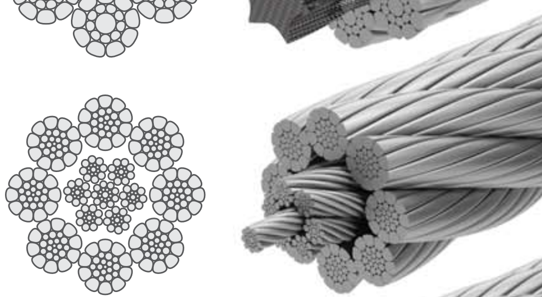
Pack™1T

Good breaking force, high flexibility, high shock resistance, good handling simplicity.
See page 29



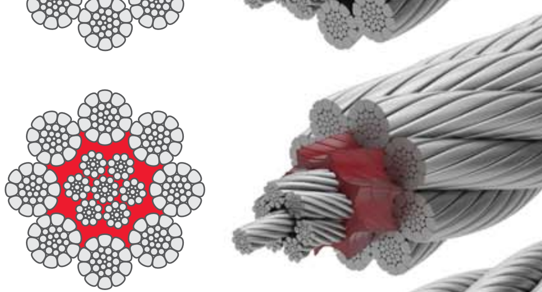
Keeport™8K

High breaking force, high wear resistance, high crushing resistance.
See page 31



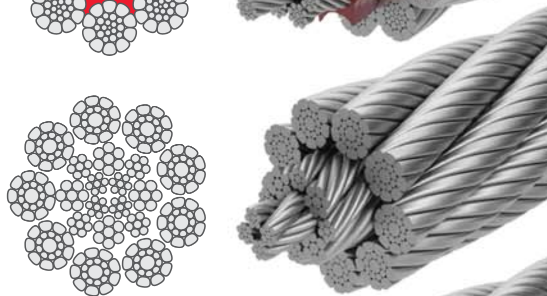
Keeport™8KP

High breaking force, high wear resistance, good fleet angle resistance, high crushing resistance.
See page 31



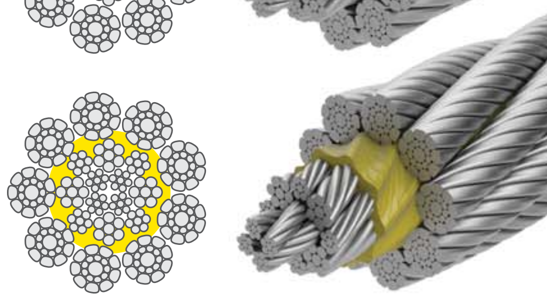
Pack™9

High breaking force, good wear resistance, good crushing resistance.
See page 35

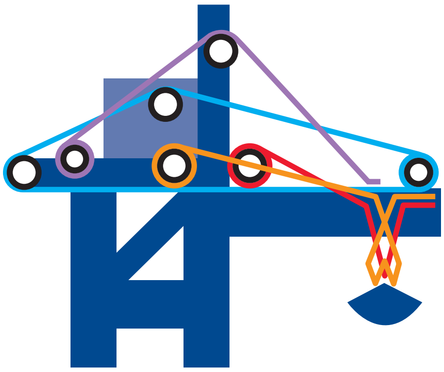


Pack™9P

High breaking force, good wear resistance, good fleet angle resistance, good crushing resistance.
See page 35



Grab Unloaders (continued)

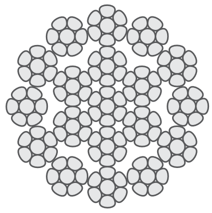


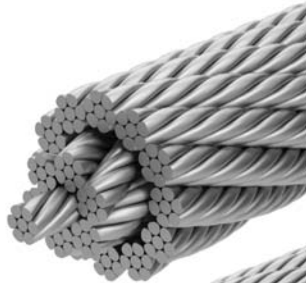
- Main hoist rope
- Boom hoist rope
- Grab closing rope
- Racking rope

19xK7LR

High breaking force, good wear resistance, good rotational stability, good crushing resistance.

See page 39

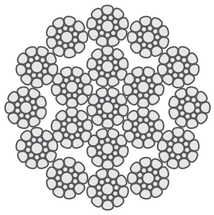


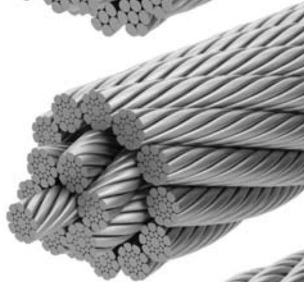


Pack™361

High breaking force, good wear resistance, good flexibility, good rotational stability, good crushing resistance.

See page 43

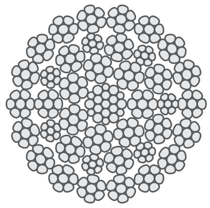


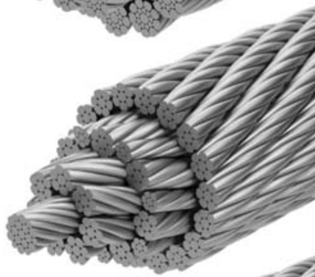


Flexpack™

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.

See page 45

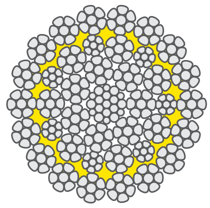


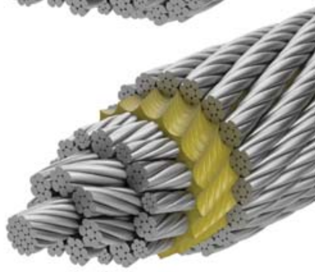


Flexpack™P

Excellent breaking force, high wear resistance, excellent rotational stability, high crushing resistance.

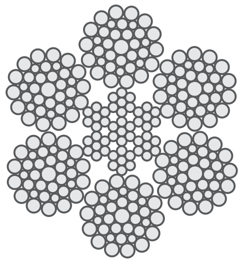
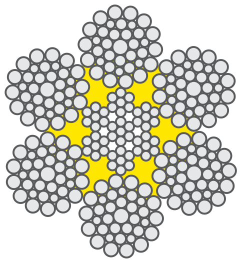
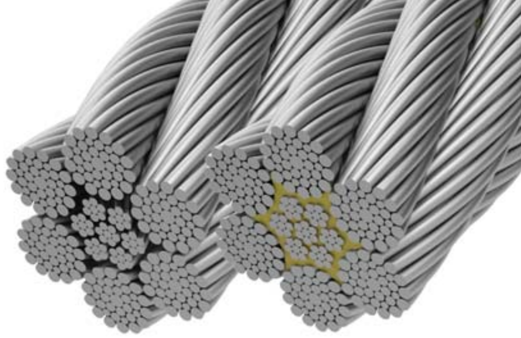
See page 45





For the applications shown the related rope types refer mainly to compacted ropes. For the same applications uncompacted ropes can also be suitable in the many cases. For more information please contact Redaelli directly.

Red™1
Red™1P

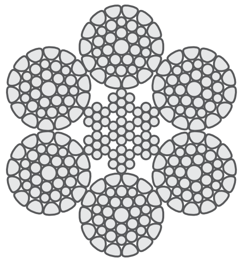
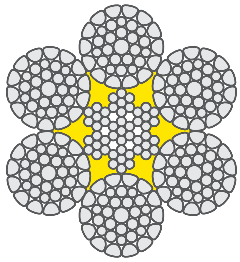
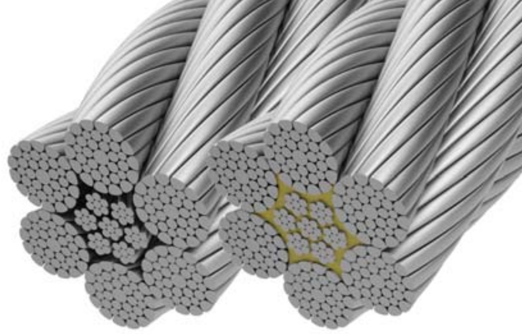
6x36WS - IWRC

Diameter		Area	Mass		Minimum Breaking Force - MBF								
					Grade 1770			Grade 1960			Grade 2160		
mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs	kN	Mtons	lbs
10		48.7	0.44	0.29	76.0	7.75	17100	84.4	8.60	19000	88.0	8.97	19800
	7/16	60.1	0.54	0.36	93.9	9.57	21100	104	10.6	23500	109	11.1	24500
12		70.1	0.63	0.42	109	11.2	24600	122	12.4	27300	127	12.9	28500
	1/2	78.5	0.71	0.48	123	12.5	27600	136	13.9	30600	142	14.5	31900
13		82.3	0.74	0.50	128	13.1	28900	143	14.5	32100	149	15.2	33500
14		95.4	0.86	0.58	149	15.2	33500	165	16.9	37200	172	17.6	38800
15		110	0.99	0.66	171	17.4	38500	190	19.4	42700	198	20.2	44600
	5/8	123	1.10	0.74	192	19.5	43100	213	21.7	47900	222	22.6	49900
16		125	1.12	0.75	195	19.8	43800	216	22.0	48600	225	23.0	50700
17		141	1.27	0.85	220	22.4	49400	244	24.9	54900	254	25.9	57200
18		158	1.42	0.96	246	25.1	55400	273	27.9	61500	285	29.1	64200
19	3/4	177	1.59	1.07	276	28.1	62100	306	31.2	68900	319	32.6	71900
20		195	1.75	1.18	304	31.0	68400	338	34.4	76000	352	35.9	79200
22		236	2.12	1.43	368	37.5	82800	408	41.6	91900			
	7/8	241	2.16	1.46	376	38.3	84500	417	42.5	93900			
24		280	2.52	1.70	438	44.6	98500	486	49.6	109000			
	1	314	2.83	1.90	490	50.0	110000	545	55.5	123000			
26		329	2.96	1.99	514	52.4	116000	571	58.2	128000			
28		382	3.43	2.31	596	60.7	134000	662	67.5	149000			
	1-1/8	398	3.58	2.41	621	63.3	140000	689	70.2	155000			
30		438	3.94	2.65	684	69.7	154000	760	77.4	171000			
	1-1/4	491	4.42	2.97	766	78.1	172000	851	86.7	191000			
32		499	4.49	3.02	778	79.3	175000	864	88.1	194000			
34		563	5.06	3.41	879	89.6	198000	976	100	220000			
35	1-3/8	597	5.37	3.61	931	94.9	209000	1030	105	233000			
36		631	5.68	3.82	985	100	222000	1090	112	246000			
38		703	6.32	4.26	1100	112	247000	1220	124	274000			
40		779	7.01	4.72	1220	124	274000	1350	138	304000			
42		859	7.73	5.20	1340	137	302000	1490	152	335000			
44		943	8.48	5.71	1470	150	331000	1630	167	368000			
	1-3/4	962	8.65	5.83	1500	153	338000	1670	170	375000			
46		1030	9.27	6.24	1610	164	362000	1790	182	402000			
48		1120	10.1	6.79	1750	178	394000	1940	198	438000			
50		1220	11.0	7.37	1900	194	428000	2110	215	475000			
	2	1260	11.3	7.61	1960	200	441000	2180	222	490000			
52		1320	11.8	7.97	2060	209	462000	2280	233	514000			
54	2-1/8	1420	12.8	8.60	2220	226	499000	2460	251	554000			
56		1530	13.7	9.25	2380	243	536000	2650	270	596000			
58	2-1/4	1640	14.7	9.92	2560	261	575000	2840	289	639000			
60	2-3/8	1750	15.8	10.6	2740	279	616000	3040	310	684000			

Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 4% - Unless otherwise specified lay type is Regular
The construction type shown is the manufacturer's standard. Other constructions can be considered on request


BAUER BG 24 H

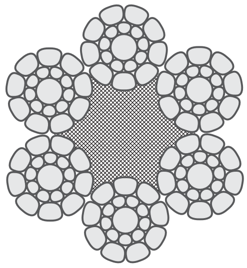
Pack™1
Pack™1P

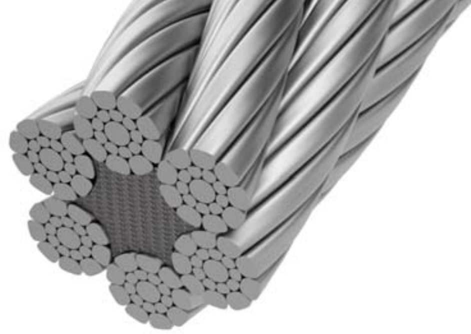




	Diameter		Area	Mass		Minimum Breaking Force - MBF								
						Grade 1770			Grade 1960			Grade 2160		
	mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs	kN	Mtons	lbs
6xK19S - IWRC	10		54.2	0.46	0.31	79.3	8.08	17800	87.6	8.92	19700	93.7	9.55	21100
		7/16	66.9	0.57	0.38	97.9	10.0	22000	108	11.0	24300	116	11.8	26000
	12		78.0	0.67	0.45	114	11.6	25700	126	12.9	28400	135	13.8	30400
		1/2	87.4	0.75	0.50	128	13.0	28800	141	14.4	31800	151	15.4	34000
	13		91.6	0.78	0.53	134	13.7	30200	148	15.1	33300	158	16.1	35600
	14		106	0.91	0.61	155	15.8	35000	172	17.5	38600	184	18.7	41300
	15		122	1.04	0.70	178	18.2	40200	197	20.1	44300	207	21.1	46500
		5/8	137	1.16	0.78	200	20.4	45000	221	22.5	49600	231	23.6	52100
6xK26WS - IWRC	16		139	1.18	0.80	203	20.7	45700	224	22.8	50400	235	24.0	52900
	17		157	1.34	0.90	229	23.4	51600	253	25.8	56900	265	27.1	59700
	18		176	1.50	1.01	257	26.2	57800	284	28.9	63800	297	30.3	66900
	19	3/4	197	1.68	1.13	288	29.3	64800	318	32.4	71500	333	34.0	75000
	20		217	1.85	1.24	317	32.3	71400	350	35.7	78800	367	37.4	82600
	22		262	2.24	1.51	384	39.1	86400	424	43.2	95400			
		7/8	268	2.28	1.54	392	40.0	88200	433	44.1	97400			
	24		312	2.66	1.79	457	46.6	103000	504	51.4	113000			
6xK31WS - IWRC		1	339	2.95	1.99	497	50.6	112000	548	55.9	123000	575	58.6	129000
	26		356	3.09	2.08	521	53.1	117000	575	58.6	129000	603	61.4	136000
	28		413	3.58	2.41	604	61.5	136000	666	67.9	150000			
		1-1/8	430	3.73	2.51	629	64.1	141000	694	70.7	156000			
	30		474	4.11	2.77	693	70.6	156000	765	78.0	172000			
		1-1/4	530	4.61	3.10	776	79.1	175000	857	87.3	193000			
	32		539	4.68	3.15	788	80.4	177000	870	88.7	196000			
	34		608	5.28	3.56	890	90.7	200000	983	100	221000			
	35	1-3/8	645	5.60	3.77	943	96.2	212000	1040	106	234000			
	36		682	5.92	3.99	998	102	225000	1100	112	248000			
	38		749	6.61	4.45	1100	112	246000	1210	123	272000			
	40		829	7.33	4.93	1210	124	273000	1340	137	301000			
6xK36WS - IWRC	42		914	8.08	5.44	1340	136	301000	1480	151	332000			
	44		1000	8.87	5.97	1470	150	330000	1620	165	365000			
		1-3/4	1020	9.05	6.09	1500	153	337000	1650	169	372000			
	46		1100	9.69	6.53	1600	164	361000	1770	181	399000			
	48		1190	10.6	7.10	1750	178	393000	1930	197	434000			
	50		1300	11.5	7.71	1900	193	427000	2090	213	471000			
		2	1340	11.8	7.96	1960	200	440000	2160	220	486000			
	52		1400	12.4	8.34	2050	209	461000	2260	231	509000			
	54	2-1/8	1510	13.4	8.99	2210	225	498000	2440	249	549000			
	56		1630	14.4	9.67	2380	242	535000	2630	268	591000			
	58	2-1/4	1740	15.4	10.4	2550	260	574000	2820	287	634000			
	60	2-3/8	1870	16.5	11.1	2730	278	614000	3010	307	678000			

Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 4% - Unless otherwise specified lay type is Regular
The construction type shown is the manufacturer's standard. Other constructions can be considered on request

Pack™ 1T

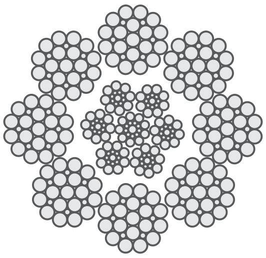
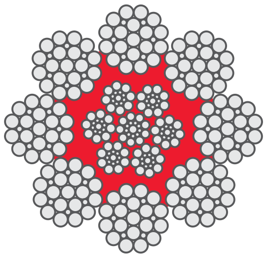
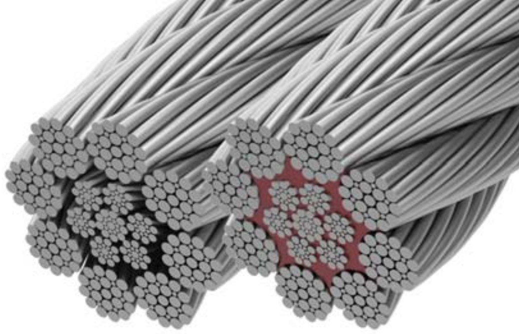




	Diameter		Area	Mass		Minimum Breaking Force - MBF					
						Grade 1770			Grade 1960		
	mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs
6xK19S - FC	10		47.9	0.42	0.28	70.3	7.17	15800	77.6	7.91	17500
		7/16	59.2	0.51	0.35	86.8	8.85	19500	95.8	9.76	21500
	12		69.0	0.60	0.40	101	10.3	22800	112	11.4	25100
		1/2	77.3	0.67	0.45	113	11.6	25500	125	12.8	28100
	13		81.0	0.70	0.47	119	12.1	26700	131	13.4	29500
	14		93.9	0.82	0.55	138	14.0	31000	152	15.5	34200
	15		108	0.94	0.63	158	16.1	35600	174	17.8	39300
		5/8	121	1.05	0.71	177	18.1	39900	195	19.9	44000
6xK26WS - FC	16		123	1.07	0.72	180	18.3	40500	199	20.2	44700
	17		138	1.21	0.81	203	20.7	45700	224	22.8	50400
	18		155	1.35	0.91	228	23.2	51300	251	25.6	56500
	19	3/4	174	1.51	1.02	255	26.0	57400	281	28.7	63300
	20		192	1.67	1.12	281	28.7	63300	310	31.6	69800
	22		232	2.02	1.36	340	34.7	76600	375	38.3	84500
		7/8	237	2.06	1.39	347	35.4	78200	383	39.1	86200
	24		276	2.40	1.62	405	41.3	91100	447	45.5	101000
6xK31WS - FC		1	304	2.68	1.80	446	45.5	100000	492	50.2	111000
	26		319	2.81	1.89	467	47.7	105000	516	52.6	116000
	28		369	3.25	2.19	542	55.3	122000	598	61.0	135000
		1-1/8	385	3.39	2.28	565	57.6	127000	623	63.5	140000
	30		424	3.74	2.51	622	63.4	140000	686	70.0	154000
		1-1/4	475	4.18	2.82	697	71.1	157000	769	78.4	173000
	32		483	4.25	2.86	708	72.2	159000	781	79.6	176000
	34		545	4.80	3.23	799	81.5	180000	882	89.9	198000
	35	1-3/8	577	5.08	3.42	847	86.4	191000	934	95.2	210000
	36		611	5.38	3.62	896	91.4	202000	989	101	222000
	38		658	5.98	4.03	965	98.4	217000	1060	109	240000
	40		729	6.62	4.46	1070	109	241000	1180	120	265000
6xK36WS - FC	42		804	7.30	4.92	1180	120	265000	1300	133	293000
	44		882	8.02	5.40	1290	132	291000	1430	145	321000
		1-3/4	900	8.18	5.51	1320	135	297000	1460	148	328000
	46		964	8.76	5.90	1410	144	318000	1560	159	351000
	48		1050	9.54	6.42	1540	157	347000	1700	173	382000
	50		1140	10.4	6.97	1670	170	376000	1840	188	415000
		2	1180	10.7	7.19	1730	176	388000	1900	194	428000
	52		1230	11.2	7.54	1810	184	407000	1990	203	449000
	54	2-1/8	1330	12.1	8.13	1950	199	439000	2150	219	484000
	56		1430	13.0	8.74	2100	214	472000	2310	236	520000
	58	2-1/4	1530	13.9	9.38	2250	229	506000	2480	253	558000
	60	2-3/8	1640	14.9	10.0	2410	245	541000	2650	271	597000

Aggregate Breaking Force = Metallic Area x Rope Grade - Unless otherwise specified lay type is Regular - The construction type shown is the manufacturer's standard. Other constructions can be considered on request

Keeport™ 8
Keeport™ 8P

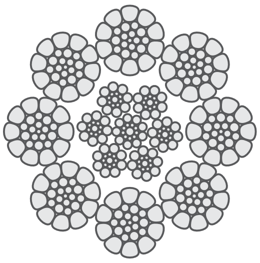




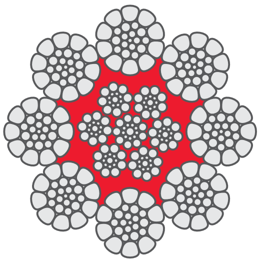
	Diameter		Area	Mass		Minimum Breaking Force - MBF					
						Grade 1770			Grade 1960		
	mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs
8x25F - IWRC	10		49.5	0.44	0.30	74.0	7.54	16700	82.0	8.36	18500
		7/16	61.1	0.55	0.37	91.4	9.32	20600	101	10.3	22800
	12		71.3	0.64	0.43	107	10.9	24000	118	12.0	26600
		1/2	79.8	0.71	0.48	119	12.2	26900	132	13.5	29800
	13		83.6	0.75	0.50	125	12.7	28100	139	14.1	31200
	14		97.0	0.87	0.58	145	14.8	32600	161	16.4	36200
	15		111	0.99	0.67	167	17.0	37500	185	18.8	41500
		5/8	125	1.11	0.75	186	19.0	42000	207	21.1	46500
	16		127	1.13	0.76	189	19.3	42600	210	21.4	47200
	17		143	1.28	0.86	214	21.8	48100	237	24.2	53300
	18		160	1.43	0.96	240	24.4	54000	266	27.1	59800
	19	3/4	180	1.60	1.08	269	27.4	60400	298	30.3	67000
	20		198	1.77	1.19	296	30.2	66600	328	33.4	73800
	22		239	2.14	1.44	358	36.5	80600	397	40.5	89300
		7/8	245	2.18	1.47	366	37.3	82300	405	41.3	91200
	24		285	2.55	1.71	426	43.4	95900	472	48.1	106000
		1	319	2.85	1.92	477	48.7	107000	529	53.9	119000
	26		334	2.99	2.01	500	51.0	113000	554	56.5	125000
	28		388	3.47	2.33	580	59.1	131000	643	65.5	145000
		1-1/8	404	3.61	2.43	604	61.6	136000	670	68.3	151000
	30		445	3.98	2.68	666	67.9	150000	738	75.2	166000
		1-1/4	499	4.46	3.00	746	76.0	168000	827	84.3	186000
	32		507	4.53	3.05	758	77.2	171000	840	85.6	189000
	34		572	5.11	3.44	855	87.2	192000	948	96.6	213000
	35	1-3/8	606	5.41	3.65	907	92.4	204000	1000	102	226000
	36		641	5.73	3.86	959	97.8	216000	1060	108	239000
	38		714	6.38	4.30	1070	109	240000	1180	121	266000
	40		792	7.07	4.76	1180	121	266000	1310	134	295000
	42		873	7.80	5.25	1310	133	294000	1450	147	325000
	44		958	8.56	5.76	1430	146	322000	1590	162	357000
		1-3/4	978	8.73	5.88	1460	149	329000	1620	165	365000
	46		1050	9.35	6.30	1570	160	352000	1740	177	390000
	48		1140	10.2	6.86	1700	174	384000	1890	193	425000

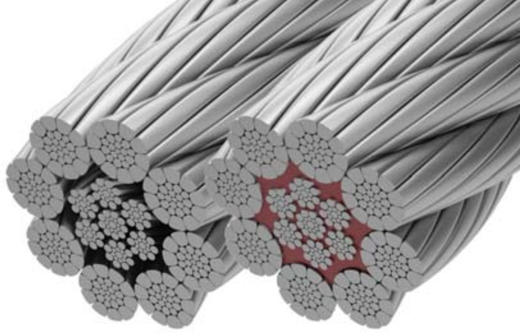
Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 3% - Unless otherwise specified lay type is Regular
The construction type shown is the manufacturer's standard. Other constructions can be considered on request



Keeport™ 8K
Keeport™ 8KP







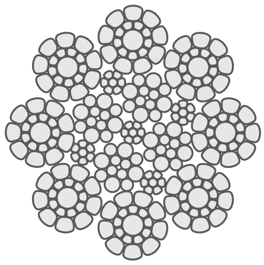
8xK26WS - IWRC

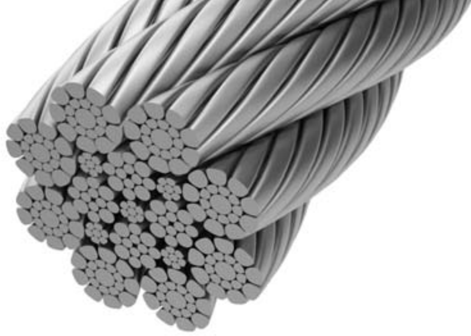
Diameter		Area	Mass		Minimum Breaking Force - MBF								
					Grade 1770			Grade 1960			Grade 2160		
mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs	kN	Mtons	lbs
8	5/16	34.2	0.30	0.20	51.5	5.25	11600	57.1	5.82	12800	62.1	6.33	14000
9		43.3	0.38	0.25	65.2	6.65	14700	72.3	7.37	16300	78.6	8.01	17700
	3/8	48.5	0.42	0.28	73.0	7.44	16400	80.9	8.25	18200	88.0	8.97	19800
10		53.4	0.47	0.31	80.5	8.21	18100	89.2	9.09	20100	97.0	9.89	21800
	7/16	66.0	0.58	0.39	99.4	10.1	22400	110	11.2	24800	120	12.2	27000
12		76.9	0.67	0.45	116	11.8	26100	128	13.1	28900	140	14.2	31400
	1/2	86.1	0.75	0.51	130	13.2	29200	144	14.7	32400	156	15.9	35200
13		90.3	0.79	0.53	136	13.9	30600	151	15.4	33900	164	16.7	36900
14		105	0.91	0.61	158	16.1	35500	175	17.8	39300	190	19.4	42800
15		120	1.05	0.71	181	18.5	40800	201	20.5	45200	218	22.2	49100
	5/8	135	1.17	0.79	203	20.7	45700	225	22.9	50600	244	24.9	55000
16		137	1.19	0.80	206	21.0	46400	228	23.3	51400	248	25.3	55900
17		154	1.35	0.91	233	23.7	52400	258	26.3	58000	280	28.6	63100
18		173	1.51	1.02	261	26.6	58700	289	29.5	65000	314	32.0	70700
19	3/4	194	1.69	1.14	292	29.8	65700	324	33.0	72800	352	35.9	79200
20		214	1.86	1.26	322	32.8	72500	357	36.4	80300	388	39.6	87300
22		258	2.26	1.52	390	39.7	87700	432	44.0	97200	469	47.9	106000
	7/8	264	2.30	1.55	398	40.6	89500	441	44.9	99200	479	48.9	108000
24		308	2.68	1.81	464	47.3	104000	514	52.4	116000	559	57.0	126000
	1	345	3.01	2.02	519	52.9	117000	575	58.7	129000	626	63.8	141000
26		361	3.15	2.12	544	55.5	122000	603	61.5	136000	656	66.8	148000
28		419	3.65	2.46	631	64.3	142000	699	71.3	157000	760	77.5	171000
	1-1/8	436	3.81	2.56	657	67.0	148000	728	74.2	164000	792	80.7	178000
30		481	4.19	2.82	725	73.9	163000	803	81.8	181000	873	89.0	196000
	1-1/4	538	4.70	3.16	811	82.7	183000	899	91.7	202000	978	99.7	220000
32		547	4.77	3.21	824	84.0	185000	913	93.1	206000	993	101	224000
34		617	5.39	3.63	931	94.9	209000	1030	105	232000	1120	114	252000
35	1-3/8	654	5.71	3.84	986	101	222000	1090	111	246000	1190	121	267000
36		692	6.04	4.07	1040	106	235000	1160	118	260000	1260	128	283000
38		771	6.73	4.53	1160	118	262000	1290	131	290000	1400	143	315000
40		855	7.46	5.02	1290	131	290000	1430	145	321000	1550	158	349000
42		942	8.22	5.53	1420	145	320000	1570	160	354000	1710	174	385000
44		1030	9.02	6.07	1560	159	351000	1730	176	389000	1880	191	423000
	1-3/4	1060	9.21	6.20	1590	162	358000	1760	180	397000	1920	195	431000
46		1130	9.86	6.64	1700	174	383000	1890	192	425000			
48		1230	10.7	7.23	1850	189	417000	2060	209	462000			
50		1340	11.7	7.84	2010	205	453000	2230	227	502000			
	2	1380	12.0	8.10	2080	212	467000	2300	235	518000			
52		1440	12.6	8.48	2180	222	490000	2410	246	543000			
54	2-1/8	1560	13.6	9.15	2350	239	528000	2600	265	585000			
56		1670	14.6	9.84	2520	257	568000	2800	285	629000			
58	2-1/4	1800	15.7	10.6	2710	276	609000	3000	306	675000			
60	2-3/8	1920	16.8	11.3	2900	295	652000	3210	327	723000			

Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 3% - Unless otherwise specified lay type is Regular
The construction type shown is the manufacturer's standard. Other constructions can be considered on request


7
6
5
4

Pack™8

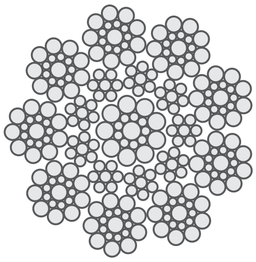
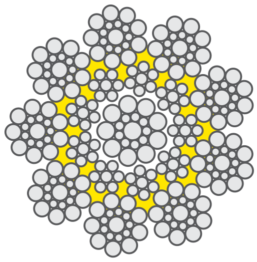
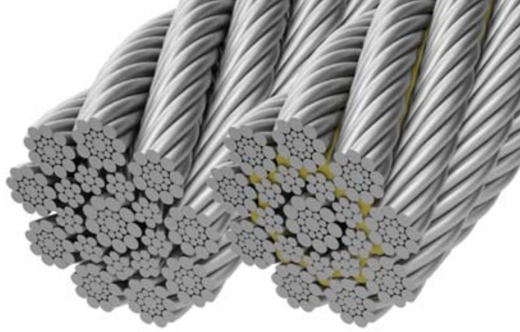




	Diameter		Area	Mass		Minimum Breaking Force - MBF Grade 2160		
	mm	inches	mm^2	kg/m	lbs/ft	kN	Mtons	lbs
8xK19S - PWRC	8	5/16	36.7	0.32	0.21	67.8	6.92	15300
	9		46.4	0.40	0.27	85.9	8.75	19300
		3/8	52.0	0.45	0.30	96.2	9.80	21600
	10		57.3	0.50	0.33	106	10.8	23900
		7/16	70.8	0.61	0.41	131	13.3	29500
	12		82.6	0.71	0.48	153	15.6	34300
		1/2	92.5	0.80	0.54	171	17.4	38500
	13		96.9	0.84	0.56	179	18.3	40300
	14		112	0.97	0.65	208	21.2	46800
	15		129	1.11	0.75	239	24.3	53700
		5/8	144	1.25	0.84	267	27.2	60100
	16		147	1.27	0.85	271	27.7	61100
	17		166	1.43	0.96	306	31.2	68900
	18		186	1.60	1.08	336	34.3	75700
	19	3/4	208	1.80	1.21	377	38.4	84800
	20		229	1.98	1.33	415	42.3	93500
	22		277	2.40	1.61	503	51.2	113000
		7/8	283	2.45	1.65	513	52.3	115000
	24		330	2.85	1.92	598	61.0	135000
		1	370	3.19	2.15	670	68.3	151000
	26		388	3.35	2.25	702	71.6	158000
	28		449	3.88	2.61	797	81.3	179000

Aggregate Breaking Force = Metallic Area x Rope Grade - Unless otherwise specified lay type is Regular - The construction type shown is the manufacturer's standard. Other constructions can be considered on request

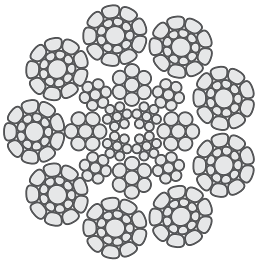
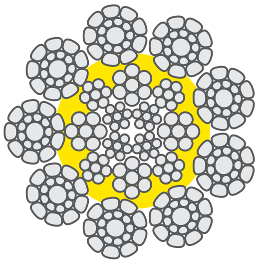
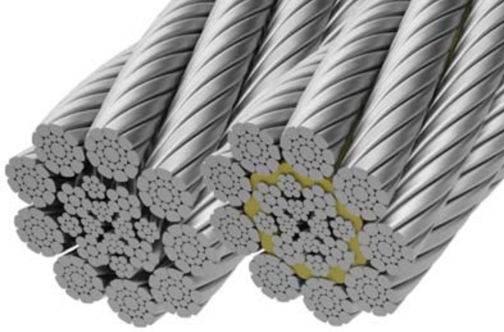
Red™9
Red™9P

	Diameter		Area	Mass		Minimum Breaking Force - MBF					
						Grade 1770			Grade 1960		
	mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs
9x19S - IWRC	12		70.1	0.63	0.42	111	11.3	24900	122	12.4	27400
		1/2	78.5	0.71	0.48	124	12.6	27900	136	13.9	30700
	13		82.3	0.74	0.50	130	13.2	29200	143	14.6	32200
	14		95.4	0.86	0.58	150	15.3	33900	166	16.9	37300
	15		110	0.99	0.66	173	17.6	38900	190	19.4	42800
		5/8	123	1.10	0.74	193	19.7	43500	213	21.7	48000
	16		125	1.12	0.75	196	20.0	44200	217	22.1	48700
	17		141	1.27	0.85	222	22.6	49900	245	24.9	55000
	18		158	1.42	0.96	249	25.3	56000	274	27.9	61700
	19	3/4	177	1.59	1.07	279	28.4	62700	307	31.3	69100
	20		195	1.75	1.18	307	31.3	69100	338	34.5	76200
	22		236	2.12	1.43	371	37.9	83600	410	41.8	92200
		7/8	241	2.16	1.46	379	38.7	85300	418	42.6	94100
	24		280	2.52	1.70	442	45.1	99500	487	49.7	110000
		1	314	2.83	1.90	495	50.5	111000	546	55.7	123000
	26		329	2.96	1.99	519	52.9	117000	572	58.3	129000
	28		382	3.43	2.31	602	61.3	135000	663	67.6	149000
		1-1/8	398	3.58	2.41	627	63.9	141000	691	70.4	155000
	30		438	3.94	2.65	691	70.4	155000	762	77.6	171000
		1-1/4	491	4.42	2.97	774	78.9	174000	853	87.0	192000
9x25F - IWRC	32		499	4.57	3.07	786	80.1	177000	867	88.3	195000
	34		563	5.16	3.47	887	90.4	200000	978	100	220000
	35	1-3/8	597	5.46	3.68	940	95.8	212000	1040	106	233000
	36		631	5.78	3.89	995	101	224000	1100	112	247000
	38		703	6.44	4.34	1110	113	249000	1220	125	275000
	40		779	7.14	4.80	1230	125	276000	1350	138	305000
	42		859	7.87	5.30	1350	138	305000	1490	152	336000
	44		943	8.63	5.81	1490	151	334000	1640	167	369000
		1-3/4	962	8.81	5.93	1520	155	341000	1670	170	376000
	46		1030	9.44	6.35	1620	166	365000	1790	183	403000
	48		1120	10.3	6.92	1770	180	398000	1950	199	439000
9x31WS - IWRC	50		1240	11.3	7.61	1950	199	439000	2150	219	484000
		2	1280	11.7	7.85	2010	205	453000	2220	226	499000
	52		1340	12.2	8.23	2110	215	475000	2330	237	523000
	54	2-1/8	1440	13.2	8.87	2270	232	512000	2510	256	564000
	56		1550	14.2	9.54	2450	249	550000	2700	275	607000
	58	2-1/4	1660	15.2	10.2	2620	267	590000	2890	295	651000
	60	2-3/8	1780	16.3	11.0	2810	286	632000	3100	316	697000

Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 2% - Unless otherwise specified lay type is Regular
The construction type shown is the manufacturer's standard. Other constructions can be considered on request

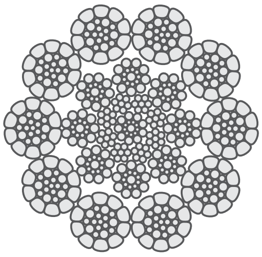
Pack™9
Pack™9P

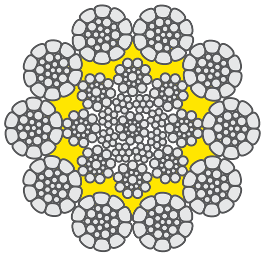




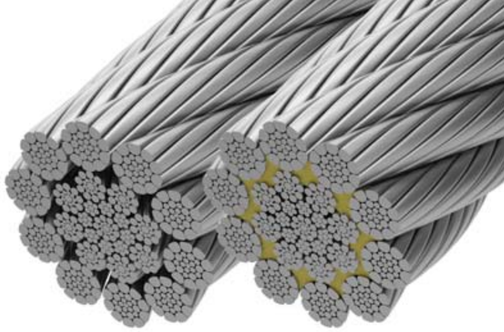
Construction	Diameter		Area	Mass		Minimum Breaking Force - MBF								
						Grade 1770			Grade 1960			Grade 2160		
	mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs	kN	Mtons	lbs
9xK19S - IWRC	12		79.2	0.69	0.46	123	12.5	27700	136	13.9	30700	145	14.8	32700
		1/2	88.7	0.77	0.52	138	14.0	31000	153	15.6	34400	163	16.6	36600
	13		92.9	0.81	0.54	144	14.7	32500	160	16.3	36000	170	17.4	38400
	14		108	0.94	0.63	167	17.1	37700	186	18.9	41800	198	20.2	44500
	15		124	1.08	0.72	192	19.6	43300	213	21.7	47900	227	23.1	51100
		5/8	139	1.20	0.81	215	21.9	48500	239	24.3	53700	254	25.9	57200
	16		141	1.22	0.82	219	22.3	49200	242	24.7	54600	258	26.3	58100
	17		159	1.38	0.93	247	25.2	55600	274	27.9	61600	292	29.7	65600
	18		178	1.55	1.04	277	28.2	62300	307	31.3	69000	327	33.3	73600
	19	3/4	200	1.73	1.17	310	31.6	69800	344	35.0	77300	366	37.3	82400
	20		220	1.91	1.29	342	34.8	76900	379	38.6	85200	395	40.3	89000
	22		266	2.31	1.56	414	42.2	93100	458	46.7	103000	478	48.8	108000
		7/8	272	2.36	1.59	422	43.0	95000	468	47.7	105000	488	49.8	110000
	24		317	2.75	1.85	492	50.2	111000	545	55.6	123000	569	58.0	128000
		1	355	3.08	2.08	551	56.2	124000	611	62.3	137000	638	65.0	143000
	26		372	3.23	2.18	578	58.9	130000	640	65.3	144000	668	68.1	150000
	28		431	3.75	2.52	670	68.3	151000	742	75.7	167000	775	79.0	174000
		1-1/8	449	3.90	2.63	698	71.1	157000	773	78.8	174000	807	82.3	182000
	30		495	4.30	2.90	769	78.4	173000	852	86.9	192000			
		1-1/4	554	4.82	3.24	861	87.8	194000	955	97.3	215000			
	32		563	4.89	3.30	875	89.2	197000	970	98.9	218000			
	34		636	5.53	3.72	988	101	222000	1090	112	246000			
	35	1-3/8	673	5.86	3.94	1050	107	236000	1160	118	261000			
	36		713	6.19	4.17	1110	113	249000	1230	125	276000			
	38		794	6.90	4.65	1230	126	278000	1370	139	308000			
	40		880	7.65	5.15	1370	139	308000	1520	154	341000			
9xK31WS - IWRC	42		956	8.40	5.65	1490	151	334000	1650	168	371000			
	44		1050	9.22	6.20	1630	166	367000	1810	184	407000			
		1-3/4	1070	9.40	6.33	1660	170	374000	1840	188	415000			
	46		1150	10.1	6.78	1780	182	401000	1980	201	445000			
	48		1250	11.0	7.38	1940	198	437000	2150	219	484000			
9xK36WS - IWRC	50		1340	11.9	8.01	2080	212	467000	2300	234	518000			
		2	1380	12.3	8.27	2140	218	482000	2370	242	534000			
	52		1440	12.9	8.67	2240	229	505000	2490	254	560000			
	54	2-1/8	1560	13.9	9.35	2420	247	545000	2680	273	604000			
	56		1670	14.9	10.1	2600	265	586000	2890	294	649000			
	58	2-1/4	1800	16.0	10.8	2790	285	628000	3090	315	696000			
	60	2-3/8	1920	17.1	11.5	2990	305	672000	3310	338	745000			

Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 2% - Unless otherwise specified lay type is Regular
The construction type shown is the manufacturer's standard. Other constructions can be considered on request

Pack™10
Pack™10P



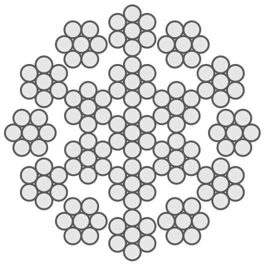


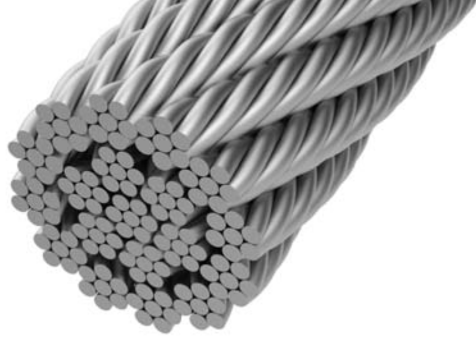


	Diameter		Area	Mass		Minimum Breaking Force - MBF								
						Grade 1770			Grade 1960			Grade 2160		
	mm	inches	mm^2	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs	kN	Mtons	lbs
10xK26WS - IWRC	16		135	1.19	0.80	209	21.3	47000	231	23.6	52000	249	25.4	56100
	17		152	1.35	0.91	236	24.0	53100	261	26.6	58700	282	28.7	63400
	18		170	1.51	1.02	264	27.0	59500	293	29.8	65900	316	32.2	71000
	19	3/4	191	1.69	1.14	296	30.2	66600	328	33.4	73800	354	36.0	79600
	20		210	1.86	1.26	326	33.3	73500	361	36.8	81300	390	39.7	87700
	22		255	2.26	1.52	395	40.3	88900	437	44.6	98400	462	47.1	104000
		7/8	260	2.30	1.55	403	41.1	90700	446	45.5	100000	472	48.1	106000
	24		303	2.68	1.81	470	47.9	106000	520	53.0	117000	550	56.0	124000
		1	339	3.01	2.02	526	53.7	118000	583	59.4	131000	616	62.8	139000
	26		356	3.15	2.12	552	56.2	124000	611	62.2	137000	645	65.8	145000
	28		413	3.65	2.46	640	65.2	144000	708	72.2	159000	748	76.3	168000
		1-1/8	430	3.81	2.56	666	67.9	150000	738	75.2	166000	779	79.5	175000
	30		474	4.19	2.82	734	74.9	165000	813	82.9	183000	859	87.6	193000
		1-1/4	530	4.70	3.16	823	83.9	185000	911	92.8	205000	962	98.1	217000
	32		539	4.77	3.21	836	85.2	188000	925	94.3	208000	977	100	220000
	34		608	5.39	3.63	943	96.2	212000	1040	106	235000			
	35	1-3/8	645	5.71	3.84	1000	102	225000	1110	113	249000			
	36		682	6.04	4.07	1060	108	238000	1170	119	263000			
	38		760	6.73	4.53	1180	120	265000	1300	133	294000			
	40		842	7.46	5.02	1310	133	294000	1450	147	325000			

Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 2% - Unless otherwise specified lay type is Regular
The construction type shown is the manufacturer's standard. Other constructions can be considered on request

19x7LR
Non Rotating

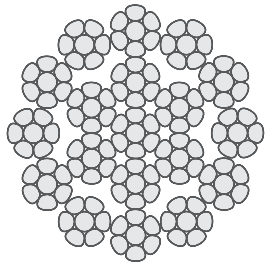


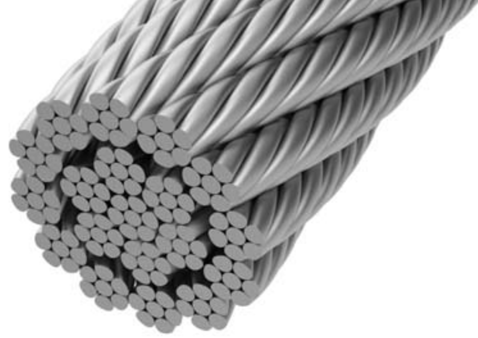


	Diameter		Area	Mass		Minimum Breaking Force - MBF					
						Grade 1770			Grade 1960		
	mm	inches	mm^2	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs
19x7 - CWS	8	5/16	29.2	0.27	0.18	45.1	4.59	10100	49.9	5.09	11200
	9		36.9	0.34	0.23	57.0	5.81	12800	63.2	6.44	14200
		3/8	41.3	0.38	0.25	63.9	6.51	14400	70.8	7.21	15900
	10		45.6	0.42	0.28	70.4	7.18	15800	78.0	7.95	17600
		7/16	56.3	0.51	0.35	86.9	8.86	19600	96.3	9.82	21700
	12		65.6	0.60	0.40	101	10.3	22800	112	11.4	25300
		1/2	73.5	0.67	0.45	114	11.6	25600	126	12.8	28300
	13		77.0	0.70	0.47	119	12.1	26800	132	13.4	29700
	14		89.3	0.81	0.55	138	14.1	31000	153	15.6	34400
	15		102	0.93	0.63	158	16.1	35600	176	17.9	39500
		5/8	115	1.05	0.70	177	18.1	39900	197	20.0	44200
	16		117	1.06	0.72	180	18.4	40600	200	20.4	44900
	17		132	1.20	0.81	203	20.7	45800	225	23.0	50700
	18		148	1.34	0.91	228	23.3	51300	253	25.8	56900
	19	3/4	165	1.51	1.01	255	26.0	57500	283	28.9	63700
	20		182	1.66	1.12	282	28.7	63400	312	31.8	70200

Aggregate Breaking Force = Metallic Area x Rope Grade - Unless otherwise specified lay type is Regular - The construction type shown is the manufacturer's standard. Other constructions can be considered on request

19xK7LR
Non Rotating





	Diameter		Area	Mass		Minimum Breaking Force - MBF					
						Grade 1770			Grade 1960		
	mm	inches	mm^2	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs
19xK7 - CWS	8	5/16	36.7	0.29	0.20	49.9	5.09	11200	55.0	5.61	12400
	9		46.4	0.37	0.25	63.2	6.44	14200	69.7	7.10	15700
		3/8	52.0	0.42	0.28	70.8	7.21	15900	78.0	7.95	17600
	10		57.3	0.46	0.31	78.0	7.95	17600	86.0	8.77	19400
		7/16	70.8	0.57	0.38	96.3	9.82	21700	106	10.8	23900
	12		82.6	0.66	0.45	112	11.4	25300	124	12.6	27900
		1/2	92.5	0.74	0.50	126	12.8	28300	139	14.1	31200
	13		96.9	0.78	0.52	132	13.4	29700	145	14.8	32700
	14		112	0.90	0.61	153	15.6	34400	169	17.2	37900
	15		129	1.04	0.70	176	17.9	39500	194	19.7	43500
		5/8	144	1.16	0.78	197	20.0	44200	217	22.1	48800
	16		147	1.18	0.79	200	20.4	44900	220	22.4	49500
	17		166	1.33	0.90	225	23.0	50700	249	25.3	55900
	18		186	1.49	1.00	253	25.8	56900	279	28.4	62700
	19	3/4	208	1.67	1.12	283	28.9	63700	312	31.8	70200
	20		229	1.84	1.24	312	31.8	70200	344	35.1	77400

Aggregate Breaking Force = Metallic Area x Rope Grade - Unless otherwise specified lay type is Regular - The construction type shown is the manufacturer's standard. Other constructions can be considered on request

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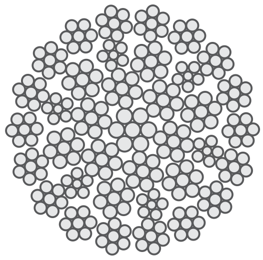
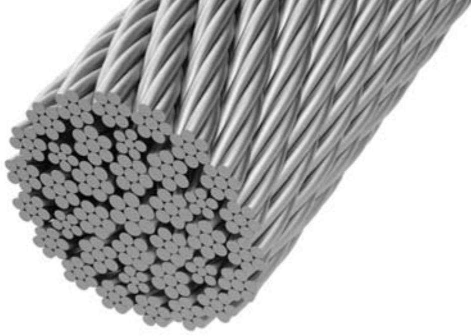
Non Rotating

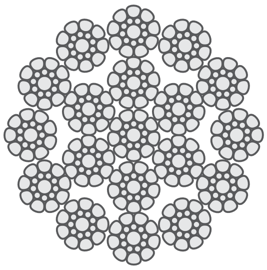


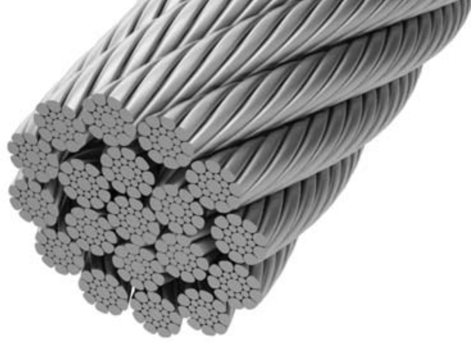


	Diameter		Area	Mass		Minimum Breaking Force - MBF					
						Grade 1770			Grade 1960		
	mm	inches	mm^2	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs
27x7 / 35x7	10		49.5	0.44	0.30	70.4	7.18	15800	78.0	7.95	17600
		7/16	61.1	0.55	0.37	86.9	8.86	19600	96.3	9.82	21700
	12		71.3	0.64	0.43	101	10.3	22800	112	11.4	25300
		1/2	79.8	0.71	0.48	114	11.6	25600	126	12.8	28300
	13		83.6	0.75	0.50	119	12.1	26800	132	13.4	29700
	14		97.0	0.87	0.58	138	14.1	31000	153	15.6	34400
	15		111	1.00	0.67	158	16.1	35600	176	17.9	39500
		5/8	125	1.12	0.75	177	18.1	39900	197	20.0	44200
	16		127	1.13	0.76	180	18.4	40600	200	20.4	44900
	17		143	1.28	0.86	203	20.7	45800	225	23.0	50700
	18		160	1.44	0.97	228	23.3	51300	253	25.8	56900
	19	3/4	180	1.61	1.08	255	26.0	57500	283	28.9	63700
	20		198	1.77	1.19	282	28.7	63400	312	31.8	70200
	22		239	2.14	1.44	341	34.7	76700	378	38.5	85000
		7/8	245	2.19	1.47	348	35.5	78300	385	39.3	86700
	24		285	2.55	1.72	406	41.3	91200	449	45.8	101000
		1	319	2.86	1.92	454	46.3	102000	503	51.3	113000
	26		334	2.99	2.02	476	48.5	107000	527	53.7	119000
	28		388	3.47	2.34	552	56.3	124000	612	62.3	138000
		1-1/8	404	3.62	2.44	575	58.6	129000	637	64.9	143000
	30		445	3.99	2.68	634	64.6	143000	702	71.6	158000
		1-1/4	499	4.47	3.01	710	72.3	160000	786	80.2	177000
	32		507	4.54	3.05	721	73.5	162000	799	81.4	180000
	34		572	5.12	3.45	814	83.0	183000	902	91.9	203000
	35	1-3/8	606	5.43	3.65	862	87.9	194000	956	97.4	215000
	36		641	5.74	3.87	912	93.0	205000	1010	103	227000
	38		714	6.40	4.31	1020	104	229000	1130	115	253000
	40		792	7.09	4.77	1130	115	253000	1250	127	281000
40x7	42		873	7.81	5.26	1240	127	279000	1380	140	310000
	44		958	8.58	5.77	1360	139	307000	1510	154	340000
		1-3/4	978	8.75	5.89	1390	142	313000	1540	157	347000
	46		1050	9.37	6.31	1490	152	335000	1650	168	371000
	48		1140	10.2	6.87	1620	165	365000	1800	183	404000
	50		1240	11.1	7.46	1760	179	396000	1950	199	439000
		2	1280	11.4	7.70	1820	185	409000	2010	205	453000
	52		1340	12.0	8.07	1900	194	428000	2110	215	475000
	54	2-1/8	1440	12.9	8.70	2050	209	462000	2270	232	512000
	56		1550	13.9	9.35	2210	225	497000	2450	249	550000
	58	2-1/4	1660	14.9	10.0	2370	241	533000	2620	267	590000
	60	2-3/8	1780	15.9	10.7	2530	258	570000	2810	286	632000

Aggregate Breaking Force = Metallic Area x Rope Grade - Unless otherwise specified lay type is Lang (d<40mm) - The construction type shown is the manufacturer's standard. Other constructions can be considered on request

Pack™ 361
Non Rotating





	Diameter		Area	Mass		Minimum Breaking Force - MBF								
						Grade 1770			Grade 1960			Grade 2160		
	mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs	kN	Mtons	lbs
19xK19S - CWS	10		56.5	0.49	0.33	74.0	7.54	16700	82.0	8.36	18500	88.0	8.97	19800
		7/16	69.8	0.60	0.40	91.4	9.32	20600	101	10.3	22800	109	11.1	24500
	12		81.4	0.70	0.47	107	10.9	24000	118	12.0	26600	127	12.9	28500
		1/2	91.2	0.78	0.53	119	12.2	26900	132	13.5	29800	142	14.5	31900
	13		95.6	0.82	0.55	125	12.7	28100	139	14.1	31200	149	15.2	33500
	14		111	0.95	0.64	145	14.8	32600	161	16.4	36200	172	17.6	38800
	15		127	1.09	0.73	167	17.0	37500	185	18.8	41500	198	20.2	44600
		5/8	143	1.22	0.82	186	19.0	42000	207	21.1	46500	222	22.6	49900
	16		145	1.24	0.84	189	19.3	42600	210	21.4	47200	225	23.0	50700
	17		163	1.40	0.94	214	21.8	48100	237	24.2	53300	254	25.9	57200
	18		183	1.57	1.06	240	24.4	54000	266	27.1	59800	285	29.1	64200
	19	3/4	205	1.76	1.19	269	27.4	60400	298	30.3	67000	319	32.6	71900
	20		226	1.94	1.31	296	30.2	66600	328	33.4	73800	352	35.9	79200
	22		274	2.35	1.58	358	36.5	80600	397	40.5	89300	426	43.4	95800
		7/8	279	2.40	1.61	366	37.3	82300	405	41.3	91200	435	44.3	97900
	24		326	2.79	1.88	426	43.4	95900	472	48.1	106000	507	51.7	114000
		1	365	3.13	2.11	477	48.7	107000	529	53.9	119000	556	56.7	125000
	26		382	3.28	2.21	500	51.0	113000	554	56.5	125000	583	59.4	131000
	28		443	3.80	2.56	580	59.1	131000	643	65.5	145000	676	68.9	152000
		1-1/8	462	3.96	2.67	604	61.6	136000	670	68.3	151000	704	71.8	158000
	30		509	4.37	2.94	666	67.9	150000	738	75.2	166000	776	79.1	175000

Aggregate Breaking Force = Metallic Area x Rope Grade - Unless otherwise specified lay type is Regular - The construction type shown is the manufacturer's standard. Other constructions can be considered on request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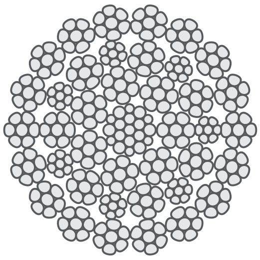
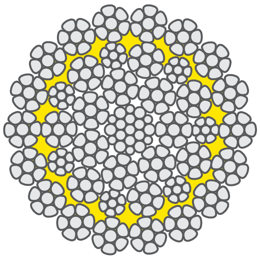
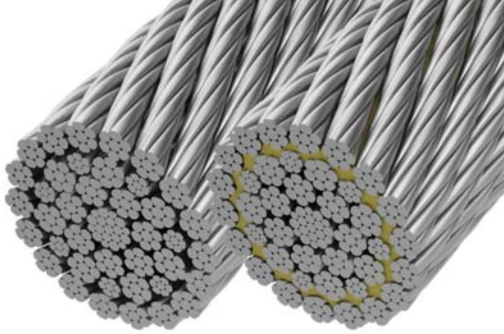
Flexpack™
Flexpack™ P
Non Rotating

Construction	Diameter		Area	Mass		Minimum Breaking Force - MBF								
						Grade 1770			Grade 1960			Grade 2160		
	mm	inches	mm²	kg/m	lbs/ft	kN	Mtons	lbs	kN	Mtons	lbs	kN	Mtons	lbs
27xK7 / 35xK7	10		57.3	0.49	0.33	83.0	8.46	18700	92.0	9.38	20700	98.0	10.0	22100
		7/16	70.8	0.61	0.41	102	10.4	23100	114	11.6	25600	121	12.3	27200
	12		82.6	0.71	0.48	120	12.2	26900	132	13.5	29800	141	14.4	31800
		1/2	92.5	0.79	0.53	134	13.6	30100	148	15.1	33400	158	16.1	35600
	13		96.9	0.83	0.56	140	14.3	31600	155	15.8	35000	166	16.9	37300
	14		112	0.96	0.65	163	16.6	36600	180	18.4	40600	192	19.6	43200
	15		129	1.11	0.75	187	19.0	42000	207	21.1	46600	221	22.5	49600
		5/8	144	1.24	0.83	209	21.3	47100	232	23.6	52200	247	25.2	55600
	16		147	1.26	0.85	212	21.7	47800	236	24.0	53000	251	25.6	56500
	17		166	1.42	0.96	240	24.5	54000	266	27.1	59800	283	28.9	63700
	18		186	1.59	1.07	269	27.4	60500	298	30.4	67100	318	32.4	71500
	19	3/4	208	1.79	1.20	301	30.7	67800	334	34.0	75100	356	36.3	80000
	20		229	1.97	1.33	332	33.8	74700	368	37.5	82800	392	40.0	88200
	22		277	2.38	1.60	402	41.0	90400	445	45.4	100000	465	47.4	105000
		7/8	283	2.43	1.64	410	41.8	92300	455	46.3	102000	474	48.4	107000
	24		330	2.83	1.91	478	48.7	108000	530	54.0	119000	553	56.4	124000
		1	370	3.17	2.14	535	54.6	120000	594	60.5	134000	619	63.1	139000
	26		388	3.33	2.24	561	57.2	126000	622	63.4	140000	649	66.2	146000
	28		449	3.86	2.60	651	66.3	146000	721	73.5	162000	753	76.7	169000
		1-1/8	468	4.02	2.70	678	69.1	153000	751	76.6	169000	784	79.9	176000
	30		516	4.43	2.98	747	76.1	168000	828	84.4	186000	864	88.1	194000
		1-1/4	578	4.96	3.34	837	85.3	188000	927	94.5	209000			
	32		587	5.04	3.39	850	86.6	191000	942	96.0	212000			
	34		663	5.69	3.83	959	97.8	216000	1060	108	239000			
	35	1-3/8	702	6.03	4.06	1020	104	229000	1130	115	254000			
	36		743	6.38	4.29	1080	110	242000	1190	122	268000			
	38		828	7.10	4.78	1200	122	270000	1330	135	299000			
	40		917	7.87	5.30	1330	135	299000	1470	150	331000			
	42		1010	8.68	5.84	1460	149	329000	1620	165	365000			
	44		1110	9.53	6.41	1610	164	362000	1780	182	401000			
		1-3/4	1130	9.72	6.55	1640	167	369000	1820	185	409000			
	46		1210	10.4	7.01	1760	179	395000	1950	198	438000			
	48		1320	11.3	7.63	1910	195	430000	2120	216	477000			
	50		1430	12.3	8.28	2080	212	467000	2300	234	518000			
		2	1480	12.7	8.55	2140	218	482000	2370	242	534000			
	52		1550	13.3	8.96	2240	229	505000	2490	254	560000			
	54	2-1/8	1670	14.3	9.66	2420	247	545000	2680	273	604000			
	56		1800	15.4	10.4	2600	265	586000	2890	294	649000			
	58	2-1/4	1930	16.6	11.1	2790	285	628000	3090	315	696000			
	60	2-3/8	2060	17.7	11.9	2990	305	672000	3310	338	745000			

Aggregate Breaking Force = Metallic Area x Rope Grade - Additional mass for plastic impregnated ropes is 1% - Unless otherwise specified lay type is Lang (d<40mm)
The construction type shown is the manufacturer's standard. Other constructions can be considered on request


COBI
Eucon
HYUNDAI
CAPITAL
swissterminal

Technical Information

Definitions

Terms used in this brochure are as follows:

δ	diameter factor of outer wire.
f	filling factor of metal section.
W	mass factor.
KR	breaking force factor.
τ	torque factor.
ρ	rotation factor of rope.
D	bending diameter on winches and sheaves.
d	rope diameter.
p	lay.
K	compacted strand.
Lay type	lay of wires (s / z), of strands (S / Z).
WSC	wire strand core according to ISO 17893.
IWRC	independent wire rope core according to ISO 17893.
PWRC	parallel wire rope core according to ISO 17893.
EPIWRC	independent wire rope covered with plastic according to ISO 17893.
SFC	synthetic fibre core according to ISO 17893.
NFC	natural fibre core according to ISO 17893.
Class	range of ropes with physical and mechanical characteristics according to ISO 17893.
Construction	detail of assembling of various elements in rope.
Tensile strength	level of breaking force of rope (standard, high, extra).
Compacting	cold deformation process of entire strand and its wires, carried out to reduce the diameter through drawing.
Plastic core rope	rope with core covered by a plastic sheath.


EVERGREEN

Reference standards

Ropes

General requirements for the ropes listed are laid down in ISO/CD 2408 and prEN 12385-2. Degrees of resistance are usually higher than the unified classes of resistance.

Rope terminations

When a termination is attached to a rope, the breaking force will be reduced depending on the type of termination. This difference is expressed as “degree of efficiency” in % compared to the breaking load, and the amount can vary between 70% and 100%.

Degree of efficiency of terminations with respect to the breaking force of the rope is shown in prEN 13411-2…6:1998 and prEN 13414-1:2000.

Tolerances

Tolerances of rope diameters

The actual diameters of the ropes are expressed as the mean of the values of two pairs of measurements that are rectangular in two sections and at least one meter apart. The measurements are either taken without a load or with a maximum tension of 5% of the breaking force and the following tolerances are acceptable:

Nominal diameter	Tolerance
From 4 to < 6 mm	0 / +7%
From 6 to < 8 mm	0 / +6%
More than 8 mm	0 / +5%

Tolerances on the length of ropes

The difference between the nominal length and the actual length of the ropes (without tension) is between the following tolerances:

Nominal length	Tolerance
Up to 400 m	0 / +5%
From 400 to 1000 m	0 / +20 m
More than 1000 m	0 / +2%

Lower tolerances on ropes can be agreed with our sales office.


ALEX
POTAIN

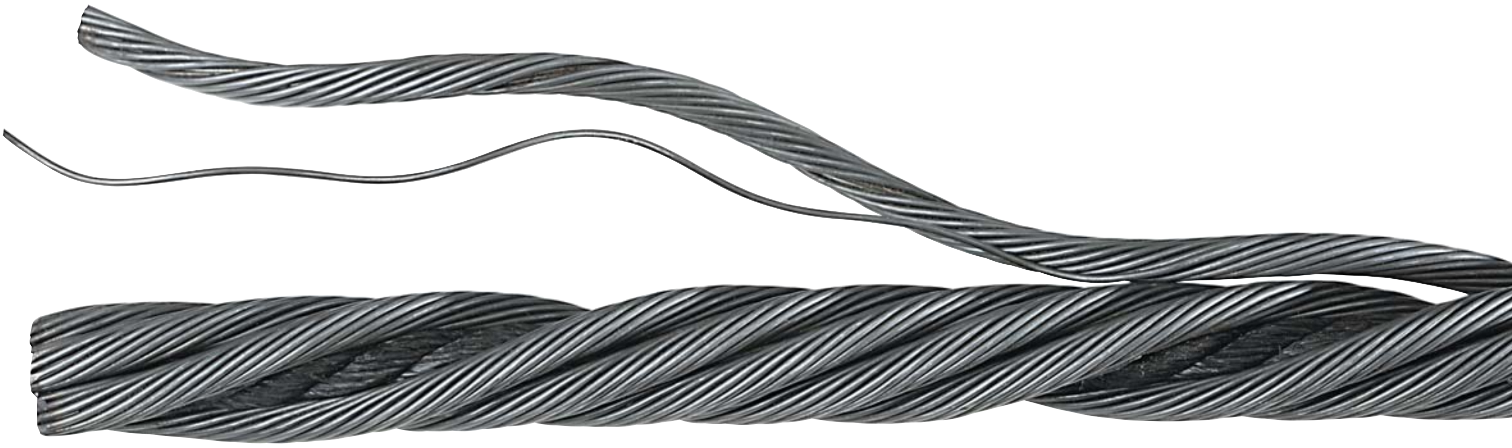
Safety characteristics

Steel wires consist of mechanical compound components to transmit force and movement in an axial direction through their end joints and through deviation on pulleys, sheaves, settings, etc.

• **A rope is not a homogeneous material** and consists of many elements (wires, strands and core) that are kept together just by adjoining them: Excessive stress can alter the geometric structure and consequently the performance.

• **A rope is not an isotropic material** and its characteristics depend on the direction that stress is applied in. (It is designed to resist axial traction but not compression or tension).

• **A rope is not a linear,** elastic material and its response to stress is not proportional to the stress itself. (This is especially true for low and high stress levels).



When the rope is exposed to repeated bending, vibrations or pulsating loads, it is necessary to remember that the rope is exposed to wear and tear. The way in which this becomes apparent depends on the intensity of stress and the type of rope used.

Lubrication during manufacturing and at maintenance intervals reduces inner friction between the various components of the rope and is therefore considered an integral part of the product.

Like many other types of materials ropes have a rate of damage that is rapid in the initial and final phases of use. During the first stages of utilization especially, damage is usually caused by:

- wrong choice of rope
- improper installation
- poor adjustment between equipment and rope.

After an initial phase of breaking-in, the rope remains stable for a long period of service (provided that the necessary maintenance is carried out).

During its final phase of use the rate of damage increases abruptly, producing evidence that it is time to replace the rope.

Most frequent examples of damage occurring during the final phase are as follows:

- breaking of wires
- general reduction of diameter
- “stiffening” of rope.

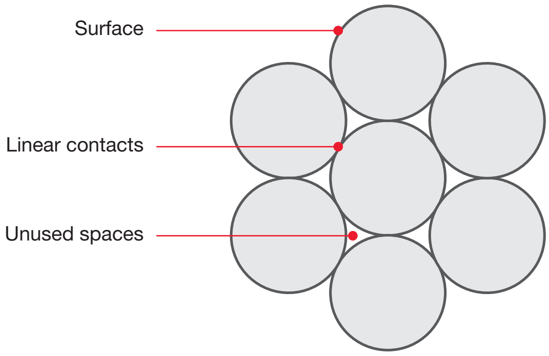
Depending on how quickly damage progresses, an estimate of the remaining life expectancy and the safety of utilization of the product must be made.

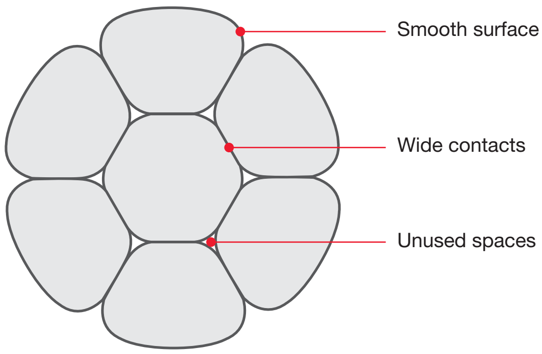
Further information about characteristics of product use can be found in the supplier’s technical documentation.

Compacted strands

Compacting of strand is a cold deformation process of the whole strand and its wires, achieved by the passage of the strand through a drawing tool and a pair of rollers.

After the compacting process significant modifications of the wire shapes are achieved, as follows:
- increase of the metallic area of the strand
- wider surfaces of contact between wires
- smoother, more regular and less-permeable strand surface
- more uniform distribution of the tension in the wires
- increased dimensional stability of the strand when subjected to side forces
- possibility to produce ropes with a longer closing pitch, so obtaining a higher modulus of elasticity.





Due to the advantages of compacting, the use of compacted ropes has increased greatly in all sectors - mainly in applications in which composite stresses (traction-side pressure) occur.

Compacting is used to produce ropes with a higher load capacity (due to increased metallic area) and ropes working under high side pressure or abrasion (due to stronger strength of strands and larger contact surface).

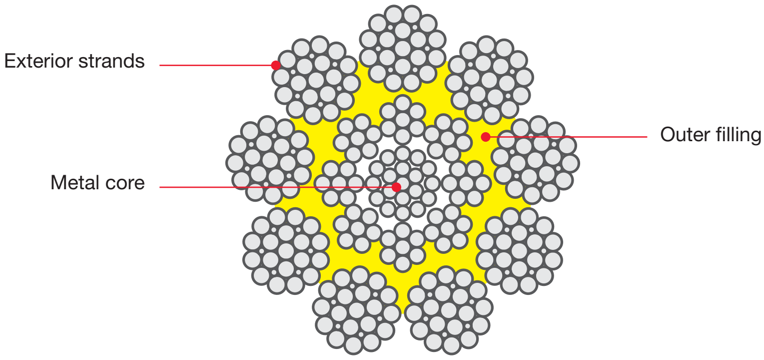
Furthermore, for the same rope breaking force it's possible to use wires with a lower tensile strength, thereby improving the rope's performance in terms of ductility and fatigue resistance.

Plastic coated core

Ropes with a plastic-coated metal wire rope core consist of a layer of strands wound on a metal core that is coated with a sheath of plastic. Inserting a plastic filler drastically reduces potential sliding of the various components and prevents geometric alterations in the ropes.

Application of a plastic coating has the following purposes:
- To create a mechanical joint that fixes the reciprocal positions of the components of the rope while allowing necessary movement.
- To reduce the internal corrosion process due to reduced permeability of the rope caused by polluting agents.
- To fill the free space between the exterior strands in order to prevent wear.

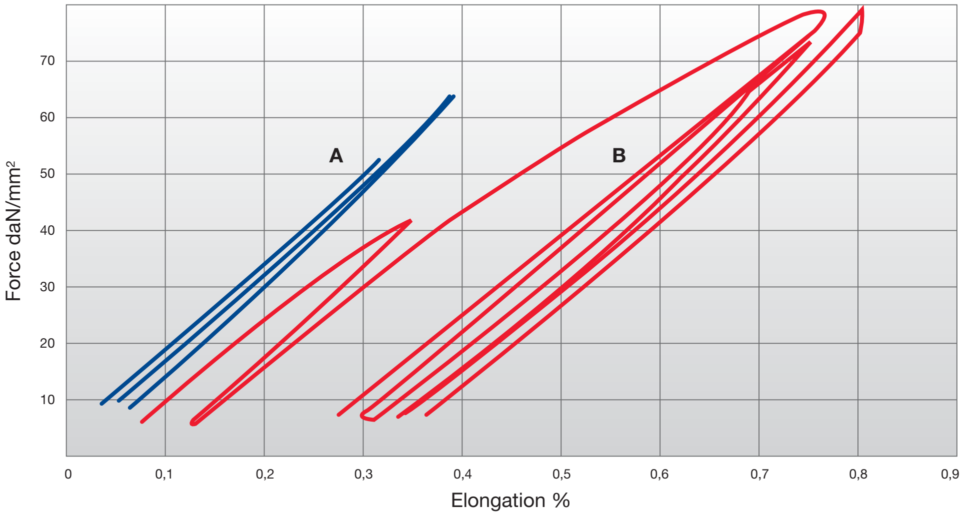
The following drawing displays the structure of ropes with a plastic-coated metal core. The type of outer material used allows continuous operation of the rope in a wide temperature range (-35°C to 90°C) without dimensional alterations or fragile breaks.



The stabilizing effect induced by plastic coatings is especially evident when the rope is exposed to the following:
- transverse pressures
- torsion caused by wide lateral deviation angles on pulleys or drums
- shock loads.

Pre-stretching

The diagram shows the different behaviour of two ropes, one (A) subject to pre-stretching treatment and the other (B) not subject to this treatment.



If use of the rope requires that permanent elongation can be ignored or reduced to a minimum it is necessary to pre-stretch.

This can be carried out in two ways:

- **Static pre-stretching:** is carried out at approx. 50% of the breaking force with a series of load cycles, permanence of load for a certain time, and unloading until complete bedding of rope occurs.
- **Dynamic pre-stretching:** is carried out in line during the closing process of the rope, with manufacturing of the rope on a pre-stretcher positioned before the final rope lay, with a tension that, in general, is 1/3 of the breaking force. In this case pre-stretching consists of traction forces and bending that represents an actual “break-in” of the rope.

“Lang” lay

Obtained stranding the wires with the same closing direction of the strands in the rope, so having wires showing a very inclined axis with respect of rope longitudinal axis.

Lang's lay dramatically improves rope resistance against wear and crushing. This advantage is especially noticeable when the rope is wound in multiple layers, operating more silently aswell.

Elastic modulus and elongation at the breaking point

The elastic modulus describes a material's capacity for elastic deformation when a force is applied on it.

The most common elastic modulus is the tensile or Young's modulus, which is indicated by the slope on the linear portion of the stress-strain curve (see figure) and is defined as

$$E = \sigma / \varepsilon$$

where σ is the tensile strength (ratio between applied force and section area) and ε is the tensile strain (ratio between deformation and initial length)

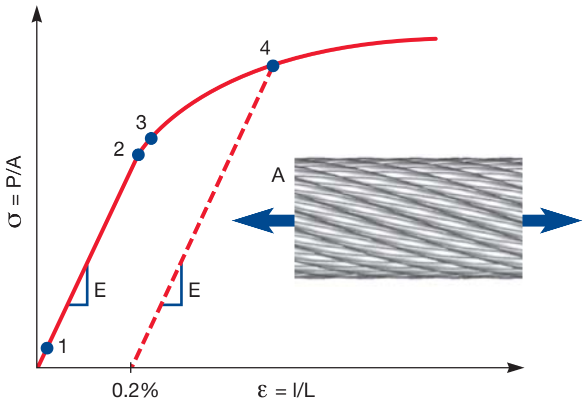
This definition is valid for isotropic materials subjected to axial stress.

Since a wire rope is not an isotropic material and its components are not subjected to axial forces, due to the fact that they are inclined with specific closing angles, it is more appropriate to refer to an "apparent tensile modulus".

Looking at the graph below, we can see that in the very first area (from the origin to point 1) the rope wires show a non-linear behaviour due to stabilization of its components. As already stated, this stabilization is due to the fact that during the closing operation there will be some slight differences in the tensioning of the different wire rope components.

After the stabilization point, the wire rope enters the proportional area characterized by the apparent tensile modulus. In this area, the rope will behave in an elastic manner: this means that when load is taken off, the wire rope will return to its original length (excepting for the first stabilization lengthening).

At a certain point, the rope will start to show plastic deformation (point 2 to 4): when the permanent deformation exceeds the 0.2%, the yield point (point 4, which is also termed the Rp_{02} point) is reached and the graph goes on with a non-linear trend until the elongation limit is reached, which corresponds to the maximum breaking force value.



Each wire rope is designed to operate within a certain range of the linear portion depending on the safety factor required. A high safety factor means that the rope will work in the lower range of the linear area, while a low safety factor means that it will work closer to the yield limit.

Each wire rope can absorb a certain quantity of energy, which also depends on the grade of the single wires: very high grade wires have already absorbed a large quantity of energy during the drawing process and therefore they have a lower amount of residual energy which can be utilized for elongation.

As already explained, if the stress to which the rope is subjected to reaches the yield value, the rope will enter the plastic area of the graph. The rope will absorb a certain amount of energy and it will maintain permanent deformation even if it is unloaded at a certain point.

This process will go on until no more residual energy is available: at this point, the rope will reach its elongation limit and the corresponding maximum breaking force and it will suffer damage and break.

A long plastic elongation and energy absorption section is essential from a safety point of view, since it implies that a rope won't break suddenly and unexpectedly, but it will have a "warning period" in which the damage can be clearly detected by a competent person.

Pressure and deformation

The actual pressure applied by the rope on the groove is a function of the force applied to the rope, the rope diameters and diameter of the sheaves.

It is commonly calculated using this formula:

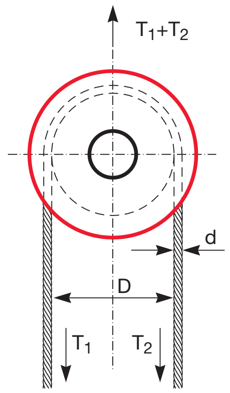
$$P = \frac{T1 + T2}{D \cdot d}$$

where: P = actual pressure in daN/cm²

T1 and T2 = rope tension in daN

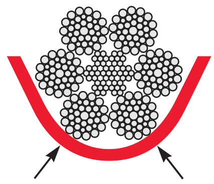
D = sheave diameter in cm

d = rope diameter in cm

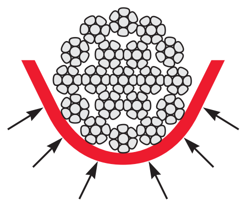


The value calculated in this way is always lower than the real pressure, because there are relatively few contact points. These contact points vary depending on the type used.

As an example, the picture below shows a six strand type rope and an non rotating multi-strand rope with 12 external strands.



Six strand rope



Non rotating multi-strand rope

The actual pressure (P) must be lower than a max value (Pmax) to avoid damaging the strands due to localised excess pressure.

The Pmax value depends on the rope construction and surface hardness of the sheaves. Pmax values can be provided by Redaelli on request.

Loss of strength due to ageing

The minimum breaking force (MBF) is a specified value, below which the measured (actual) breaking force is not allowed to fall in a prescribed breaking force test. [EN 12385-2 3.10.10]

Breaking force is a very simple criterion for rope acceptance which was selected more than a century ago because it was the only measurable element, even if there are many other rope characteristics which should be considered, like for example yield stress, proportional stress, fatigue limit stress, etc.

An excess of MBF is not a true safety parameter and does not generate increased safety, since it is achieved by pushing up one or more design variables.

Two common methods for increasing the MBF are the use of high strength wires, which on the other hand reduces the ductility of the wire, and the use of a large number of small wires, making it easier to obtain higher strength but drastically reducing the cooperation level of the rope components.

Wire ropes which are composed of wires having similar diameters and properties can reach the MBF without overstressing the design parameters, therefore they ensure uniform behaviour of all the components better efficiency of the material and a more reliable service life.

The breaking force of each steel wire rope will reduce over its service life. This reduction is due to a reduction of metallic area, material modifications and geometrical modifications and in some cases this may also occur if the rope has not been used.

The reduction of breaking force may also be caused by ageing, which is a process that generates a continuous increase in the hardness of a metal.

Ageing cannot be prevented, because it is an intrinsic phenomenon of each wire rope, which is affected by time and temperature anyway, independently of the measures the rope maker adopts during production.

Ageing is influenced by temperature, since exposure to high temperature (conventionally higher than 80°C) for a short time or a relatively low temperature for a long time could modify the material's properties.

In the past, the focus was put on the galvanizing process, which is mandatory to prevent corrosion and which could affect ageing, since is performed at very high temperatures.

Instead it should be pointed out that the modern high speed drawing process has been shown to prevent the ageing process.

The cold forming process for high strength wires, especially in case of large wire diameters, can facilitate the ageing process. This is due to the fact that, to obtain high grade steel, a huge quantity of energy must be supplied to the wires, drastically reducing the ductility of the steel.

Wires having a grade of 1960 or lower can maintain an acceptable ductility even after ageing, therefore in this case the reduction of breaking force values would be very limited.

Wire compacting, which implies a high quantity of energy absorption and heat generation, could also theoretically affect ageing, but modern compacting technologies minimize wire heating and exposure time using rollers and double pulling capstans which improve rapid cooling of the strands.

It is important to underline that a reduction in the measured breaking force of a wire rope stored for a long period is not generally demonstrated.

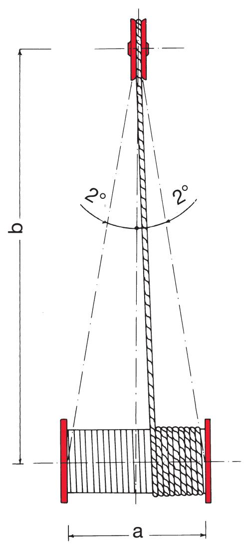
The variation in the ductility of wires due to ageing affects the rope's behaviour only over the plastic portion of the load/elongation curve, therefore fatigue performance in ageing ropes is not affected, because the applied loads must always be lower than the yield point.

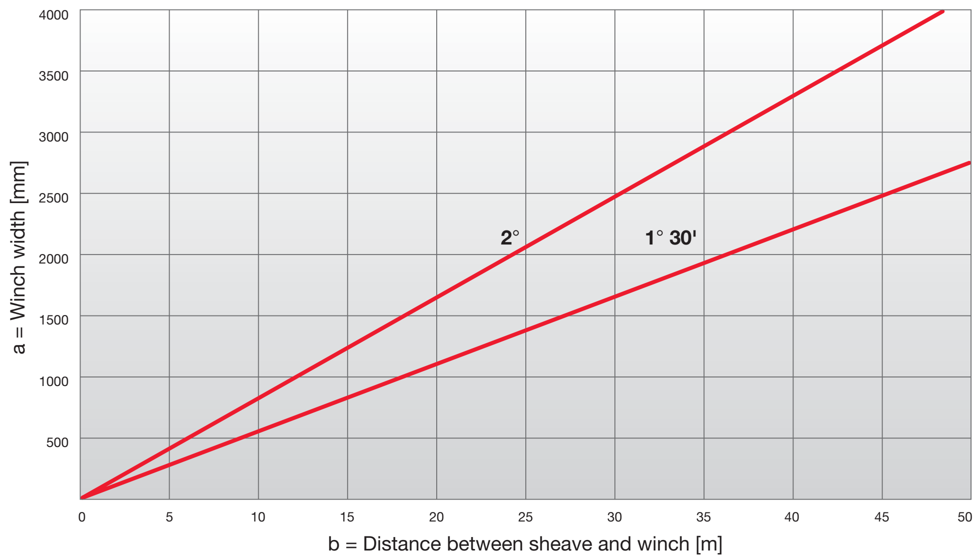
The reduction of breaking force does not indicate a corresponding reduction of the fatigue performances, therefore the measured breaking force on an aged rope should be disregarded as an indication of the remaining lifespan of the product.

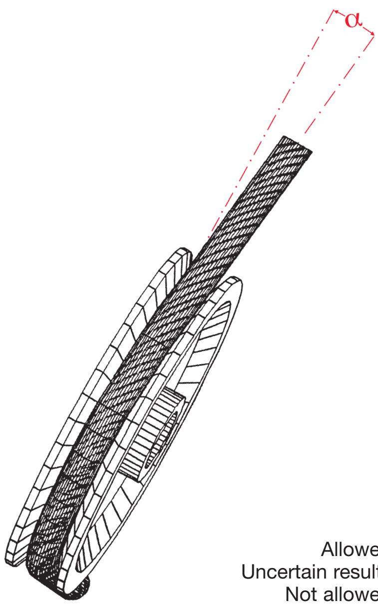
Fleet angle

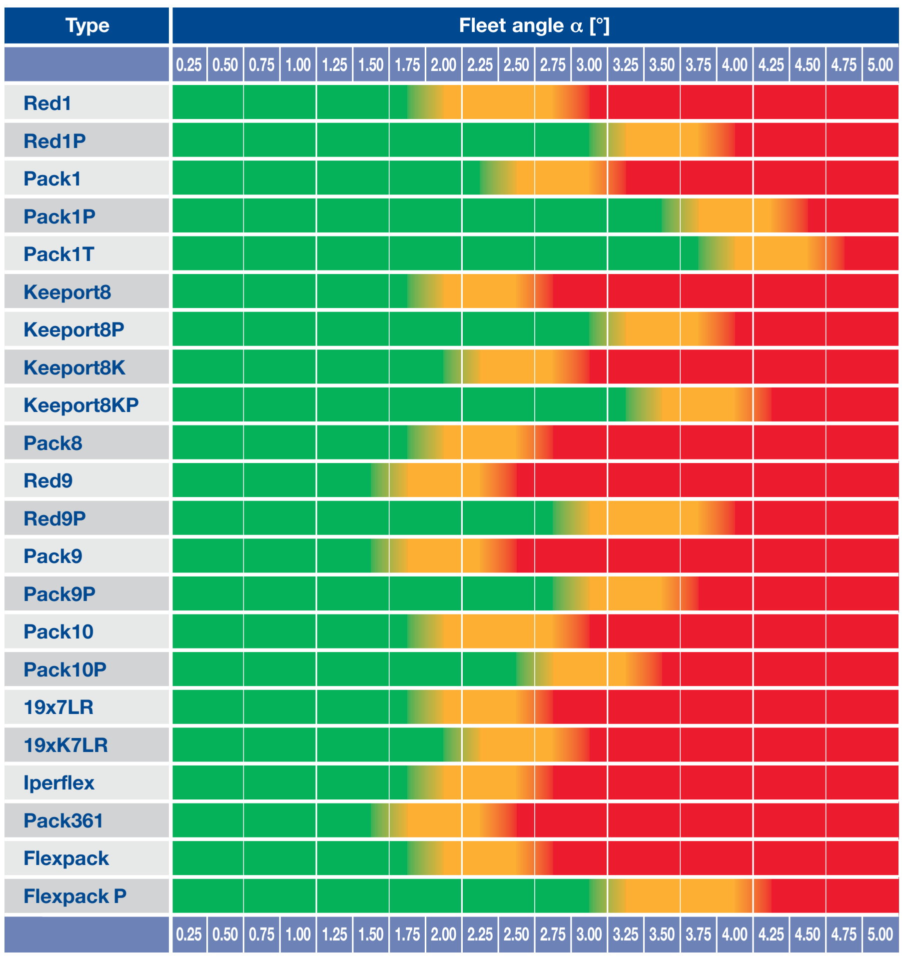
Whenever a rope reaches a sheave on which it is wound with a deflection angle, it is also forced to twist around its axis before reaching the sheave bottom. This mainly arises when the distance between winch and sheave is too short. Generally, the maximum angle for special hoisting ropes should never exceed 1.5° ÷ 2° to avoid distortion of the steel wire rope.

However, considering the peculiar characteristics of our range of rope constructions, the table below gives the maximum recommended, risky, and unacceptable fleet angles.









Allowed
Uncertain results
Not allowed

Rotational stability

For each special rope, the value of the torque (τ) and the value (ρ) for the angle of rotation of the ropes should be 20% of the minimum breaking force.

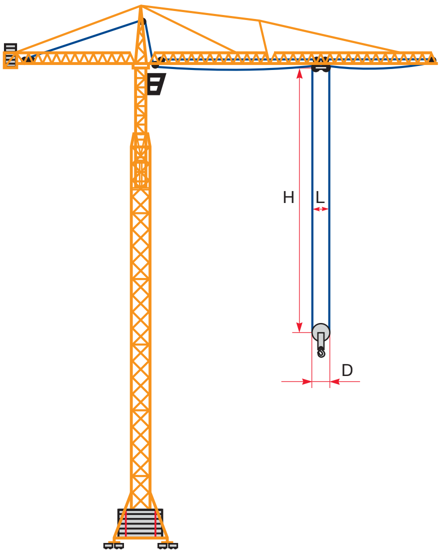
For practical reasons, these values make it possible to fix the rotation of a rope in single-fall, or make it possible to verify the equilibrium of a block for systems with a significant lifting height.

In single-fall applications, the rotation of the rope is proportional to the free length when the weight of the rope is disregarded:

$$\mathbf{R = \rho \bullet L \bullet F/S}$$

with:

R	rotation	[deg]
ρ	unit rotation factor	[deg/1000d Mpa]
L	length of ropes	[mm]
F	applied force	[kN]
S	rope section	[mm²]



In applications with multiple falls, the maximum lifting height that maintains the stability of the system can be calculated as follows:

$$\mathbf{H = L \bullet D / 4 \bullet d \bullet \tau}$$

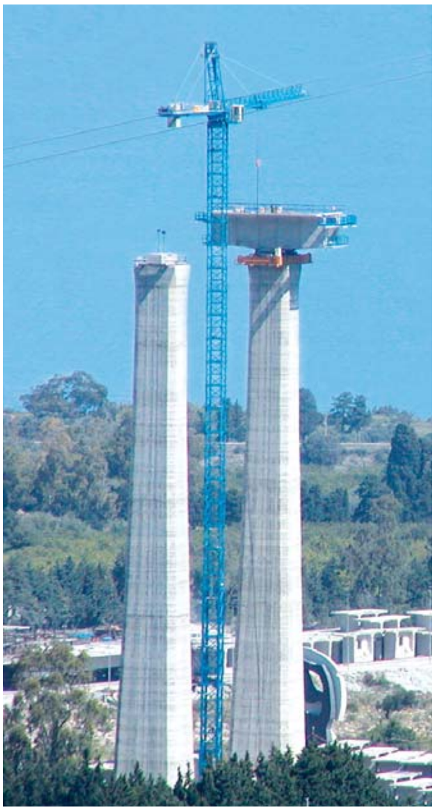
with:

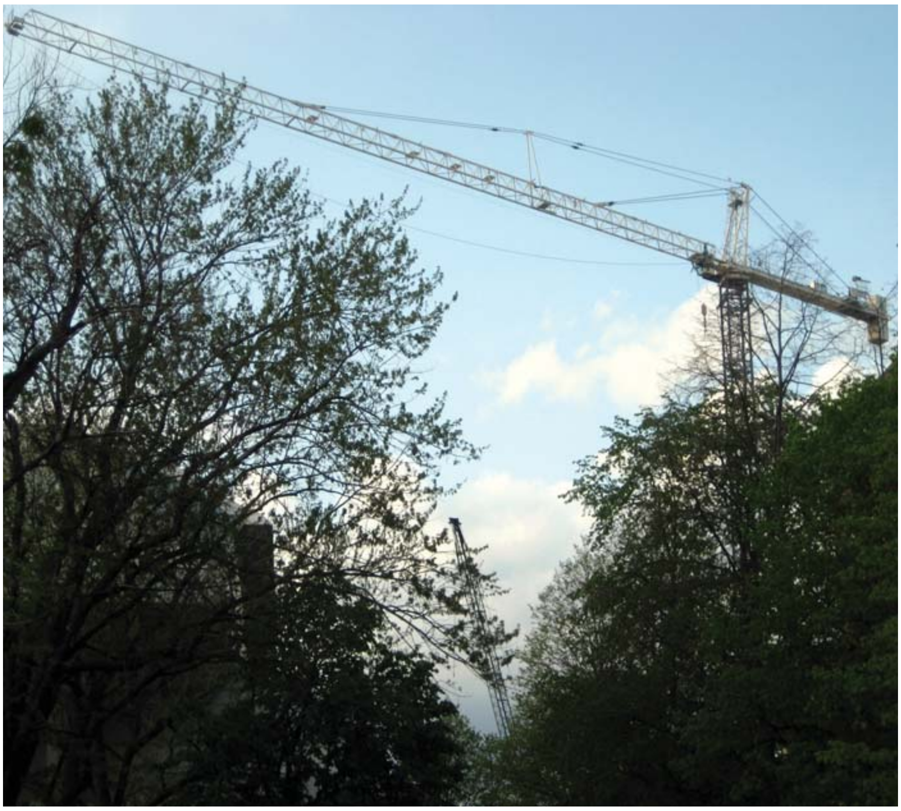
τ	torque factor of ropes	[]
L	distance between the ropes	[mm]
D	diameter of block	[mm]
d	diameter of rope	[mm]
H	lifting height	[mm]

As in the quite common situation with L=D then $H = D^2 / 4d\tau$, which shows how the lifting height is related to the square of the dimension of the block.

In the event that systems are made up of more than two branches (N), the following applies:

- with uneven pitch: the value Li = L • (N-1) / N and Di = D • (N-1) / N
- with even pitch: L and D are replaced by the diagonals of the rectangle circumscribed at the branches of the rope.





Ropes used over sheaves and winches

Diameter of sheaves and winches

The service life of ropes used on sheaves and winches depends essentially on the correct dimensioning of the grooves and on the correct choice of the ratio between the diameter of the rope and the winch, normally called the bending ratio.

The applicable standards for the various applications provide minimum bending ratios. In particular, FEM set variable D/d values for winches, return sheaves and adjustment sheaves for classification of the mechanism.

Bending ratios which we believe ensure an optimal service life of the rope are indicated below.

- **Operating winches and sheaves**
  D/d ≥ 25
- **Return sheaves**
  D/d ≥ 20
- **Lifts and elevators, EN 81-1**
  D/d >40 for load suspension pulley <30 for compensating pulley

where:

D = diameter at the bottom of the groove of winches or sheaves in mm

d = nominal diameter of the rope in mm

Dimensions of winch grooves

Whenever possible winches must be grooved and must comply with the dimensions shown in the drawing.

When the rope is wound around the winch in several overlapping layers, there are major concentrated stresses and friction between the windings laid alongside and on top of each other.

Stress is even greater at the cross-over point. To attenuate wear, and thus extend the rope's service life, we recommend that the rope be shortened after a given period, cutting off a piece at the end fixed to the winch.

In this way sections of the rope subject to greater use change position, and sections in good condition take their place.

This cutting operation is performed periodically in systems subject to heavy-duty operating conditions, without waiting for complete deterioration of the rope.

A type of rope must be chosen that can support the mutual pressures and frictions between the spires; therefore, ropes with steel core, multi-strand and smooth surfaces should be chosen (see compacted ropes).

Criteria for single layer winches

d = rope diameter

p = groove pitch, equal to

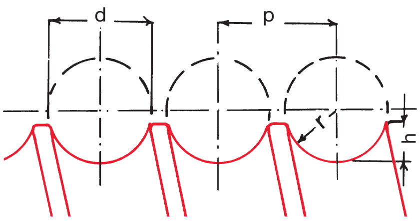
p = 1.15 x d for ropes with a diameter of up to 10 mm

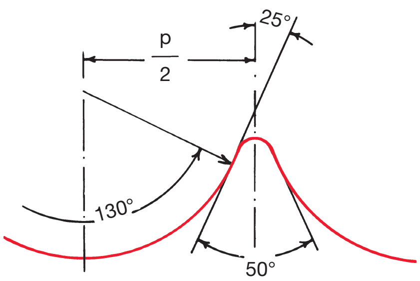
p = 1.12 x d for ropes with a diameter of up to 20 mm

p = 1.11 x d for ropes with a diameter of more than 20 mm

h = 0.4 x d

r = 0.55 x d





Ropes used over sheaves and winches (continued)

Multi-layer winches

Multiple lays require that the winding of the spires be tightened and under tension.

The pitch of the spires must be slightly higher than the tolerance diameter for the rope and the lay tension must be approx. 2% of the breaking force of the rope, while the angle between the rope and the area of the flanges must be between 0.25° and 1.75°.

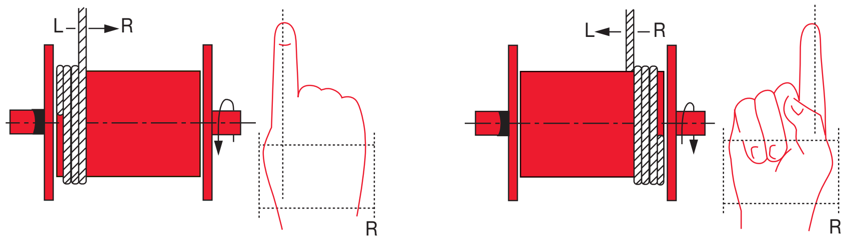
Choosing the winding direction

Ropes must be wound around winches uniformly.

It is vital that the rope windings be laid very close together on the first layer, without over-lapping or crossing-over the subsequent layers, with crushing of the rope.

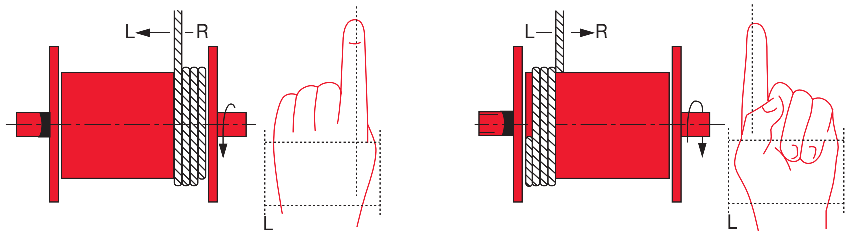
The winding direction of the rope and rotation direction of the winch has to be taken into account as shown below:

USE RIGHT HAND FOR RIGHT TORQUE ROPES



TOP WINDING BOTTOM WINDING

USE LEFT HAND WITH LEFT TORQUE ROPES



TOP WINDING BOTTOM WINDING

Ropes used over sheaves and winches (continued)

Shape and dimensioning of grooves

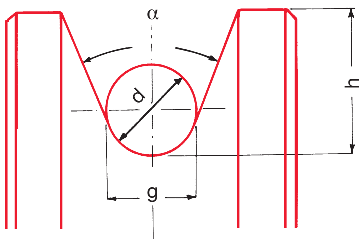
Correct dimensioning of the groove is essential for the rope's service life. The bottom of the groove must be larger than the nominal diameter of the rope and must be smooth, circular, without indentations and steps, and perfectly rounded with the sides.

The groove must not prevent the rope from being subjected to lateral stress and its diameter must always be greater than that of the rope. The correct scaling of the grooves (for ropes with diameter d and dimensional tolerance from 0 to 4%) must be as follows:

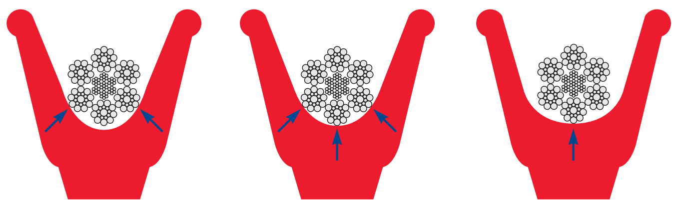
Minimum diameter at new groove: $Ø_{min}$ = 1.05 d
Maximum diameter at new groove: $Ø_{max}$ = 1.10 d
Suggested diameter at new groove: Ø = 1.08 d

The opening angle between the sides of the grooves must be between 30° and 60°, with higher values for the fleet angles.

d = rope diameter
g = groove diameter = 1.08 • d
h = 1.75 • d
h min. = 1.41 • d
α = 45°÷ 60°



The following drawing shows the possible connections between the rope and groove.



• Connection with narrow groove (left). This affects the lifespan of the rope and sheave. Crushing of the rope substantially alters its safety and functionality characteristics.

• Correct connection (at center)

• Connection with wide groove (right). This causes an increase in contact pressure that is almost proportional to the oversize of the groove.

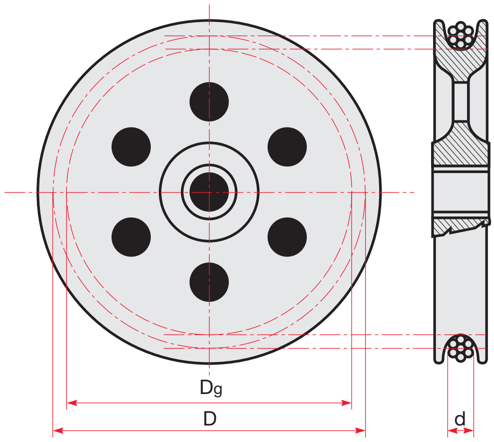
Lay ratios

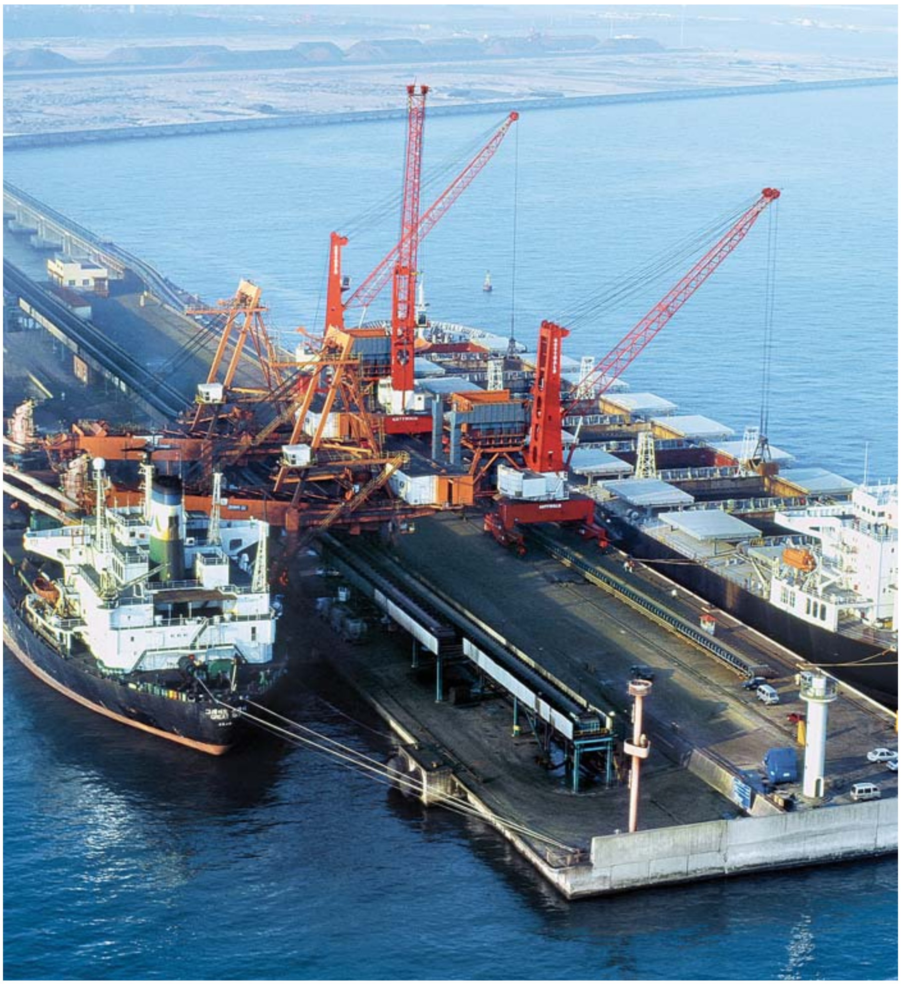
Each deviation by pulleys, rollers, etc. produces extra stress on the rope components that can be seen as follows:

- reduction of its breaking force
- reduction of its fatigue life.

The lay ratio D/d is the ratio between the curving diameter and the nominal diameter of the rope.

The rope standards applied for the various applications show the minimum lay ratios. In particular, the FEM sets the variable values of D/d for drums, return pulleys and adjustment pulleys for classification of mechanism.





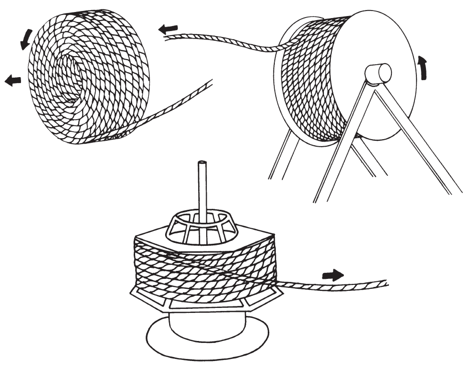
Winding and setting up

The ropes are supplied by the manufacturer wound around a spool or cross, or wound into appropriately fastened coils depending on the diameter and length of the rope or upon the customer's requests.

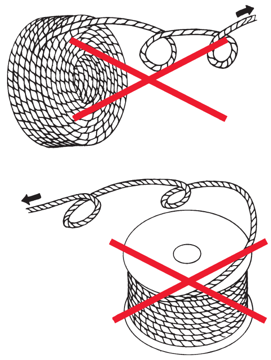
If the rope is supplied on a spool or cross, a rod of suitable diameter and length will be passed through its central hole and two stands will be affixed at the sides. Pull the end of the rope to unwind it making sure that the rope does not loosen on the spool.

If the rope is supplied in a roll, place it on a reel and pull the end of the rope to unwind it so that the roll rotates around its axis.

If the roll is small the rope can be unwound by keeping the external end steady on the ground and unwinding the rope by rolling the roll along the ground in a vertical position.



CORRECT WINDING



INCORRECT WINDING

Replacing ropes

Before positioning a new rope, check that the grooves of the sheave and winch have not been worn or deformed by the old rope. If so, the grooves will have to be milled and restored to their original state (see page 63).

It is extremely important to check that the sheaves rotate freely without excessive clearance. If necessary, replace the bearing or bushings.

If the rope is wound around a winch (grooved or smooth) and the rope is multi-layered, the spires of the first layer must be wound very tightly together, keeping the rope under minimum tension during the winding operation so as to avoid overlapping and anomalous operation of the machine.

If the old rope is used to pull the new one through the various sheaves in the system, it is important to ensure that any anomalous twisting of the old rope is not conveyed to the new one, causing irregular internal tension which could jeopardise the service life of the new rope or even cause the core to bulge or come out.

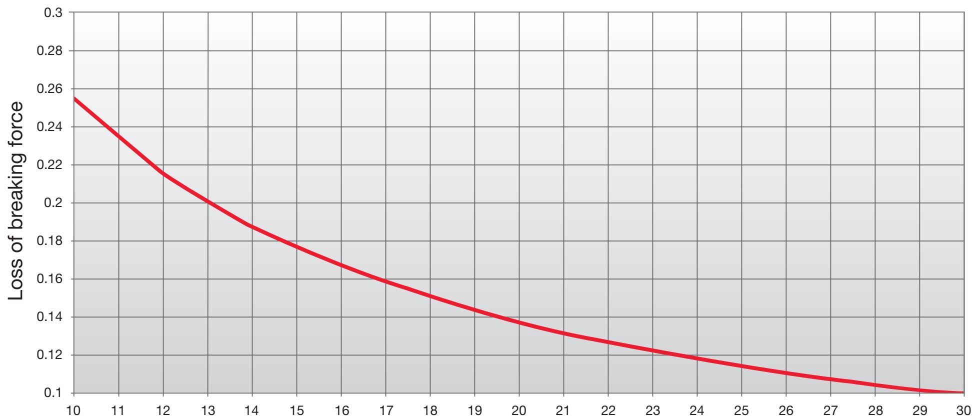
The ends of the two ropes must not be joined together directly (e.g. welding them together with clamps). An object able to absorb torsions should be placed between the old and new rope (e.g. a section of fibre rope connected to the ends of the ropes by means of clamps or a rope-sock).

Reduction of breaking force in relation to bending ratio

The reduction of the breaking force of a rope exposed to a static traction force is lower than that for a rope in motion.

This is due to the transverse forces on the rope that raise the state of stress of the material and on the friction that prevents physical sliding between the strands and consequently more uniform redistribution of the tension acting on it.

The following graph shows the strength loss in a rope in motion.



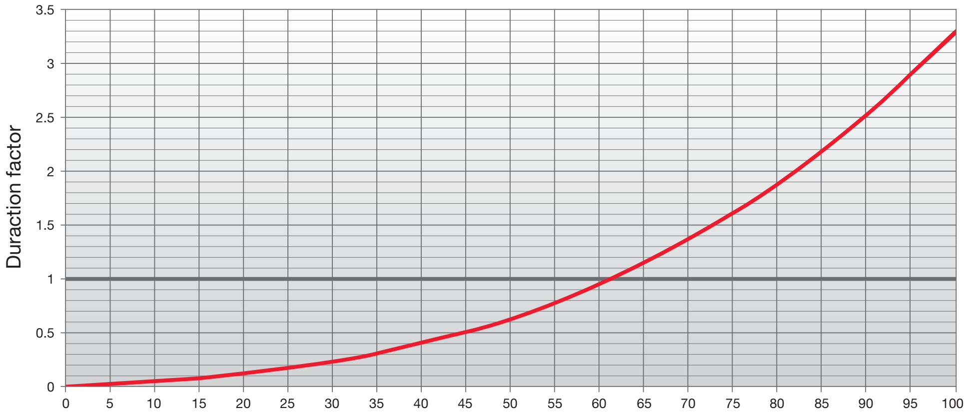
Rope lifespan

It is difficult to predict the service life of a rope (expressed as an absolute number of work cycles) without experimental data obtained under conditions similar to the actual operating conditions, and it is affected by a significant degree of disparity in the results obtained.

Knowing the service conditions for a certain rope, it is reasonable to use the service life based on other types of ropes operating under the same conditions as an estimate for the lifespan of the same type of rope operating under different conditions.

The following graph shows the relative service life of a special rope with various lay ratio values.

The reference duration (equal to 1) is obtained by testing with D/d = 62.

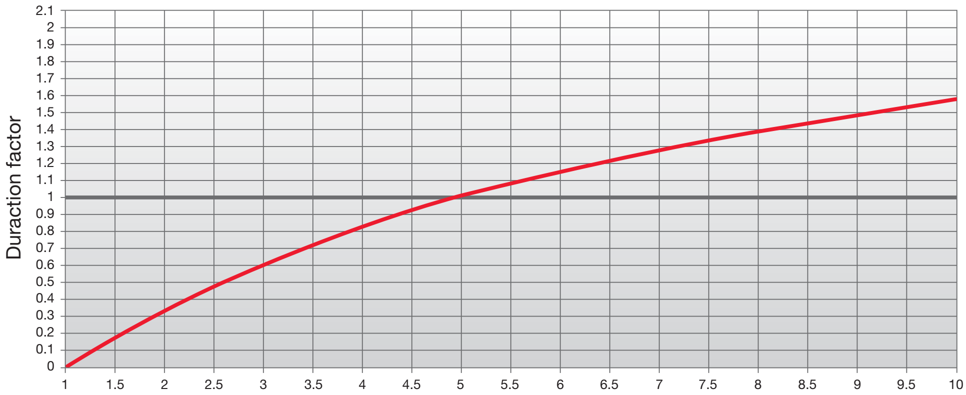


Various lay ratios reduce, decrease or increase the duration by a factor that can be obtained as shown in the graph.

The relative duration of bending fatigue is also shown as the load applied on the rope.

The progress of relative duration of bending is shown in the following graph.

The reference time (equal to 1) is obtained by carrying out testing with a safety coefficient of 5.



Rope lifespan
(continued)

Taking into consideration that the reference condition is D/d = 20 and CS = 5 (most common condition in the field for industrial lifting equipment), the relative duration factor under such conditions is listed in the schedule.

Relative service factor										
Safety factor	Lay ratio D/d									
	16	20	24	28	32	36	40	44	48	52
2	0.24	0.33	0.44	0.57	0.72	0.89	1.09	1.32	1.59	1.89
3	0.44	0.60	0.79	1.02	1.30	1.61	1.98	2.40	2.87	3.41
4	0.60	0.82	1.09	1.40	1.77	2.20	2.70	3.28	3.93	4.67
5	0.73	1.00	1.32	1.71	2.16	2.69	3.30	4.00	4.79	5.69
9	0.84	1.15	1.52	1.96	2.48	3.08	3.78	4.59	5.50	6.53
7	0.93	1.27	1.68	2.17	2.75	3.41	4.19	5.08	6.09	7.23
8	1.00	1.38	1.82	2.35	2.97	3.70	4.54	5.50	6.60	7.84
9	1.07	1.47	1.95	2.52	3.18	3.96	4.86	5.89	7.06	8.39

Different types of ropes under identical conditions of use will have different service lives depending on their structure, lubrication conditions, etc.

Using the relative service life table above, data is provided for any kind of rope with strands under certain load conditions, making it possible to predict performance under other conditions.

Winding on small diameters and service life

In systems not subject to accident prevention standards or not inspected by expert certification boards, at times sheaves and winches are used with relatively small lay ratios (D/d).

In this case the rope is subject to a load loss, which could be major, but above all performance is worse due to fatigue phenomena.

This loss increases as the lay ratio decreases and is more marked in ropes with a textile core.

It is difficult to predict the service life of a rope because it depends on many factors such as:

- **rope related variables:**
  - composition of type of rope
  - external diameters
  - lay pitch
  - lubrication
- **operating machine related variables:**
  - dimensions of the sheaves and winch
  - materials
  - condition of bearings or bushings
  - kinematic motion
- **working conditions related variables:**
  - rope rate
  - work loads
  - shocks or tears
  - dusty environment
  - temperature
  - maintenance

Experience gained from operating systems and laboratory tests have shown that the service life of ropes used in ideal conditions essentially depends on the work load and correct choice of D/d ratio which must never fall below 16, even for the most flexible ropes.

Radial stiffness

Radial stiffness is an essential characteristic in many rope applications, for example on multi-layer winch drums, where the rope is subjected simultaneously to the pulling force of the traction winch and the compression of adjacent layers.

Excessive wire rope deformation can generate a high flange shear stress, while excessive wire stiffness can cause drum hoop stress.

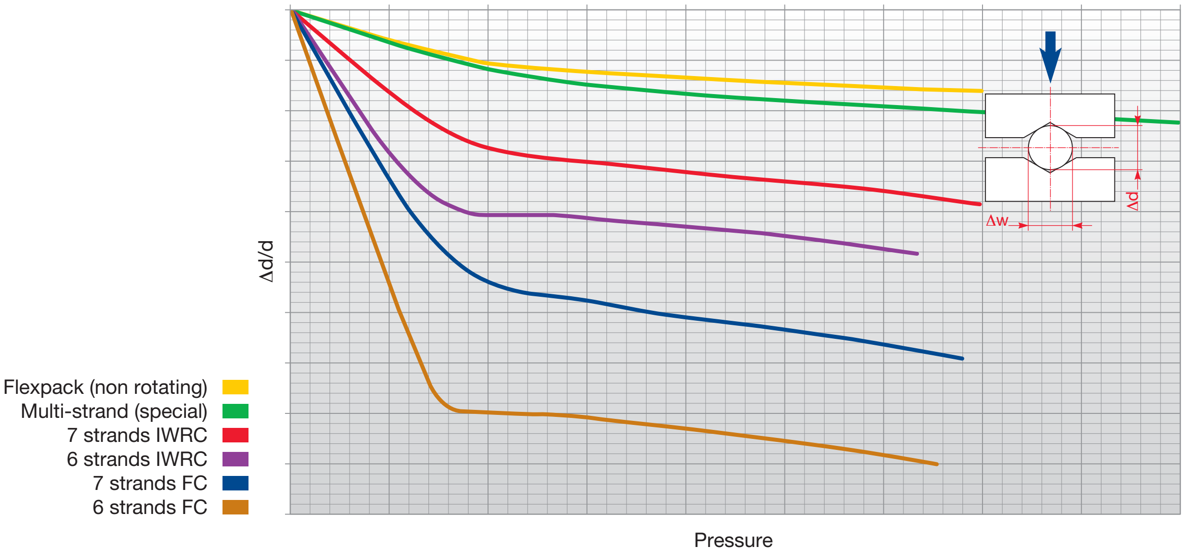
In both cases, severe damage to the winch may occur.

Radial stiffness correlates pressure and radial deformation according to the formula

$$K = \frac{P}{\Delta d/d}$$

where P is the pressure to which the wire rope is subjected
and Δd/d is the variation of the wire rope diameter.

Redaelli conducted several experiments to measure the radial stiffness of different wire rope constructions, as summarized in the graph below.



For each curve, two main areas can be identified: the main ratio for diameter variation is obtained during the first stage of compression, while after having reached a certain deformation value, the diameter variation slows down and the curves show similar slopes.

Six and seven strands fibre core wire ropes are the most sensitive to the compression effect, while special compacted ropes (Flexpack and independent wire rope core) have a much higher diameter stability in relation to pressure.

It has to be said that after each pressure cycle the wire rope retains a certain degree of permanent deformation.

This permanent deformation is particularly significant after the first cycle, while after a few cycles the rope diameter shows stabilization.

End fittings

Ropes are normally fitted with sockets to fix the loads to be lifted and to attach the rope to the crane, crane truck etc.

These are extremely delicate points which must be manufactured with great precision and inspected regularly to ensure utmost efficiency and safety.

The most commonly used sockets are shown below.

Soft eye and eye with thimble

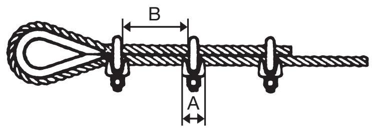
These can be blocked in two ways:

- **Clips**

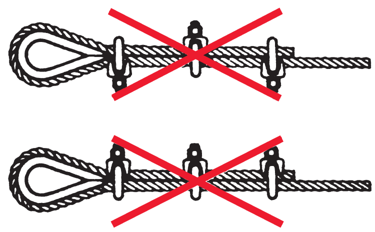
For maximum efficiency:

- Position the clips correctly. Incorrect assembly of these clips can reduce the performance of the socket by 60% in relation to the rope's breaking force.
- Assemble the clips so that the inner distance between the two bridges is 1.5 to 3 times (max) the width of the bridge.
- Gradually tighten the bolts to the correct torque value using a tight-end key.

A Bridge width
B From 1.5 to 3 times (max) the width of the bridge



CORRECT



INCORRECT

- **Cylindrical or conical aluminium ferrule**

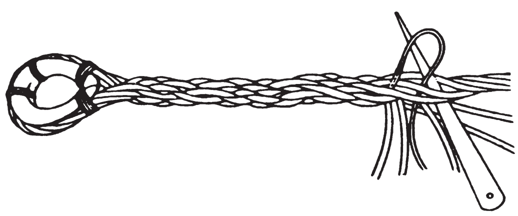
The slot is fixed using a pressed clamp. This method is not recommended only in extremely high temperature conditions concentrated close to the clamp (max. 100 °C).

- **Steel ferrule**

Forged steel ferrule to close the slot resulting from the intertwining of strands.

- **Hand splicing**

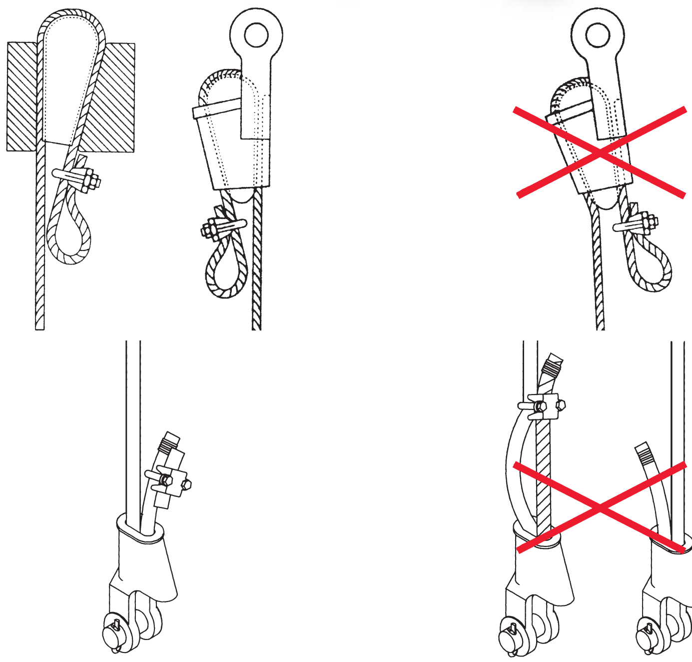
This is a traditional method where the rope end is fixed by splicing the strands in the rope after the slot has been formed. It does not have a clamp.



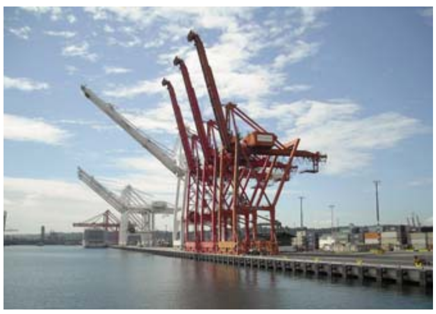
End fittings
(continued)

Spelter socket
The socket is fixed to the rope using pure zinc, low melting point metals and/or resin.

Asymmetrical wedge socket (EN 13411-6)
This can be fitted and removed easily and rapidly. When fitting, attention must be paid to ensure that the loaded leg of the rope lies along the axis of the forks. The other section should be fixed using a clamp.



CORRECT INCORRECT



End fittings
(continued)

End fitting efficiency

Efficiency means the ratio between the rope's breaking force (R) and the load under which the socket breaks.

The table below shows the efficiency of the most commonly used end fittings.

The relation below has to be applied to know the actual breaking force of a socket:

R eff. = R • a

where:
R = rope breaking force in daN
R eff. = actual breaking force of the socket in daN
α = efficiency grade

Connection type	Ø rope	Efficiency grade α
Wire rope clip	All	0.8
Aluminium ferrule	All	0.9
Steel ferrule	All	0.9
Hand splicing	≤ 60	0.8
Spelter socket	All	1
Swaged	All	0.90
Wedged ≤ 1960 N/mm² > 1960 N/mm²	All	0.85 0.80

Swivels

Since all non rotating Redaelli special wire ropes, like Flexpack, do not have a tendency to unlay under load, they can be used with a swivel at one end.

Swivels can be recommended for particular crane applications, for example to lift weights at great heights or for long periods of continuous repeated work.

Swivels can be used only with non rotating ropes, since non-rotation resistant ropes would untwist under the load, causing permanent changes to their structure and reducing their mechanical properties.

In order to prevent unlaying, non-rotation resistant steel wire ropes must be fixed with both ends secured against rotation.

Rope swivels, Crosby Laughlin different types:

S-5
Eye & Eye

S-2
Jaw & Jaw

S-3
Jaw & Eye

S-4
Eye & Jaw

Fixed end attachment

In general, it should be noted that in order to preserve their performance levels, all ropes should maintain their construction parameters during operations.

Therefore, their ends must be connected to an attachment which prevents rotation due to gyratory torque or induced by the system.

All lifting equipment must be of the correct size to counteract the gyratory torque of the ropes used in order to maintain the equilibrium of the system with the rope ends blocked.

In the case of non rotating ropes installed on tower cranes, the end must be attached to a sheave only when the winch does not rotate with the crane boom.

In all other cases sheaves can be used only during the initial breaking-in stages and the sheave must be blocked when the rope has achieved its operating position.

If the system is not balanced, a sheave can be used to release the torsion reactions caused in the rope but this unfavourably affects its resistance and service life (ruptures, bulges, undulations etc.).

Adapting ropes to working conditions

When a new rope is installed in a system it must be used for a short period after its installation with smaller loads than those envisaged for normal working conditions.

In this way all the elements have time to settle and adjust to normal working conditions.

If this breaking-in period is not observed, the rope will immediately be subjected to excessive stress, at times causing premature breakages or in any case possibly resulting in a shorter service life.

Reel handling

The wire rope is supplied on a steel reel supported by a wooden or steel cradle, which is not permanently connected to the reel. The bent nails or wire hooks connecting the cradle and the reel are installed only for aligning the reel with the cradle.

If not provided with special fittings, the reel must be lifted using a proper shaft to be inserted in the reel hole and the shaft must be connected to a suitable lifting beam using slings.

To relocate the reel, the cradle must be connected to the lifting shaft using textile or steel ropes to prevent it falling during lifting. To install the reel over the pay off, the cradle must be disconnected from the reel before lifting.

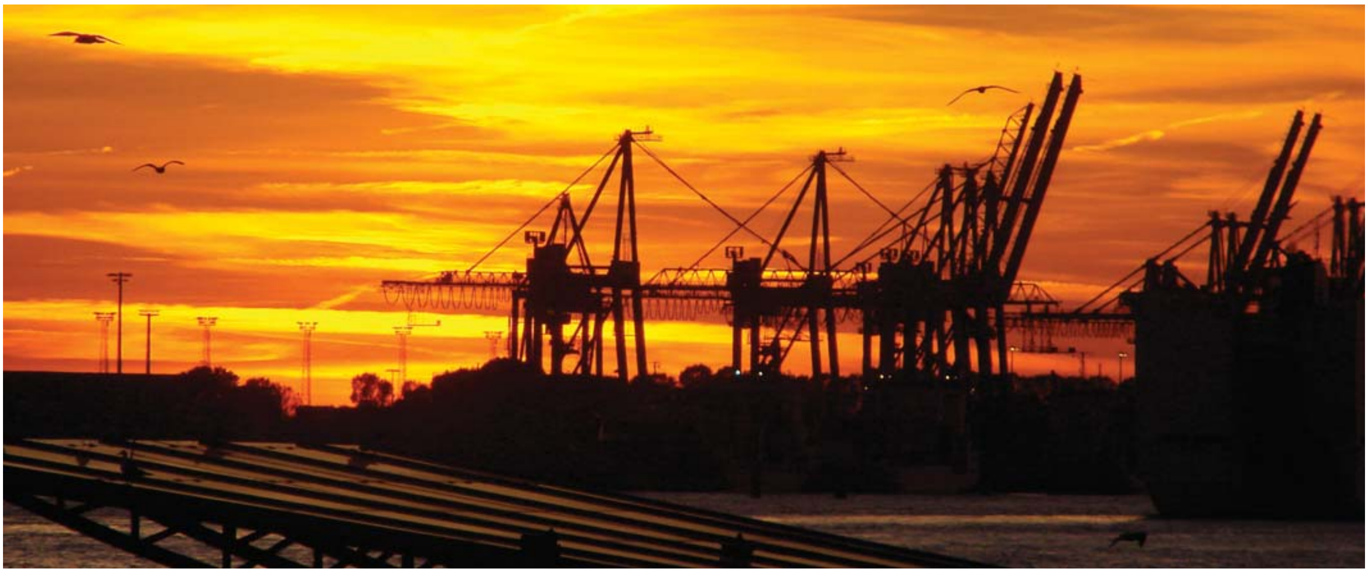
For the uncoiling operation, the reel must be placed over the pay-off so that the end will be extracted from the bottom.

After installing the reel and before removing the lifting gear, rotation of the reel due to its unbalanced weight must be prevented.

The outer end of the rope must be disconnected from the reel taking care to prevent any rope reactions.

The braking system, if required, is to engage at least two opposite reel lays and must be capable of working in both directions.

The rope end must be connected to the pulling rope by a suitable connection capable of withstanding the required pulling force, which should not exceed 2 tons using one braking device or 5 tons using two braking devices (one at each rope side).

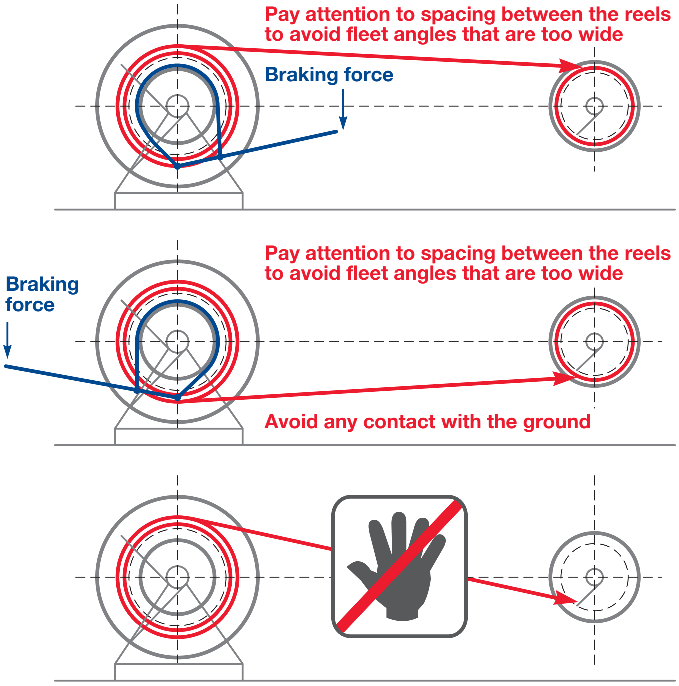


Safety issues

During all the handling operations, the rope must not be in contact with the ground, edges or an unsuitable environment.

In the case of spooling on a drum or winch, the rope must be unwound using a proper tension (2% of the MBF or 10% of the working load) and avoiding excessive fleet angles.

Moreover, the drum on which the wire rope is supplied with must have proper braking to avoid over running.



Serving

A serving is a wrapping of single wire laid tightly around a rope to prevent its wires from kicking or moving to slacken themselves when the rope is cut between two adjacent servings.

It must be applied using a serving mallet to keep it under proper tension and get it tight.

The serving wire should be tinned annealed mild steel or soft iron wire and its size should be selected depending on the rope diameter (see table below).

To perform a proper serving, the following tools are required: a vice to hold the rope, serving mallets having shaped heads made of soft material to avoid damaging the rope, a reel which can be mounted on the mallets, pliers and wire cutters, a soft head hammer and a heavy soldering iron.

The length of the serving depends on the purpose of the serving itself and on the size and type of the rope. If the purpose of the serving is to restrain the cut end of a rope, it must be longer than one intended to restrain the end of a short sample to be cut from a rope.

For the cut end of six strands ropes, two servings each of a length at least six times the rope diameter should be used.
For the cut end of a large spiral or locked coil rope a serving or servings each of a length twenty times the rope diameter is advisable.

Serving must be kept in place until the rope end is otherwise secured. In case of large spiral or coiled rope, serving should also be backed up by a minimum of six two-bolt clamps set clear of the served length.

There are two types of serving: ordinary and soldered.

Ordinary or buried-wire serving is usually confined to stranded ropes and to parts of the rope which do not have to be fitted into sockets or other confined spaces.

It is achieved by laying the first part of the serving wire along the length of rope to be served, and then by winding the wire tightly over it in coils so that the two ends of the serving wire finish at the same place where they can be twisted together and cut off short to complete the serving.

The soldered or wiped serving is the best type of solution. It is suitable for spiral and locked coil ropes and for parts of rope which are to be threaded through sockets.

This serving is performed directly on the rope, without any buried wire being present, so that the two ends of the serving wire lie at opposite ends of the serving.

Sizes of tinned annealed mild steel or soft iron serving wire for ropes of various sizes		
Rope diameter	Size of single serving wire	Standard wire gauge
mm (inch)	mm	SWG
Less than 22 (7/8")	1.30÷1.50	17
From 22 to 38 (7/8"-1.1/2")	1.50÷1.70	16
Larger than 38 (>1.1/2")	1.80÷2.20	15

Inspection and replacement criteria

In compliance with ISO 4309, the operating safety of a rope is ensured above all by correct evaluation of:

- number of breakages and their position
- wear of wires
- internal and external corrosion
- damage and deterioration of the rope.

Breakage of wires (according to ISO 4309)

The broken wires that are visible on the outside surface of the rope must be counted, naturally taking into consideration the most worn section of the rope.

The broken wires have to be checked on both lengths; the rope must be replaced if the number of broken wires exceeds the indicated minimum even on just one of the two lengths.

Inspection and replacement criteria (continued)

Wear of the wires

Checking the rope in relation to its replacement must take into consideration, more than simply the number of broken wires.

Flattening of wires due to wear is a forerunner to imminent breakage.

In the presence of worn wires, the time between inspections must be shortened and checking of broken wires must take into consideration wires with a diameter that is visibly reduced by around 50% compared to the original value.

Internal and external corrosion

External corrosion reduces the diameter of the wires.

The indications in the paragraph above apply in this case too, and even tighter caution criteria must be adopted because corrosion causes more serious deterioration than wear.

Evaluation of internal corrosion requires expertise. Clamps can be used to open the rope, with a careful untwisting manoeuvre (see ISO 4309).

REMARKS:

In multi-layered ropes and ropes with a metal core, inspection should be made only on the external layer.

Broken wires must have two clearly visible broken ends.

Wire breakage in 6 and 8 strand ropes is greater in the external layers. This is not the case for multi-strand ropes where breakage involves the inner part and so is not visible.

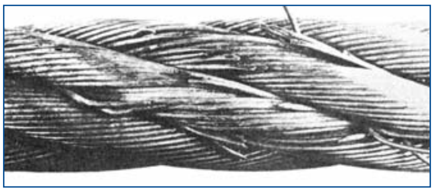
We recommend replacing ropes when there are broken wires close to each other, in a length of not more than 6 d or concentrated in a single strand.

Rope deterioration and replacement criteria (as per ISO 4309)

Apart from the broken wire count, ropes should be replaced when:

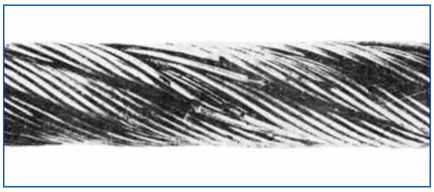
a) the rope diameter, even at just one point, is 7% smaller than the nominal diameter
b) the rope appears permanently crushed, twisted or bent
c) the core can be seen even at just one point
d) while in tension, there are one or more loose strands.

The photos show examples of deterioration of ropes, describing the cause and replacement conditions.



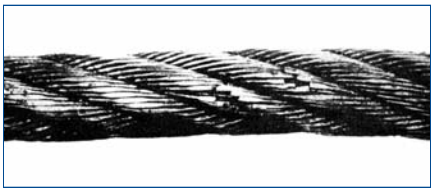
Broken wires out of position in two strands of a regular lay rope. This rope must be replaced.

Major wear and high number of broken wires in a regular lay rope. This rope must be replaced immediately.

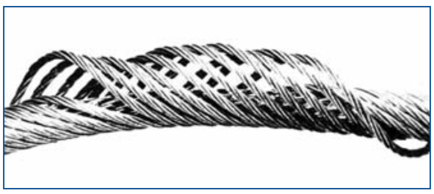


Broken wires in a single strand and slight wear in a lang lay rope. In this case the broken wires must be removed to make the rope smooth.

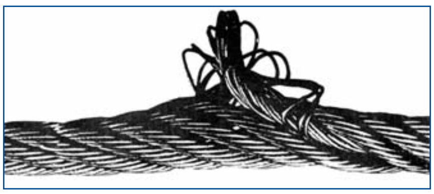
Broken wires in several strands, close to a return sheave (sometimes hidden by the sheave). This rope must be replaced.



Broken wires in two strands due to bending fatigue, linked to major localised wear. This rope must be replaced.



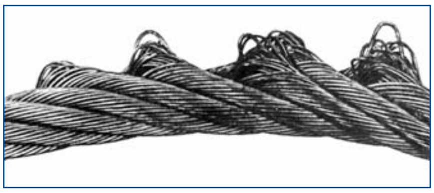
Birdcage in a multilayer (non rotating) type rope caused by forced rotation around small grooves or excessive fleet angle. This rope must be replaced immediately.



Protrusion of the steel core, generally linked to basket deformation. This rope must be replaced immediately.

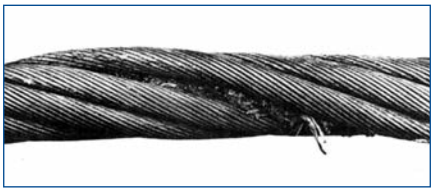
Rope deterioration and replacement criteria (as per ISO 4309)
(continued)

The wires of a single strand have loosened although inspection of a section of rope has shown that the deformation can be seen at regular intervals, normally equal to the lay pitch. This defect must be kept under control.



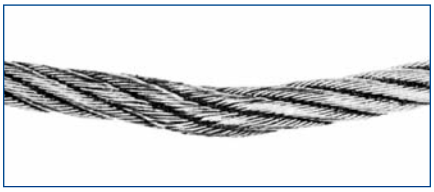
More serious example of the previous defect with protrusion of the inner wires of the strands. Major localised defect caused by applying shock loads.
This rope must be replaced immediately.

Confined increase of diameter of a lang lay rope, caused by distortion of the metal core caused by a dynamic load. There are also traces of corrosion and major wear of the external wires. This rope must be replaced immediately.

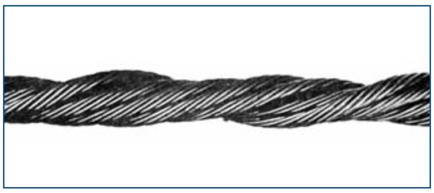


Confined increase of diameter of the rope, due to the protrusion of the textile core between the external strands.
This rope must be replaced.

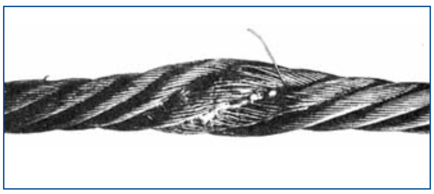
Major kink causing fibre core protrusion.
This rope must be replaced immediately.



Wire rope which has been twisted during installation and used. Now subject to localised wear and lengthening of the strands. This rope must be replaced.



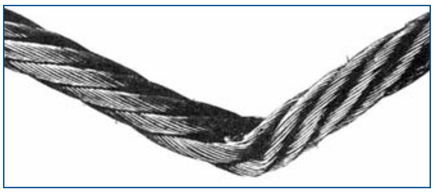
Confined reduction in the rope diameter because the outer strands tend to fill the volume of the textile core which has been destroyed. This rope must be replaced immediately.



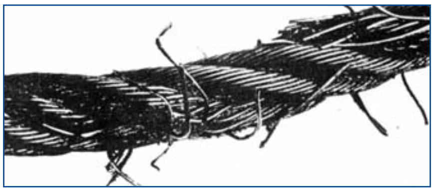
Flattened section caused by local crushing due to mechanical action; this causes a lack of equilibrium in the strands. There are also broken wires.
This rope must be replaced.

Rope deterioration and replacement criteria (as per ISO 4309)
(continued)

Flattened section of a multi-strand rope caused by mechanical action on a long section caused by incorrect unwinding from a winch. Note the increased lay pitch of the external strands with unbalanced tension under load conditions. This rope must be replaced.



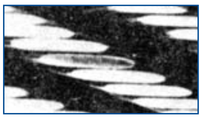
Example of major bending. This rope must be replaced.



Typical example of a rope which has come out of the groove of a sheave and has been trapped with resulting deformation and flattening, with local wear and many broken wires. This rope must be replaced immediately.

Cumulative effects of several deterioration factors. Note the major wear of the external wires, which has caused loosening of the wires resulting in basket deformation. The risk here is that the rope could be expelled from the sheave. This rope must be replaced immediately.

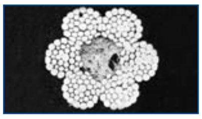
Slight flattening of external wires. Small reduction of the rope diameter.



Continuous flattening; metal wires which begin to loosen, with a reduction of diameter that can be estimated at approx. 40%. Immediate replacement.

Start of surface corrosion.

Highly perforated surface and completely loosened wires. Serious reduction in diameter with space between the wires of more than half their diameter. Immediate replacement.



Example of major internal corrosion. Clear reduction of the area of many external wires of the strands, in the contact area of the core, high level of compression, lack of space between the strands and ensuing reduction in the diameter of the rope. Immediate replacement.

Helical distortion is a distortion where the longitudinal axis of the rope has a helical shape. In this condition the rope must be inspected continuously. There may be wear and broken wires in the event of prolonged use. The rope must be replaced if the deformation exceeds the value set in UNI ISO 4309.

Lubrication

During the manufacturing process the rope receives proper lubrication which provides protection against corrosion and internal and external friction for a certain period of time.

During the working life the initial lubrication may expire, therefore the ropes have to be re-lubricated, particularly in the zones subject to bending, using a lubricant recommended by the rope manufacturer.

Servicing must be carried out regularly depending on the lifting device, application and type of rope. If re-lubrication is not performed properly and regularly, a severe reduction of the rope's service life has to be expected.

The application of lubrication with brushes, rags, gloves, or by other means is costly, risky, and ineffective, since it forms a film on the surface which water vapour can penetrate, generating condensation and rust starting from the inside.

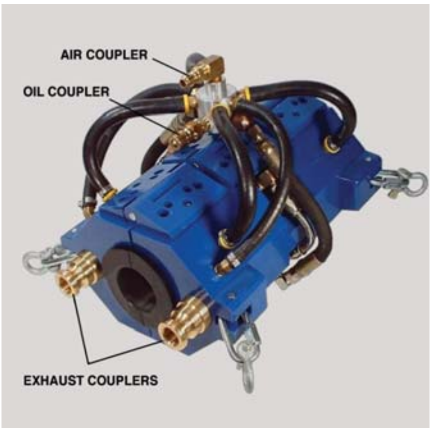
In this case, the wire rope can appear to be in good condition externally, while corrosion and friction are destroying it from the inside.

If only a little lubricant is required, pressure spray nozzles can be used, even if the optimal lubrication process is the use of a high pressure system at 20 bar minimum (285PSI), which guarantees lubricant penetration between the strands inside the rope as well.

It can also be used as a wire rope cleaner before application of lubricant in cases where ropes operate in extremely abrasive conditions or are subjected to chemicals.

This system can use a wide range of lubricants (excepting Bitumastic) but higher viscosity products are recommended. Oil or liquid lubricants will disappear from the rope very quickly.

Before choosing the re-lubricant, ensure that it is compatible with the lubricant applied during manufacturing (Nyrosten T55 based lubricant). Please contact Redaelli Customer Service if a different lubricant is normally used.



Technical Information

Storage

Ropes are supplied with lubrication which protects them during transportation, a certain period of storage depending on the ambient atmosphere and the initial period of use.

Ropes must be stored in a vertical position (with the axis of the steel reel parallel to the ground) in a cool, dry, clean and well-ventilated indoor warehouse, avoiding contact with the ground.

All ropes standing outside must be placed on suitable supports for the storage reels to avoid penetration of the steel reel arms into the ground.

They must be protected with breathable waterproof fabric covers that don't allow the formation of humidity and condensation and secured in order to maintain proper ventilation.

If the rope has to be stored for long periods, especially in locations subject to high temperatures, it should be periodically rotated by half a revolution to prevent the lubricant draining. This operation should be performed more frequently in case of temperatures higher than 25°C.

At the same time, the wire rope should be checked to detect any trace of corrosion or inadequate lubrication.

Ropes which have been stored for a long time should in any case be cleaned to remove scales, fouling or incrustation, then lubricated and, if possible, dipped in oil before installation.


GOTTWALD
HHLA
HHLA Frucht- und Kühl-Zentrum

Data required for enquiries

Enquiries to Redaelli for steel wire ropes should include the following minimum data:

1. Reference data

Project name and number
Application type (*)

2. Wire rope data

Reference Standard (*)
Rope class or construction (*)
Rope grade
Lay direction and type (*)
Surface (Bright/zinc coated/Zn95Al5) (*)
Compacted strands (Y/N) (*)
Nominal diameter and tolerance (*)
Expected diameter under tension
Nominal length and tolerance (*)
Minimum Breaking Force (*)
Minimum aggregate breaking force

3. Rope packing

Reel type (steel, wooden, special)
Standard, seaworthy or other packing type

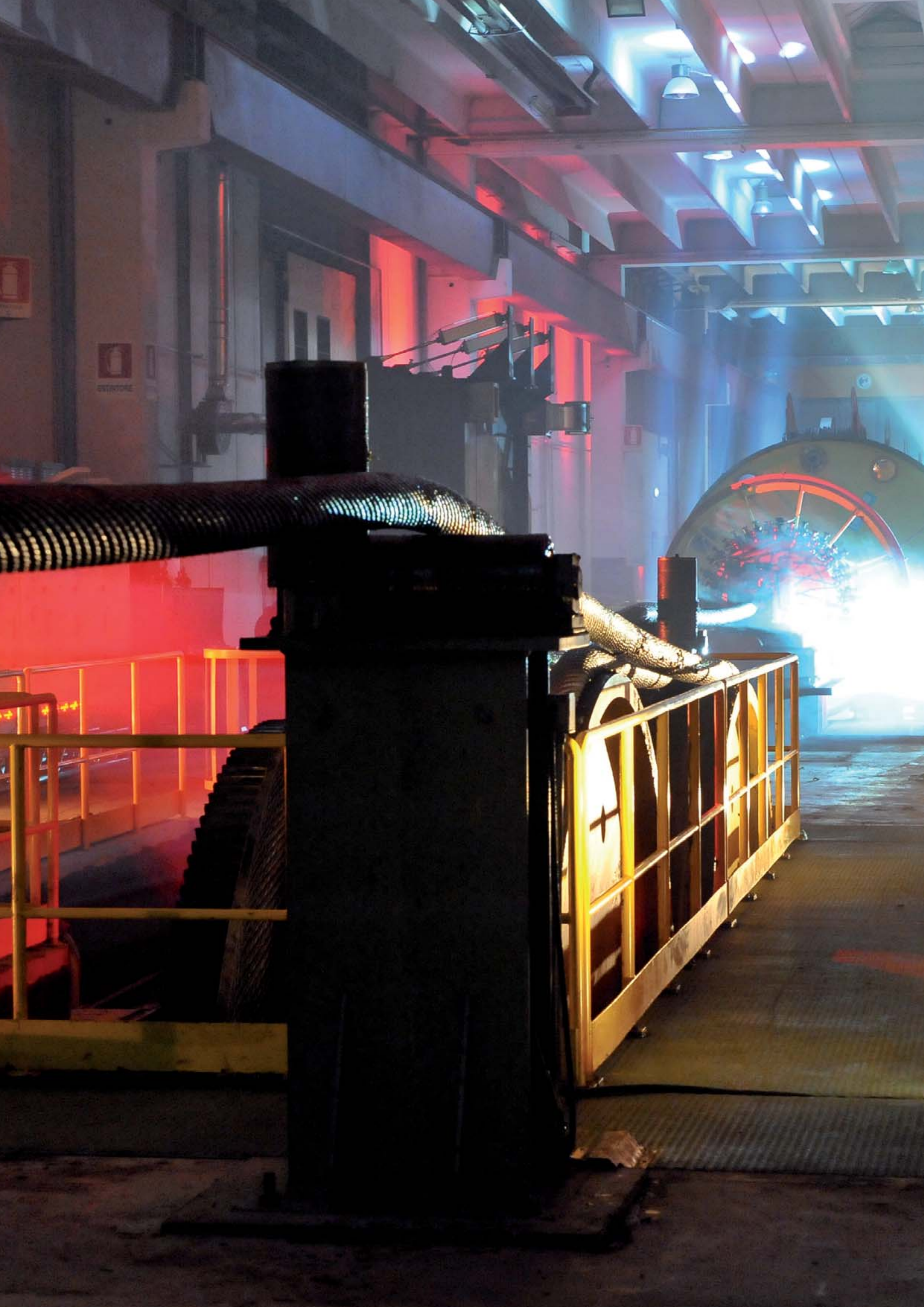
4. Other

Required certifications
Required documentation (manufactures standard, special, API, etc.)

(*) *Mandatory*

Please send your kind inquiry directly to our sales team or to e-mail address shown in our website www.redaelli.com

We will reply as quickly as possible.



A Giant Rope, a Rope for Giants

December, 2009 Opening of Redaelli's new factory at the harbour in Trieste (Italy)

With almost 200 years experience in wire rope manufacturing and with a new plant in Trieste, Redaelli is one of the leading hi-tech steel wire rope producers. The new plant is currently able to produce the biggest state-of-the-art steel wire ropes in the world.

The location of the plant at the dockside in Trieste harbour allows huge reels to be loaded without any prior road transport.

March, 2010 Redaelli manufacturers a world record steel wire rope

Redaelli, the leading Italian manufacturer of hi-tech steel wire ropes and tensostructure engineering, breaks a new world record: the production of the heaviest steel wire rope in the world with a net weight of 361.1 tons.

The record has been certified by Guinness World Records Ltd.

The record-breaking FLEXPACK rope, a compacted non rotating steel wire rope, is 3020 meters long and has a nominal diameter of 160 mm.

February, 2011 Redaelli again breaks a Guinness World Record

A new prestigious award with Flexpack, a 152 mm compacted non rotating steel wire rope for offshore applications, that weights over 420 tons.

A technological and industrial success that Redaelli devotes to the 150th Anniversary of National Unity in Italy. Along with its products Redaelli also exports its worldwide international award that once again recognises Italy's strength when it comes to style and innovation.

Redaelli

The Company

Founded in 1819, Redaelli started up as a steel drawing mill in the Lecco area in Italy.

Around 1860 the original mill expanded into a larger factory and in 1870 it became a public limited company.

By the 1980's, Redaelli had begun to diversify its activities by expanding its product range into the design and construction of steel drawing and cabling machinery.

In July 2008 it sold its steel cord and pre-stressing sectors, and the Company, with ropes as its core business, became part of Severstal-Metiz group of companies.

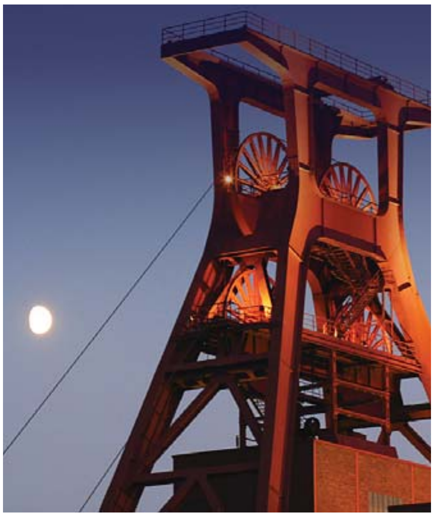
Now, Redaelli is a leading international manufacturer of steel wire ropes used in a variety of applications, including cableways, cranes, offshore, mining, and tensostructure engineering.

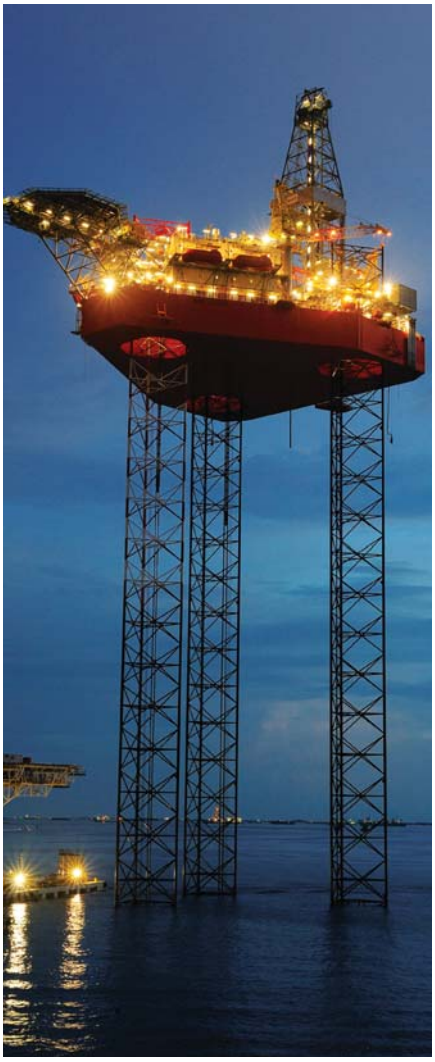
Its presence in so many different market sectors ensures ongoing growth in terms of production volumes and profitability, whilst its expansion policy outside Europe mainly in the Far East, USA, Emerging Markets, and with the subsidiary companies in Shanghai and San Paolo, is undergoing a consolidation process, which includes new fields of action and clients.

The Company is based in Milan, Italy and has plants and operations in Italy at Gardone Val Trompia (Brescia) and Trieste, more than 300 employees in total.

A central corporate structure covers the functions of marketing and communications, raw material purchasing, finance and control, and quality assurance.

This integrated organization allows Redaelli to efficiently and quickly react to market events and trends, use common technologies as a lever, have a better purchasing power, and optimize its financial resources.





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