برنتن واير روبس ش م ح

Brunton Wire Ropes FZCo.

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an usha martin Group company

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TITAN OIL FIELD ROPES

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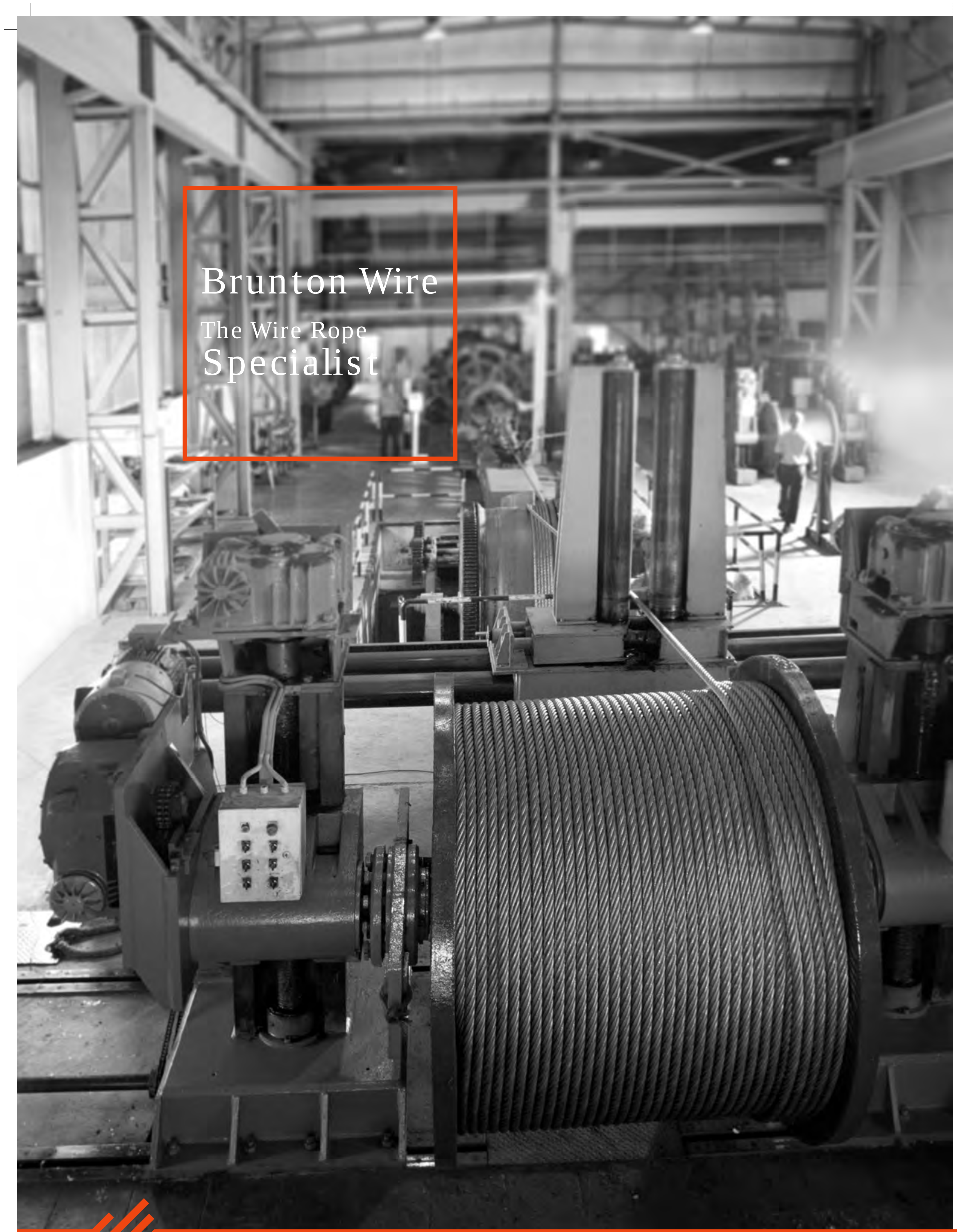

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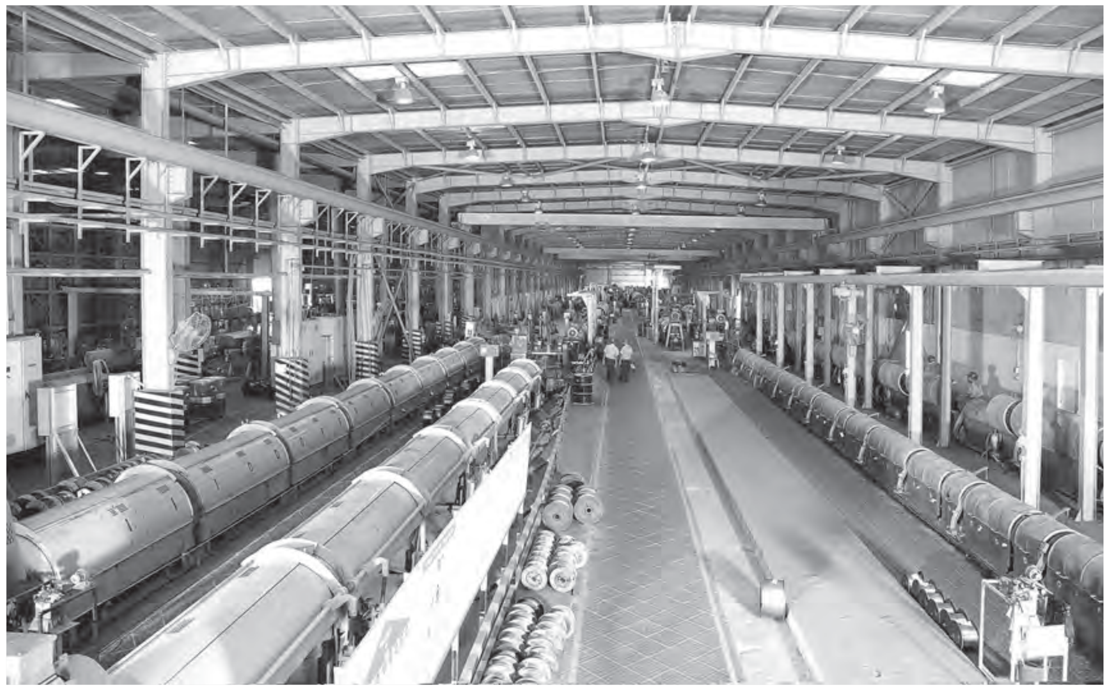
BWR
Brunton Wire Ropes FZCo.

CONTENTS

BRUNTON WIRE - THE MOST RELIABLE WIRE ROPE COMPANY



Brunton Wire Ropes FZCo., is a rope specialist, manufacturing steel wire ropes in Jebel Ali Free Zone, Dubai from the year 2003. It is one of the 5 global plants that the billion-dollar Rope & Specialty steel giant USHA MARTIN GROUP has and is one of the best in the world.

This company, backed by 100 years plus group experience in evolving advanced rope designs, with elaborate manufacturing base globally possessing state-of-the-art machines, rich experience on negotiating the dynamic market forces, has today become a 'REAL SOLUTION PROVIDER' to the markets it serves. Brunton Wire is proud to have the products sold continuously to more than 31 countries in Europe, North America, South America, North Asia, Australia, Africa, and Middle East & South East Asia.

This plant, in Dubai, produces & supplies steel wire ropes for Oil & Gas, Crane, General Engineering, Fishing, Dredging, Mining, Elevator applications having a very wide diameter range between 3mm and 77mm.The capability of producing and selling new generation ropes like the compacted & plasticated ropes have helped the consumers to get a complete solution from a single plant.

The elaborate testing facilities from raw material to final product gives the plant a qualitative edge over many competitors and thus, enjoys the confidence of many major oil giants, mining groups, elevator OEMs, big rigging companies. This plant is QMS certified and additionally has Lloyds & API (American Petroleum Institute) certifications. As a result Brunton Wire Ropes has grown more than 300% in 15 years.

The extensive inventory planning clubbed with a sound logistics leverage due to its Geographical position & supported by a large efficient port like Jebel Ali, have helped Brunton Wire's customers to get ropes faster in all parts of the world.

The group's R&D is continuously helping Brunton Wire to offer new designs to the consumers thereby, gaining a technological leadership.

In short, the backward integration model of the Usha Martin Group in resonance with the quality excellence datum and aided by the experienced executive leadership, have made Brunton Wire Ropes FZCo., to be a name that spells enormous reliability to all sections of wire rope consumers all around the globe.

Certifications

Test house approved by Lloyd Register of Shipping

9A - 0070

Intertek

UKAS MANAGEMENT SYSTEMS

BRUNTON WIRE WIRE ROPES

The "EDGE" over Competition

Quality and Performance

The QUALITY POLICY is a statement relating to a broad spectrum of VALUE ADDED features, which together aim to ensure Quality, Reliability and Customer Delight. The following attributes give insight to the facts which precisely help you to identify what differentiates BRUNTON WIRE from its competitors.

Engineering

Brunton Wire's engineering expertise differentiates itself from the competition. BWR products are manufactured with Raw Materials from USHA MARTIN, world leaders in speciality wire & rope products, using state of art machinery. In-house designed machinery and procedures for selecting and testing raw materials to allow for extra strength, extended fatigue performance and improved rotational resistance have resulted in BRUNTON WIRE being viewed as the STANDARD for the chosen industry, both Nationally and Internationally.

BWR is proud to have its facility awarded certification for our Quality Assurance Program according to BS EN ISO 9001 Standards. The plant has also been approved for API 9A certification.

BWR is one platform which has integrated Product & Process technology, manufacturing excellence and testing standards, application engineering & training know-how of the whole group.

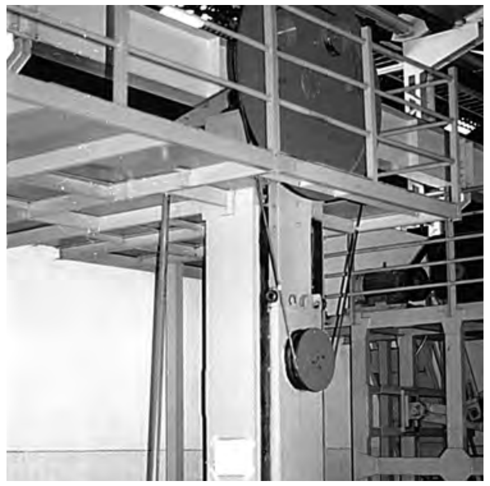
Commitment to Quality

Brunton Wire tests a sample from each production batch to destruction in order to designate each rope by the actual breaking force which is stated on the test certificates. This gives the user a confirmation that the rope has met or exceeded its specified minimum breaking force value. Many of our competitors mention the calculated minimum breaking force value which is not verified until used by the Valued Customer. BWR has also the testing facilities for fatigue life, crush resistance and rotational characteristics for the products within our High Performance Range.

Customer Service

Service at Brunton Wire is second to none. BWR believes that excellence is achieved not only by having the product available when you want it, but by also providing a knowledgeable team of field sales representatives, a fully trained and capable Customer Services Team dealing specifically with enquiries and orders. The expert rope engineers provide a complete solution to the valued end user, with their ability to interpret their special needs from design through to manufacture and application. Brunton Wire realizes that our customers should be knowledgeable about the properties, installation, use, inspection and maintenance of our products. Thus, we provide formal product training through seminars and continuous interaction.

QUALITY GUARANTEE



Guaranteed Raw Material Quality

Good raw material input at the beginning of the rope making process combined with tight process control ensure consistently high quality in the finished rope. Usha Martin manufactures steel and rod to International standards and to even more exacting internal standards through its mini blast furnace - arc furnace - ladle furnace - vacuum degassing electromagnetic stirring - continuous casting route.

A close and unique co-operation between company owned ISO 9001 certified steel making, rod manufacturing and wire drawing facilities guarantee production feed materials which are 'tailor made' to attain the required properties of ductility and tensile strength which are essential in the finished rope.

Guaranteed Breaking Force

While operating a rigorous programme of testing throughout the production process Brunton Wire confirm the minimum breaking force of each and every finished rope with an actual test to destruction.

The Test Certificate which is supplied with every rope will indicate a minimum guaranteed breaking force and the actual breaking force at which the test sample broke.

The Brunton Wire testing facility is approved by Lloyds Register of Shipping.

Guaranteed Quality Systems

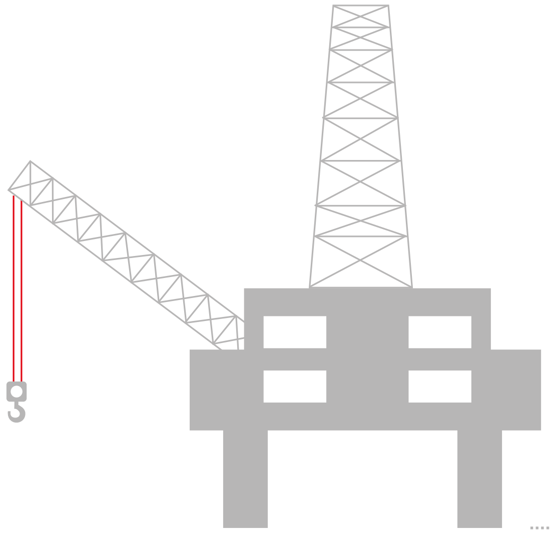
Certification to ISO 9001 requires that Brunton Wire document all work procedures, processes and related activities covering design, development, production, shipping and commercial activity.

ISO 9001 is a guarantee to our customer's that we will do exactly what we say we are going to do. Wire and Wire Ropes Division at Ranchi is the first and the only one in India to receive the prestigious award for excellence in TPM from Japanese Institute of Productivity Management (JIPM). Brunton Wire is also having the API-9A monogram.

Guaranteed Bending Fatigue Characteristics

Bending fatigue resistance is the ability of the wire rope to withstand repeated bending over a sheave under constant or fluctuating loads.

The ability to withstand bending fatigue will, along with other factors, determine the life of the rope and is therefore of interest to both the rope maker and the crane operator.

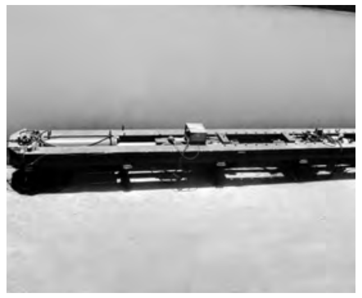


INFRASTRUCTURE


Wire Spooling & Long Stranding Machines (18 Bobbin, 25 Bobbin & 3 no. 36 Bobbin)


Seven Bobbin Skip Strander


6 x 60 Closer


200 T capacity 25 M Tensile Testing Machine


8 Bobbin closer


600 T Press

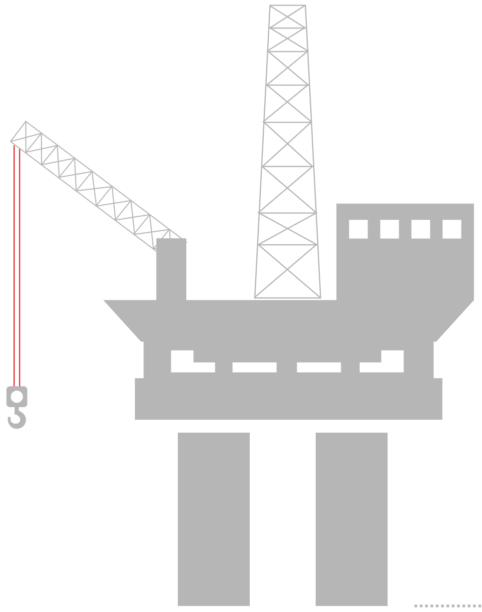

6+12+18 Planetary Strander for non-rotational Crane Ropes


High Speed Wire Rewinders


Fatigue Testing Machine

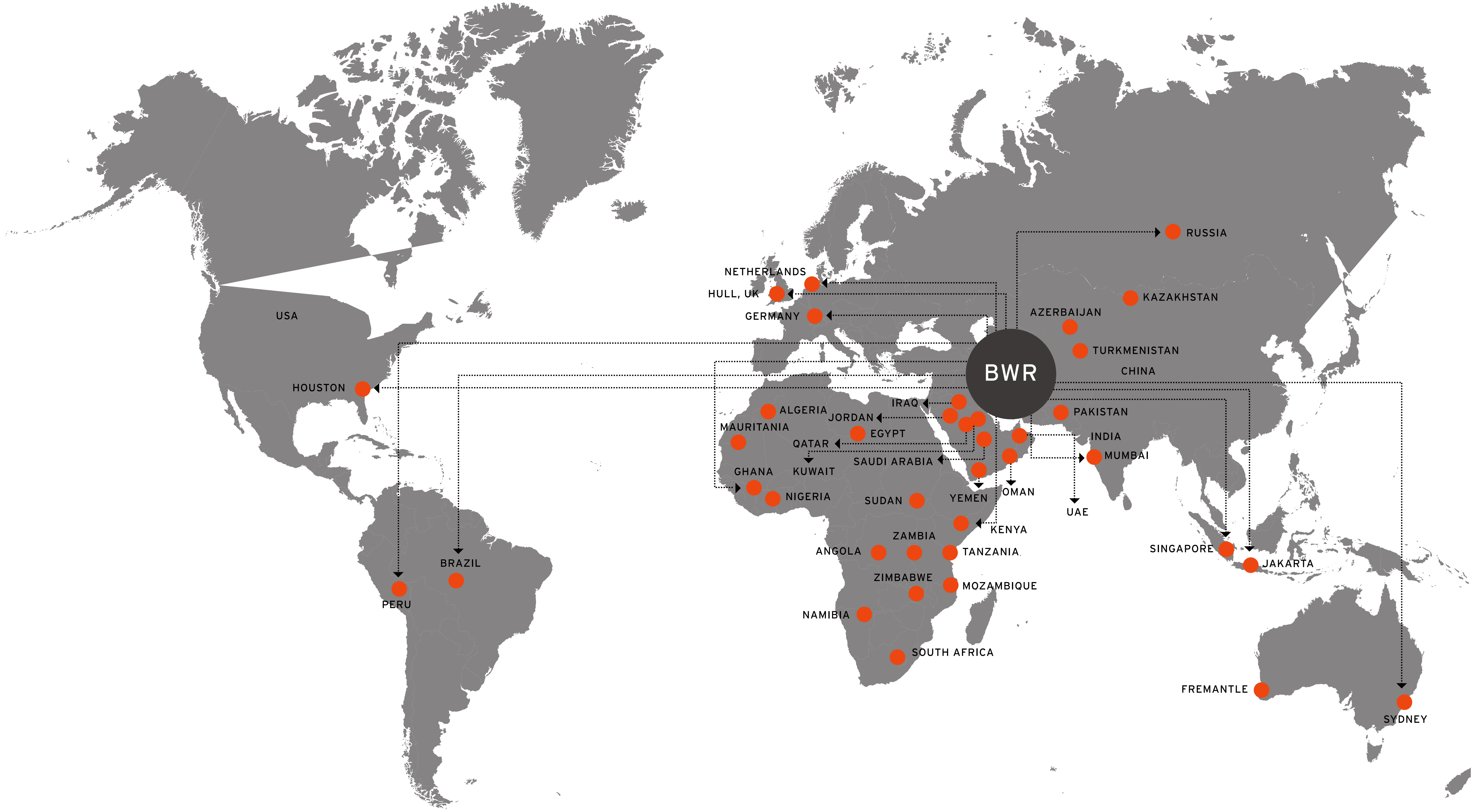
Brunton Wire Ropes FZCo. has comprehensive manufacturing and testing facilities to make a wide range of wire ropes of various Constructions & Applications, starting from wire. At present it has large number of machines, some of them are listed below.

- High Speed Wire Rewinders
- 37 Bobbin Stranding Machines
- 25, 19 & 18 Bobbin Stranding Machines
- Series of 6 & 7 Bobbin Stranding Machines
- High Speed Skip Strander
- 8 & 6 Bobbin Closing Machines
- Wet Drawing Machines
- 37 Bobbin Planetary Closing Machine for Crane Rope
- 50T Planetary Closing Machine
- 'State of the Art' 25 Mtrs long 200 T Tensile Testing Machine
- Wire Tensile Testing Machine
- Fatigue Testing Machine for Elevator Rope
- Rigging shop with 'Hydraulic Presses', Automatic cut to length machine & Rigging Towers



Brunton Wire Ropes FZCo.

CUSTOMER SPREAD

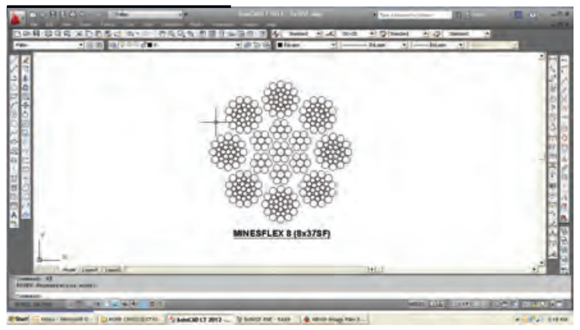


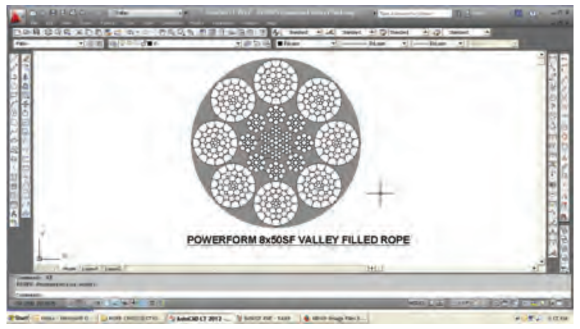
SOME OF THE CUSTOMERS THIS GROUP SERVES...

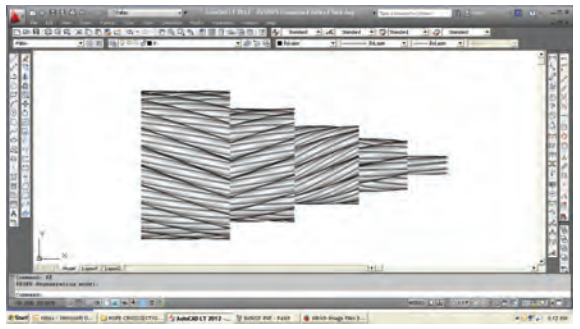
bp
Saipem
BKE
PETROBRAS
GAZPROM NEFT
DIAMOND OFFSHORE
Chevron
Technip
SAGT South Asia Gateway Terminals (Pvt.) Ltd. Port of Colombo, Srilanka
Kuwait Drilling Company
SBM OFFSHORE
KAZAKHMYS
Statoil
INTERMOOR
ROSNEFT
Weatherford
OCP
Abraj Energy Services LLC
Oman Oil Company
VALE
WESTMORELAND COAL COMPANY
bhpbilliton
NORTH AMERICAN COAL CORPORATION FREEDOM MINE
Coal India Ltd.
РУСАЛ
ENRC

ANGLO AMERICAN
СУЭК
TATA STEEL
MICT
ADANI
PORT KLANG malaysia
PTP
DP WORLD
Port of Tacoma
PIP PHUOCLONG ICD - PORT
Manitowoc
GROVE
POTAIN
TADANO
GOTTWALD port technology
LIEBHERR
KOBELCO
TEREX
Schindler
OTIS
ThyssenKrupp Elevator
MITSUBISHI ELECTRIC
KONE

MINIMUM ROPE INFORMATION



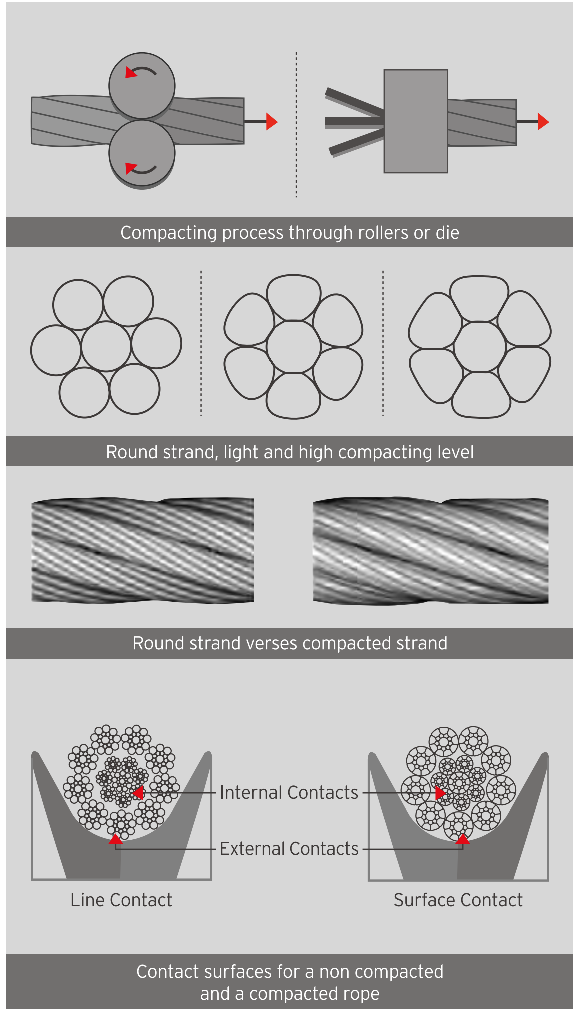




When providing an enquiry or a purchase order, at least the following information should be supplied:

- Reference standard, i.e. EN 12385-4
- Quantity and length
- Nominal diameter
- Rope class or construction
- Core type
- Rope grade
- Wire finish or coating
- Lay direction and type (single layer ropes are normally manufactured right hand ordinary lay unless otherwise stated by the purchaser)
- Preformation (outer strands of single layer and parallel-closed ropes are normally preformed during manufacture. The purchaser should specify any particular preformation requirements)
- Lubrication (at least the strands are lubricated during manufacture. The purchaser should specify any particular lubrication requirements).
- Type of inspection document - refer EN 12385-1
- Any particular marking requirements
- Any particular packaging requirements
- Required minimum breaking force
- Application of the rope

BENEFITS OF COMPACTED STRANDS



Compacting process through rollers or die

Round strand, light and high compacting level

Round strand verses compacted strand

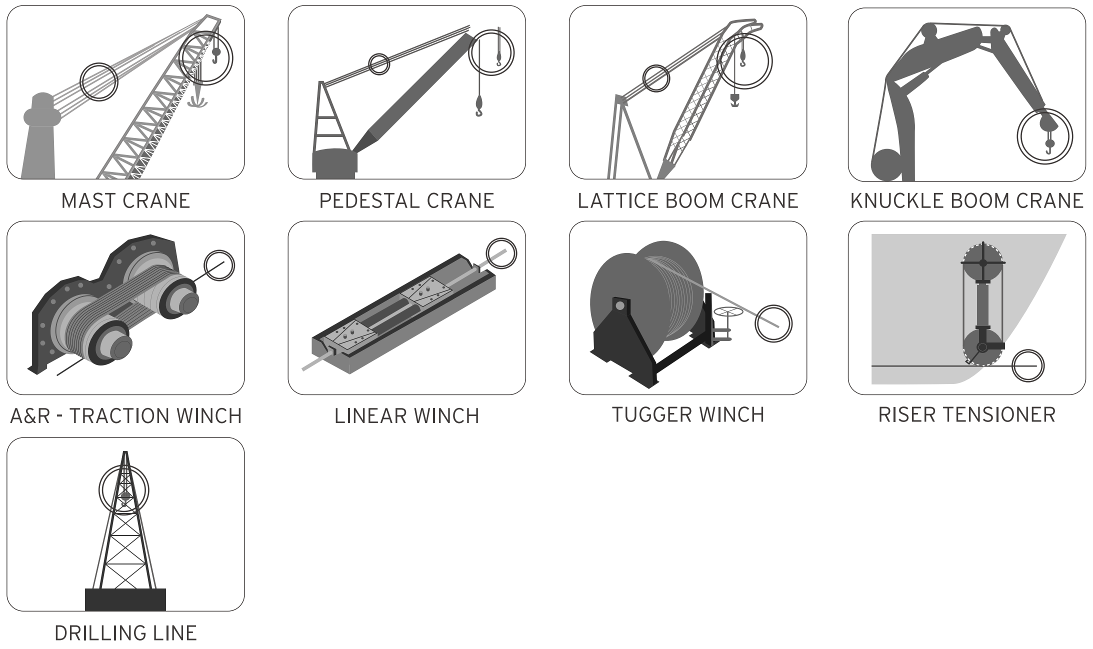
Contact surfaces for a non compacted and a compacted rope

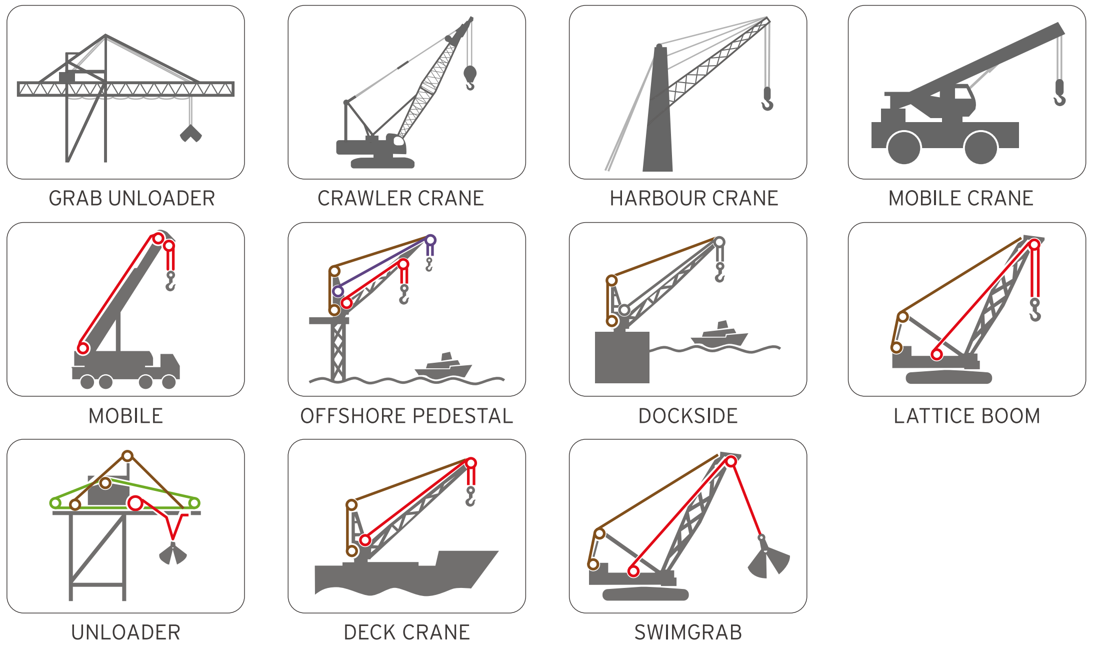
Ropes for special applications and heavy lifting activities require a high load efficiency and breaking load, which cannot be achieved using traditional round strands. For this reason, these ropes are typically composed by compacted strands, whose compacting level can be designed and modulated depending on specific requirements. Compacted strands are obtained by the passage through a die or a series of rollers applied on the strander machine just after the closing point, as shown in the figure.

The main benefit of compacted strands adoption is the increase of metallic area in respect to round strands, which allows to get higher breaking force. This process also gives higher cooperation level to the individual wires, homogeneous and stable strand diameter, resistance to side pressure, wear and abrasion.

Finally, smoother contact surface between the strands and rounder profile gives better spooling performance and resistance to crushing.

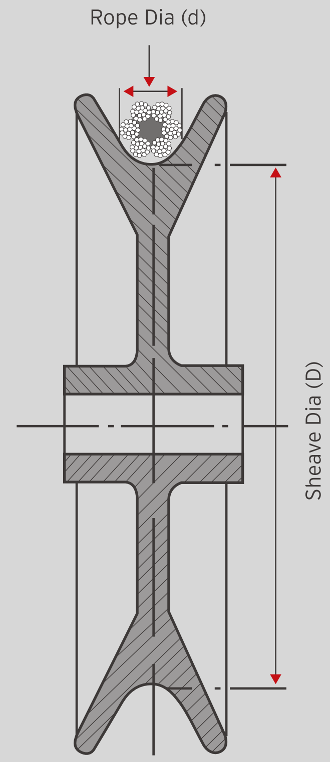
GUIDE TO APPLICATION & ROPE DUTY





■ MAIN HOIST ■ BOOM HOIST ■ TROLLEY/RACKING ROPE ■ WHIP HOIST

PULLEY / ROPE BENDING RATIO (D/d RATIO)



Note:

The ratios are based on Max. rope speed of 60 meters/min. For each increase of 30 mtrs/min. in excess of 60 meters per min., add 5% to the drum diameter.

Sheave Or Drum/Rope Diameter Ratio (D:d)

Sl. No.	Construction	D : d Ratio	
		Recommended	Minimum
1	6x7 (6-1)	53	43
2	6x19S (9-9-1)	40	32
3	6x26SW (10-5+5-5-1)	37	29
4	6x25F (12-6F-6-1)	32	26
5	6x31SW (12-6+6-6-1)	32	26
6	6x37SF (12-12-6F-6-1)	32	26
7	6x36SW (14-7+7-7-1)	28	22
8	6x43SF (14-14-7F-7-1)	28	22
9	6x50SFS (14-14-7F-7-7-1)	28	22
10	6x41SW (16-8+8-8-1)	25	20
11	6x49SW (16-8+8-8-8-1)	25	20
12	6x49SF (16+16+8F-8-1)	25	20
13	6x46SW (18-9+9-9-1)	22	18
14	6x52SW (18-9+9-9/6-1)	22	18
15	6x55SF (18-18-9F-9/6-1)	23	18
16	8x19S (9-9-1)	33	26
17	8x26SW (10-5+5-5-1)	30	24
18	8x25F (12-6F-6-1)	26	21
19	8x31SW (12-6+6-6-1)	26	21
20	8x37SF (12-12-6F-6-1)	26	21
21	8x36SW (14-7+7-7-1)	23	18
22	8x50SFS (14-14-7F-7-7-1)	23	18
23	17x7 (11:6-1)	34	27
24	18x7 (12:6-FC)	32	25
25	19x7 (12:6-1)	32	25
26	34x7 (17:11/6-FC)	24	19
27	35x7 (16:6+6-6-1)	25	20
28	6x25FS (12/12/▲)	42	35
29	6x8FS (7/▲)	63	53
30	6x28FS (15/12/▲)	36	30
31	Locked Coil Winding Rope	152	100

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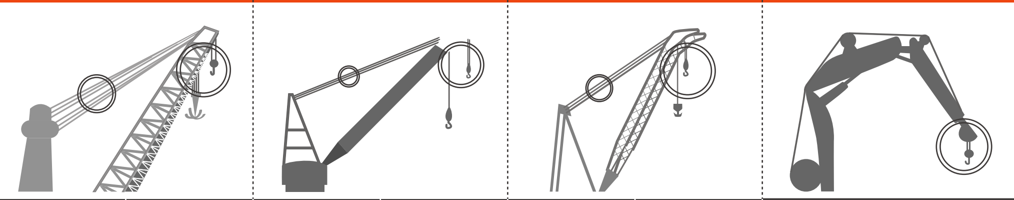
Brunton Wire Ropes FZCo.

OIL & GAS WIRE ROPE APPLICATION SELECTOR

Key
✓ Recommended
! Allowed
✗ Not recommended



	Mast Crane		Pedestal Crane		Lattice Boom Crane		Knuckle Boom Crane
	Boom	Hoist	Boom	Hoist	Boom	Hoist	
HYFLEX 35 / 35P	✗	✗	✗	✗	✗	✗	✗
POWERFORM 35 / 35P / 35MPS / 35MS	✗	✓	✗	✓	✗	✓	✓
POWERFORM 8 / 8P	✗	✗	✓	!	✓	✗	✗
POWERFORM 10S / 1 0PS	✗	!	✗	!	✗	!	✗
POWERFORM 10MS / 10MPS	✓	!	✓	!	✓	!	✗
DRILLFLEX6 / DRILLFORM6 / 6P / DRILLFORMAX 6 / DRILLFORM8/8P	✗	✗	✗	✗	✗	✗	✗
POWERFORM 6RT	✗	✗	✗	✗	✗	✗	✗

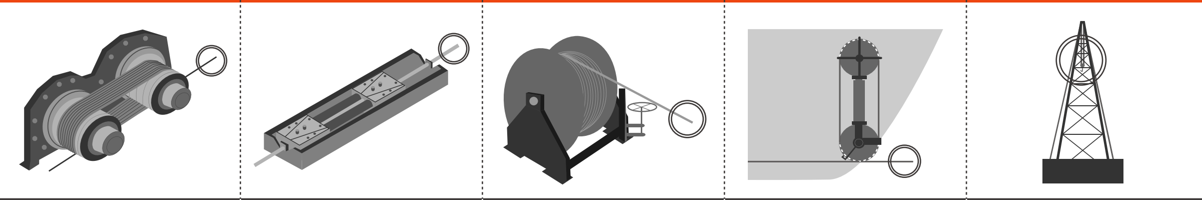
ROPE PROPERTIES	FILL FACTOR (f)	MBF FACTOR (k)	MASS FACTOR (km) in air	MASS FACTOR (km) in water	E.MODULUS (E)* [Kn/mm2]	TORQUE FACTOR (t)*		REFERENCE LAY FACTOR (KL)*	Rotation deg./lay (R)*	
						Lang	Reg		Lang	Reg
POWERFORM 35MS / MPS	0.715	0.86-1.00	0.0049	0.0042	127	0.02	0.01	7	2	0.5
POWERFORM 10S / 10PS	0.695	0.81-0.95	0.0047	0.004	125	0.055	0.045	6.5	14	4
POWERFORM 10MS / 10MPS	0.695	0.82-0.96	0.0047	0.004	127	0.125	0.09	6.5	120	70
DRILLFORMAX 6	0.67	0.78-0.84	0.0045	0.0038	122	0.11	0.078	6.5	90	60
POWERFORM 6RT	0.67	0.75-0.79	0.0045	0.0038	122	0.11	0.078	6.5	90	60

Note: Nominal values @ 20% MBF for trained rope.

ROPE PROPERTIES	FILL FACTOR (f)	MBF FACTOR (k)	MASS FACTOR (km) in air	Typical Lay Type	E.MODULUS (E)* [Kn/mm2]	TORQUE FACTOR (t)*	REFERENCE LAY FACTOR (KL)*	Rotation deg./lay (R)*
POWERFORM 8LS / 8LPS	0.69	0.96	0.0047	Reg	120	0.085	6.5	6
POWERFORM 10LS / 10LPS	0.71	0.94	0.0048	Reg	120	0.09	6.75	70
POWERFORM 8XLS	0.74	1.02	0.0049	Reg	130	0.085	6.5	60
POWERFORM 10 XLS	0.78	1.02	0.0051	Reg	130	0.1	6.75	90

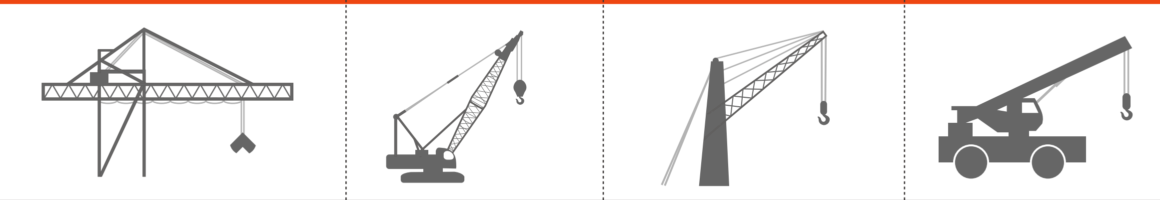
Note: Nominal values @ 20% MBF for trained rope.

Key
✓ Recommended
! Allowed
✗ Not recommended

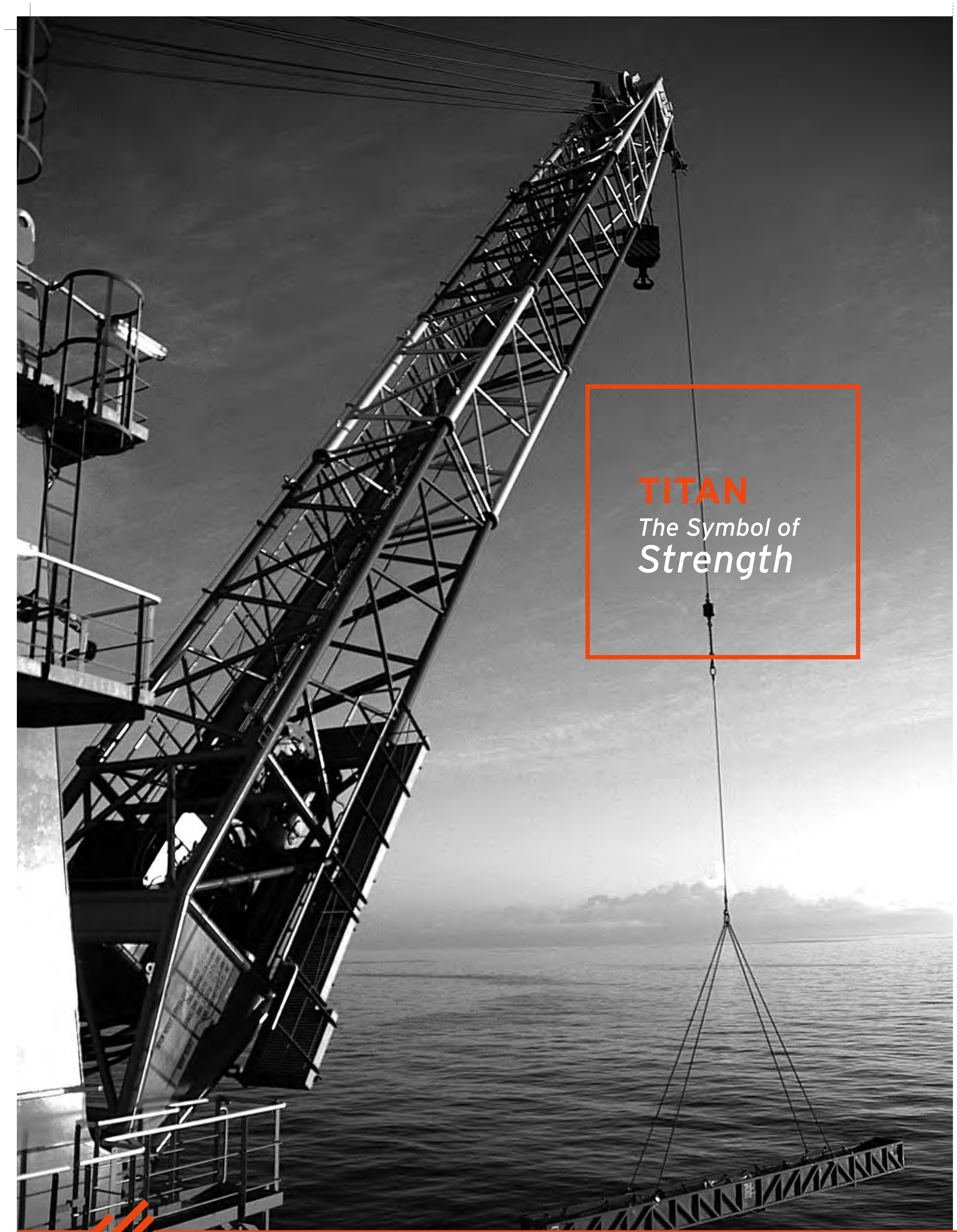


	A&R - Traction Winch	Linear Winch	Tugger Winch	Riser Tensioner	Drilling Line
HYFLEX 35 / 35P	✗	✗	✗	✗	✗
POWERFORM 35 / 35P / 35MPS / MS	✓	✓	✓	✗	✗
POWERFORM 8 / 8P	✗	✗	✗	✗	✗
POWERFORM 10S / 10PS	!	!	✗	✗	✗
POWERFORM 10MS / 10MPS	!	!	✗	✗	✗
DRILLFLEX6 / DRILLFORM6 / 6P / DRILLFORMAX 6 / DRILLFORM8 / 8P	✗	✗	✗	✗	✓
POWERFORM 6RT	✗	✗	✗	✓	✗

Key
✓ Recommended
! Allowed
✗ Not recommended



	GRAB Unloaders				Crawler Cranes		Harbour Cranes			Mobile Cranes
	Boom	Hoist	Grab Closing	Racking	Boom	Hoist	Boom	Hoist	Luffing	Hoist
HYFLEX 8 / 8P	✗	!	!	✗	✗	✗	✗	✗	✗	✗
POWERFORM 8 / 8P	✓	!	✗	✗	✗	✓	✓	!	✗	✓
POWERFORM 8LS / 8LPS / 8XLS / 10LS / 10LPS / 10 XLS	✓	!	✗	✗	✓	✗	✓	!	✓	✗
HYFLEX 35 / 35P	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
POWERFORM 35 / 35P	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓

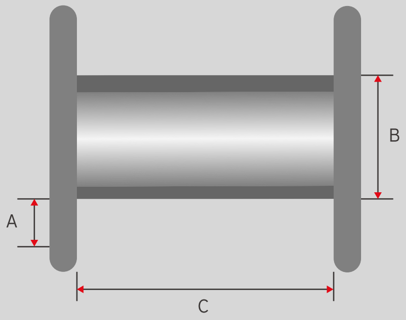


Brunton Wire Ropes FZCo.

ROPE CALCULATOR

Rope Calculator

MBF [kN] = $K \cdot d^2$ (d = nominal diameter [mm])
Mass [kg/m] = $Km \cdot d^2$
Metallic area (A) [mm2] = $0.785 \cdot f \cdot d^2$
Axial stiffness (EA) [MN] = $E \cdot 0.785 \cdot f \cdot d^2/1000$
Elastic elongation —— = Load [kN] / (EA•1000)
Rope torque [Nm] = $t \cdot d \cdot$ load [kN]



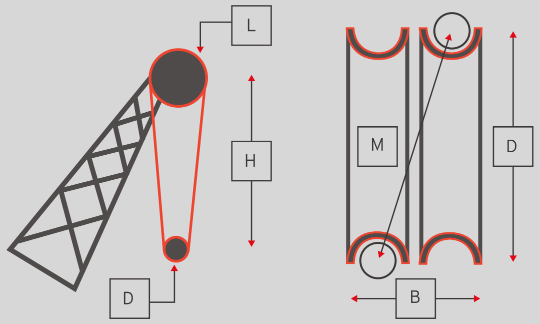
$$L = \frac{\Pi \cdot A \cdot C}{d^2}(A+B)$$

A, B, C [m] | L [m] | d [mm]

Maximum Lifting Height for Block Stability

Approximate calculation
in case of number of falls higher than 2
$H = L \cdot M / (4 \cdot d \cdot t)$

where $M = \sqrt{(B^2+D^2)}$



$H = L \cdot D / (4 \cdot d \cdot t)$

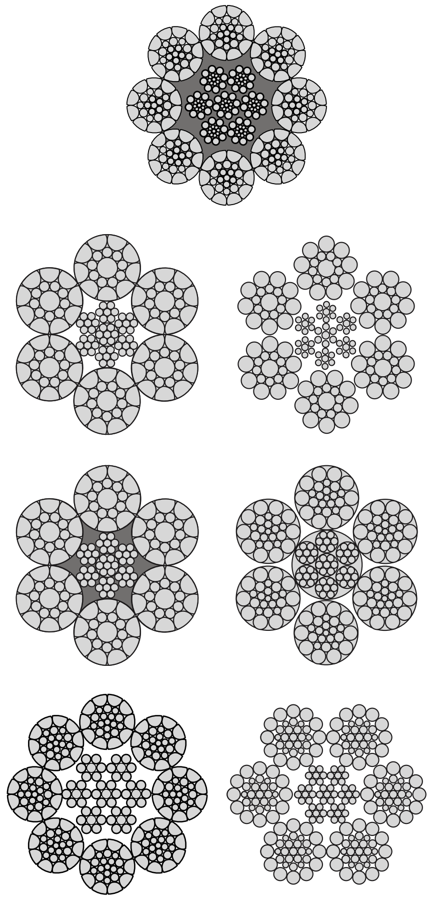
TITAN DRILLING LINES

Deteriorating Forces

- Abrasion
- Drum/Sheave wear fatigue
- Crushing forces from multi-layer winding on drum
- Shock load

Properties required

- Flexibility
- Abrasion resistance
- Stable construction to absorb crushing forces



Drillflex 6/Drillform 6/6P/Drillform 8/8P

Construction	Nominal Rope Diameter	
Rope	in.	mm
6x19S	1 to 1-1/2	25 - 42
6x26SW	15/8 to 2-1/4	25 - 58
6x31SW	1 to 1-1/2	25 - 38

Drillflex 6

Nominal Rope Diameter		Approximate Mass		Minimum Breaking Force			
in.	mm	lb/ft	kg/m	EIPS		EEIPS	
				MT	kN	MT	kN
1	26	1.85	2.75	46.9	460	51.6	506
1 1/8	29	2.34	3.48	58.9	578	64.9	636
1 1/4	32	2.89	4.30	72.5	711	79.7	782
1 3/8	35	3.49	5.19	87.1	854	96.2	943
1 1/2	38	4.16	6.19	103	1010	113	1110
1 5/8	42	4.88	7.26	119	1170	133	1300
1 3/4	45	5.66	8.42	139	1360	153	1500
1 7/8	48	6.49	9.66	158	1550	174	1710
2.0	52	7.39	11.0	179	1760	197	1930
2 1/8	54	8.34	12.4	201	1970	220	2160
2 1/4	58	9.35	13.9	224	2200	247	2420

Note: The Wire Rope conforms to the applicable sections of API Specification 9A.

Abbreviated terms used in this brochure

XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

Drillform 6/6P

Nominal Rope Diameter		Approximate Mass		Minimum Breaking Force			
in.	mm	lb/ft	kg/m	1770		1960	
				MT	kN	MT	kN
1	26	2.00	2.97	47.0	461	53.9	529
1 1/8	29	2.53	3.76	59.6	584	68.3	670
1 1/4	32	3.12	4.64	73.5	721	84.3	827
1 3/8	35	3.77	5.61	88.9	872	102	1000
1 1/2	38	4.37	6.50	104	1023	120	1176
1 5/8	42	5.13	7.63	122	1201	141	1380
1 3/4	45	5.95	8.85	142	1393	163	1600
1 7/8	48	6.83	10.2	163	1599	187	1838
2.0	52	7.77	11.6	185	1819	213	2090
2 1/8	54	8.76	13.0	206	2022	237	2328
2 1/4	58	9.83	14.6	231	2270	266	2613

Note: The Wire Rope conforms to the applicable sections of API Specification 9A.

Drillformax 6

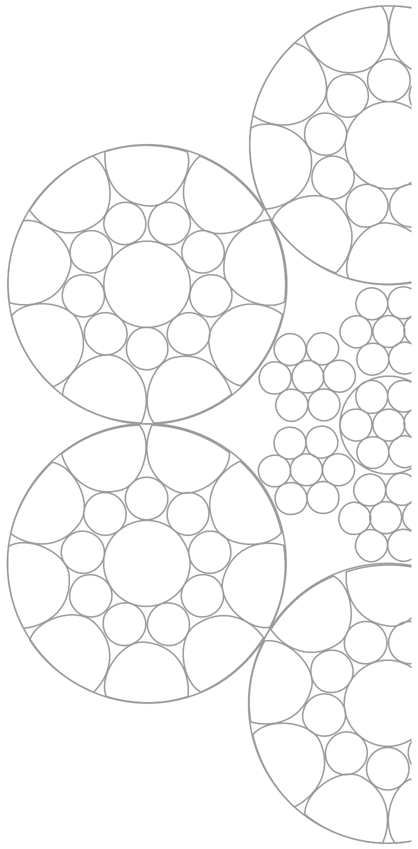
Diameter		Mass				MBF	
Metric	Imperial	Metric		Imperial		Force	Load
mm	in.	Air	Water	Air	Water	1770	1770
		kg/m	kg/m	lb/ft	lb/ft	kN	tonnes
28.6	1 1/8	3.71	3.15	2.50	2.12	686	69.9
31.8	1 1/4	4.58	3.89	3.08	2.62	833	84.9
34.9	1 3/8	5.53	4.70	3.72	3.16	1000	102
38.1	1 1/2	6.58	5.59	4.43	3.77	1170	119
41.3	1 5/8	7.71	6.55	5.19	4.41	1380	141
44.5	1 3/4	8.95	7.61	6.03	5.12	1590	162
50.8	2	11.7	9.95	7.88	6.70	2010	205

These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

Drillform 8/8P

Nominal Rope Diameter		Approximate Mass		Minimum Breaking Force			
in.	mm	lb/ft	kg/m	1960		2160	
				MT	kN	MT	kN
3/4	19	1.12	1.66	32.3	317	34.6	339
7/8	22	1.53	2.27	44.2	434	47.3	464
1.0	26	2.00	2.97	57.8	567	61.8	606
1 1/8	29	2.58	3.84	73.1	717	78.2	767
1 1/4	32	3.23	4.81	91.6	899	97.9	960
1 3/8	35	3.86	5.75	109.4	1073	117.0	1148
1 1/2	38	4.56	6.79	129.3	1268	138.3	1357
1 5/8	42	5.57	8.29	157.9	1549	168.9	1657
1 3/4	45	6.37	9.48	176.9	1735	189.2	1856
1 7/8	48	7.43	11.06	206.2	2023	220.4	2162
2.0	52	8.33	12.39	231.0	2266	247.2	2425

Note: The Wire Rope conforms to the applicable sections of API Specification 9A.



برنتن واير روبس ش م ح
Brunton Wire Ropes FZCo.

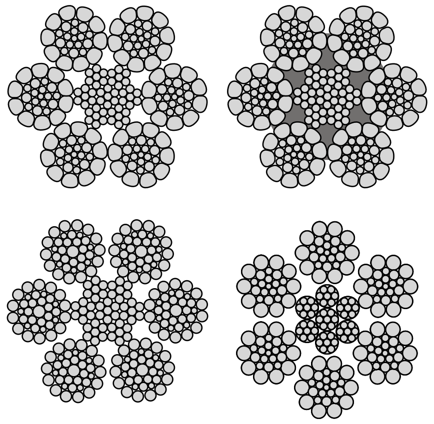
TITAN RISER TENSIONER ROPES

Deteriorating Forces

- Continuous bending loads
- Fatigue (Bending & Tension)
- Sheave and Drum wear
- Crushing/internal wire pressure

Properties required

- High degree of flexibility
- Fatigue resistance
- Resistant to drum and sheave wear or abrasion resistance
- Superior quality core



Construction	Nominal Rope Diameter	
Rope	in.	mm
6x26SW	1 to 1 3/4	25 to 45
6x36SW	1 3/4 to 2	45 to 52

Hyflex

Nominal Rope Diameter		Approximate Mass		Minimum Breaking Force	
				EIPS	
in.	mm	lb/ft	kg/m	MT	kN
1	26	1.79	2.66	46.9	460
1 1/8	29	2.28	3.39	58.9	578
1 1/4	32	2.84	4.23	72.5	711
1 3/8	35	3.44	5.12	87.1	854
1 1/2	38	4.01	5.97	103	1010
1 5/8	42	4.95	7.37	119	1170
1 3/4	45	5.64	8.39	139	1360
1 7/8	48	6.49	9.66	158	1550
2.0	52	7.26	10.81	179	1760

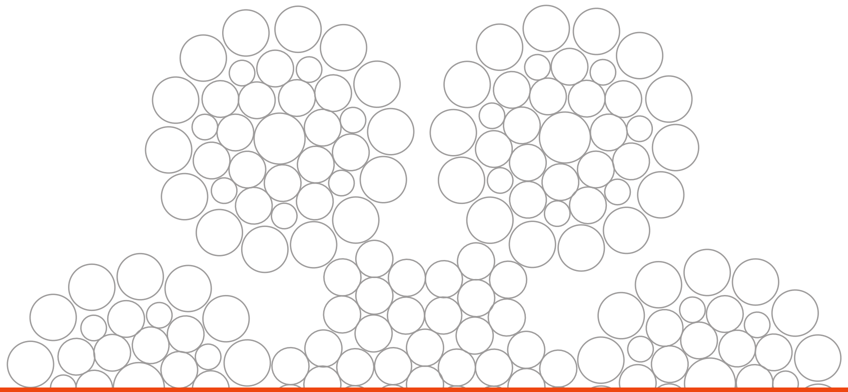
Note: The Wire Rope conforms to the applicable sections of API Specification 9A.

Powerform 6RT

Diameter		Mass				MBF			
Metric	Imperial	Metric		Imperial		Force		Load	
		Air	Water	Air	Water	1770 dual	IPS/1960	1770 dual	IPS/1960
mm	in.	kg/m	kg/m	lb/ft	lb/ft	kN	kN	tonnes	tonnes
44	1 3/4	8.71	7.41	5.87	4.99	1450	1530	148	156
	1 3/4	8.89	7.56	5.99	5.09	1480	1560	151	159
48	1 7/8	10.4	8.81	6.98	5.93	1730	1820	176	186
	2	11.6	9.87	7.82	6.65	1940	2040	198	208
52		12.2	10.3	8.19	6.96	2030	2140	207	218
54	2 1/8	13.1	11.2	8.83	7.51	2190	2300	223	234
56		14.1	12.0	9.50	8.08	2350	2480	240	253
58	2 1/4	15.1	12.9	10.2	8.66	2520	2660	257	271
60	2 3/8	16.4	13.9	11.0	9.37	2730	2870	278	293
64	2 1/2	18.4	15.7	12.4	10.5	3070	3240	313	330
	2 5/8	20.0	17.0	13.5	11.4	3330	3510	339	358
70	2 3/4	22.1	18.7	14.8	12.6	3680	3870	375	394
73	2 7/8	24.0	20.4	16.2	13.7	4000	4210	408	429
76		26.0	22.1	17.5	14.9	4330	4560	441	465

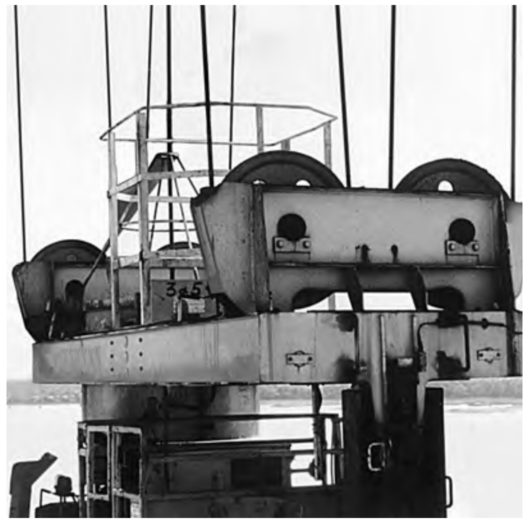
These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

- Compliant to international standards
- High fatigue resistance
- High dimensional stability
- Enhanced sheave imprinting resistance if dual strength



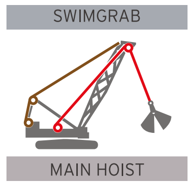
Brunton Wire Ropes FZCo.

HYFLEX 8/8P



- Hyflex 8P is a flexible high strength eight strand steel wire rope with plastic impregnated core.
- A sample of rope from each production batch is tested to destruction in order to confirm compliance with catalogue breaking force values.
- Good bending fatigue life
- Greater surface contact area resulting from the eight strand construction.
- Fully lubricated in manufacturing
- Optional plastic impregnation of the steel core. (P) signifies full plastic impregnation of the steel core.

Typical Applications

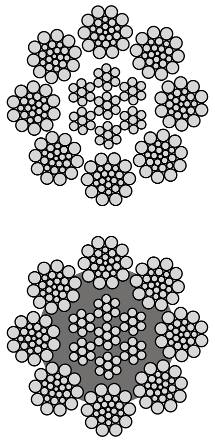


BOOM HOIST ■
MAIN HOIST ■
TROLLEY ■

NOM. ROPE DIA. mm	NOM. ROPE DIA. in	APPROX. MASS kg/100m	MINIMUM BREAKING FORCE GALVANISED & UNGALVANISED ROPE GRADE 1960 N/mm²		MINIMUM BREAKING FORCE GALVANISED & UNGALVANISED ROPE GRADE 2160 N/mm²	
			kN	tonnes	kN	tonnes
10		43.5	72.9	7.4	81.4	8.3
11		52.6	86.1	8.8	96.5	9.8
12		62.6	105	10.7	117.0	11.9
	1/2	70.2	123	12.5	131.0	13.4
13		73.5	124	12.6	138.0	14.1
14		85.3	143	14.6	160.0	16.3
15		97.9	164	16.7	183.0	18.7
16	5/8	111.0	187	19.1	208.0	21.2
17		126.0	211	21.5	239.0	24.4
18		141.0	239	24.4	267.0	27.2
19	3/4	157.0	269	27.4	300.0	30.6
20		174.0	295	30.1	331.0	33.7
22		211.0	356	36.3	400.0	40.8
	7/8	215.0	360	36.7	402.0	41.0
24		251.0	423	43.1	475.0	48.4
	1	281.0	470	47.9	525.0	53.5
26		297.0	500	51.0	562.0	57.3
28		345.0	572	58.3	642.0	65.4
	1 1/8	359.0	596	60.8	665.0	67.8
30		396.0	656	66.9	733.0	74.7
32	1 1/4	451.0	747	76.1	836.0	85.2
34		509.0	843	85.9	945.0	96.3
36		570.0	935	95.3	1053.0	107.0
38	1 1/2	635.0	1043	106.0	1172.0	119.0
40		704.0	1162	118.0	1313.0	134.0
42		785.0	1305	133.0	1462.0	149.0
44		862.0	1412	144.0	1577.0	161.0
	1 3/4	879.0	1441	147.0	1613.0	164.0
46		942.0	1543	157.0	1731.0	176.0
48		1025.0	1680	171.0	1885.0	192.0
50		1113.0	1833	187.0	2065.0	210.0
	2	1148.0	1882	192.0	2101.0	214.0
52		1203.0	1972	201.0	2202.0	224.0

* Mass per unit length of HYFLEX 8P increases by approx. 3%

Note:
- Rope Sizes and Breaking Force not shown in the standard table, may be available on request and prior confirmation.
- HYFLEX 8P is available for rope diameter 16 mm and above on special request and prior confirmation.



Standard Characteristics Hyflex 8/8P		
Construction	8x26SW(10-5+5-5-1)-CWR 8x36SW(14-7+7-7-1)-CWR	
Compacted	Yes	No
		◆
Tensile Grade	1960	2160
	◆	
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	
Average Fill Factor (%)	59.8	
Turn value at 20% of breaking force degrees/rope lay	87	
Nominal rope lay length (NRD = Nominal Rope Diameter)	6.25 - 6.75 X NRD	
Discard Criteria	Refer to ISO 4309:1990	
Warning : Hyflex 8/8P in Langs lay must only be used in applications where both ends are secured and are unable to rotate.		

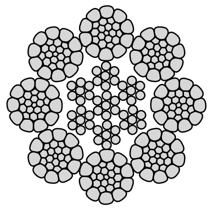
Abbreviated terms used in this brochure

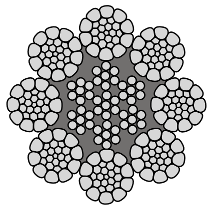
XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

Brunton Wire Ropes FZCo.

POWERFORM® 8/8P

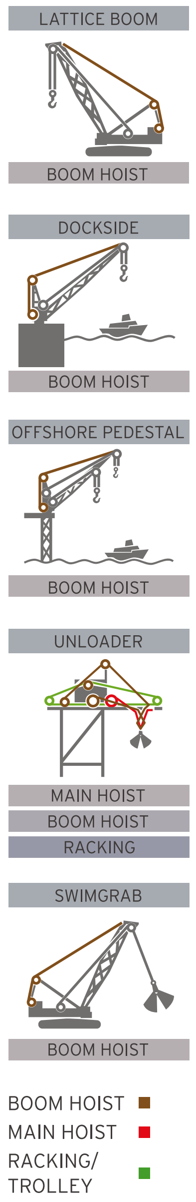
- Powerform® 8P is a high strength eight strand rope with plastic impregnated core ideal for situations where longer service life is required.
- A sample of rope from each production batch is tested to destruction in order to confirm compliance with catalogue breaking force values.
- High fatigue life resulting from the unique compaction process.
- Maximum resistance to crushing. Recommended for multi-layer spooling operations.
- Increased abrasion resistance resulting from the unique compaction process.
- Greater surface contact area resulting from the eight strand construction and compacted finish give longer rope life and reduced sheave wear.
- Fully lubricated in manufacturing.
- Optional plastic impregnation of the steel core. (P) signifies full plastic impregnation of the steel core.





Standard Characteristics Powerform® 8/8P		
Construction	8xK26SW(10-5+5-5-1)-CWR 8xK36SW(14-7+7+7-1)-CWR	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	
Average Fill Factor (%)	65.5	
Turn value at 20% of breaking force degrees/rope lay	94	
Nominal rope lay length (NRD = Nominal Rope Diameter)	6.5 x NRD	
Discard Criteria	Refer to ISO 4309:1990	
Warning : Powerform 8/8P® in Langs lay must only be used in applications where both ends are secured and are unable to rotate.		

Typical Applications



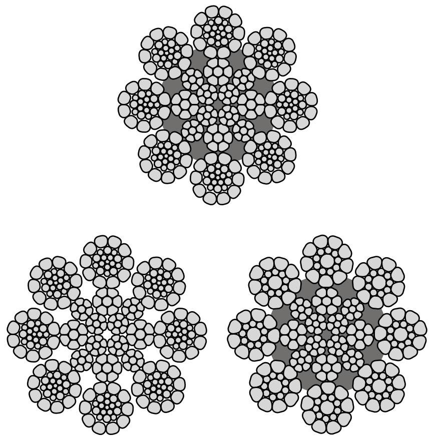
NOM. ROPE DIA. mm	NOM. ROPE DIA. in	APPROX. MASS kg/100m	MINIMUM BREAKING FORCE GALVANISED & UNGALVANISED ROPE GRADE			
			1960 N/mm²		2160 N/mm²	
			kN	tonnes	kN	tonnes
10		46.0	87.8	9.0	94	9.6
11		55.7	106.0	10.8	114	11.6
12		66.2	126.0	12.8	135	13.8
	1/2	74.2	142.0	14.5	152	15.5
13		77.7	148.0	15.1	159	16.2
14		90.2	172.0	17.5	184	18.8
15		104.0	198.0	20.2	211	21.5
16	5/8	118.0	225.0	22.9	241	24.6
17		133.0	254.0	25.9	272	27.7
18		149.0	284.0	29.0	304	31.0
19	3/4	166.0	317.0	32.3	339	34.6
20		184.0	351.0	35.8	376	38.3
22		223.0	425.0	43.3	455	46.4
	7/8	227.0	434.0	44.2	464	47.3
24		265.0	506.0	51.6	541	55.1
	1	297.0	567.0	57.8	606	61.8
26		318.0	594.0	60.6	635	64.7
28		368.0	688.0	70.1	737	75.1
	1 1/8	384.0	717.0	73.1	767	78.2
30		423.0	790.0	80.5	846	86.2
32	1 1/4	481.0	899.0	91.6	960	97.9
34		543.0	1013.0	103.0	1083	110.0
36		609.0	1138.0	116.0	1218	124.0
38	1 1/2	679.0	1268.0	129.0	1357	138.0
40		752.0	1405.0	143.0	1503	153.0
42		847.0	1535.0	156.0	1651	168.0
44		929.0	1700.0	173.0	1819	185.0
	1 3/4	948.0	1735.0	177.0	1856	189.0
46		1016.0	1858.0	189.0	1985	202.0
48		1106.0	2023.0	206.0	2162	220.0
50		1200.0	2200.0	224.0	2349	239.0
	2	1239.0	2266.0	231.0	2425	247.0
52		1298.0	2374.0	242.0	2541	259.0

* Mass per unit length of POWERFORM 8P increases by 3%

Note:
- Rope Sizes and Breaking Force not shown in the standard table, may be available on request and prior confirmation.
- POWERFORM 8P is available for rope diameter 16 mm and above on special request and prior confirmation.

POWERFORM® 8LS/8LPS

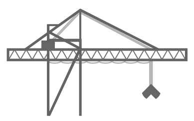
- Smoother contact surface in respect to conventional hoist ropes
- High resistance to side pressure and crushing
- Enhanced resistance to fleet angle if plastic impregnated



Standard Characteristics Powerform® 8LS/8LPS		
Construction	8xK19S 8xK26SW	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆

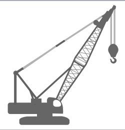
Typical Applications

GRAB UNLOADERS



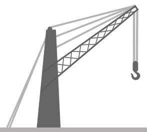
BOOM

CRAWLER CRANES



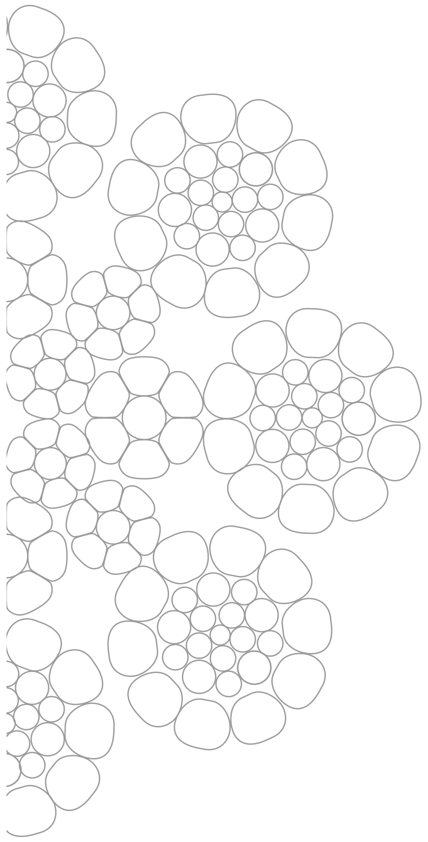
BOOM

HARBOUR CRANES



BOOM

LUFFING



Diameter		Metallic area		Mass		MBF		
mm	in.	MM²	in.²	kg/m	lb/ft	kN	tonnes	kips
13		92.1	0.143	0.761	0.511	162	16.5	36.5
14		107	0.166	0.882	0.593	188	19.2	42.3
15		123	0.190	1.01	0.680	216	22.0	48.6
	5/8	137	0.213	1.13	0.762	242	24.7	54.4
16		140	0.216	1.15	0.774	246	25.1	55.3
17		158	0.244	1.30	0.874	277	28.3	62.4
18		177	0.274	1.46	0.980	311	31.7	70.0
19	3/4	197	0.305	1.62	1.09	347	35.3	78.0
20		218	0.338	1.80	1.21	384	39.1	86.4
22		264	0.409	2.18	1.46	465	47.4	105
	7/8	269	0.417	2.22	1.49	474	48.3	107
24		314	0.487	2.59	1.74	553	56.4	124
25		335	0.520	2.81	1.89	594	60.5	134
	1	346	0.537	2.90	1.95	613	62.5	138
26		363	0.562	3.04	2.04	642	65.5	145
28		421	0.652	3.53	2.37	745	75.9	168
	1 1/8	438	0.679	3.67	2.47	776	79.1	175
30		483	0.749	4.05	2.72	855	87.2	192
	1 1/4	541	0.839	4.54	3.05	958	97.6	215

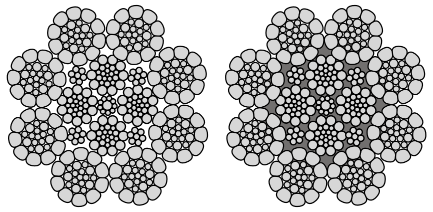
These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

MBF values are referred to 2160 grade, custom values are available on demand.

Abbreviated terms used in this brochure
XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

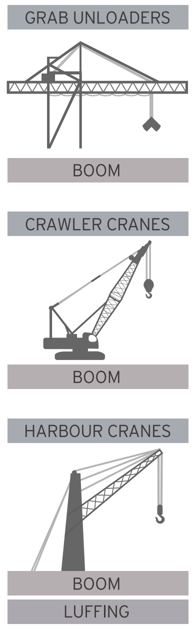
POWERFORM® 8XLS

- Smoother contact surface in respect to conventional hoist ropes
- High resistance to side pressure and crushing
- Enhanced resistance to fleet angle if plastic impregnated
- Extremely high MBF
- Enhanced radial stiffness and diameter stability
- High resistance to side pressure and crushing



Standard Characteristics Powerform® 8XLS		
Construction	8xK26SW 8xK31SW	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆

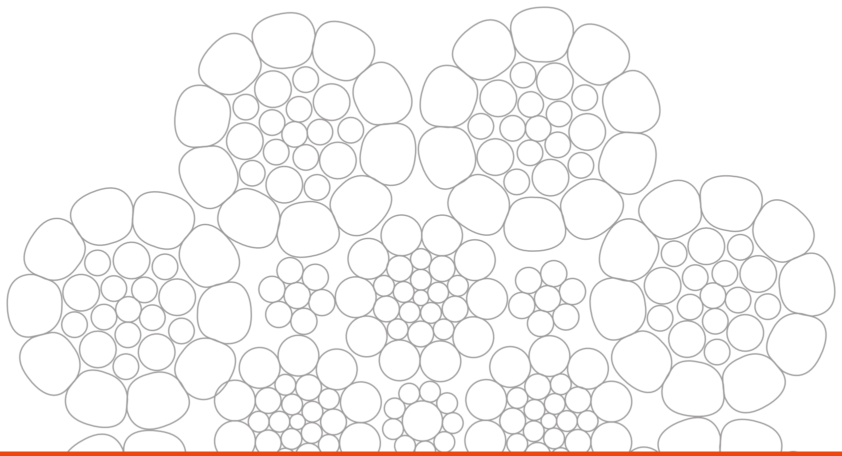
Typical Applications



Diameter		Metallic area		Mass		MBF		
mm	in.	MM^2	$in.^2$	kg/m	lb/ft	kN	tonnes	kips
10		57.7	0.089	0.490	0.329	102	10.4	23.0
11		69.8	0.108	0.593	0.398	123	12.6	27.8
12		83.1	0.129	0.706	0.474	147	15.0	33.1
	1/2	93.1	0.144	0.790	0.531	165	16.8	37.0
13		97.5	0.151	0.828	0.556	172	17.6	38.8
14		113	0.175	0.960	0.645	200	20.4	45.0
15		130	0.201	1.10	0.741	230	23.4	51.6
	5/8	145	0.225	1.23	0.830	257	26.2	57.8
16		148	0.229	1.25	0.843	261	26.6	58.8
17		167	0.259	1.42	0.952	295	30.0	66.3
18		187	0.290	1.59	1.07	331	33.7	74.4
19	3/4	208	0.323	1.77	1.19	368	37.5	82.9
20		231	0.358	1.96	1.32	408	41.6	91.8
22		279	0.433	2.37	1.59	494	50.3	111
	7/8	285	0.442	2.42	1.63	504	51.4	113
24		332	0.515	2.82	1.90	588	59.5	132
25		364	0.564	3.06	2.06	638	65.0	143
	1	375	0.582	3.16	2.12	658	67.1	148
26		393	0.610	3.31	2.23	690	70.3	155
28		456	0.707	3.84	2.58	800	81.5	180
	1 1/8	475	0.736	4.00	2.69	833	84.9	187
30		524	0.812	4.41	2.96	918	93.6	207
	1 1/4	586	0.909	4.94	3.32	1030	105	231

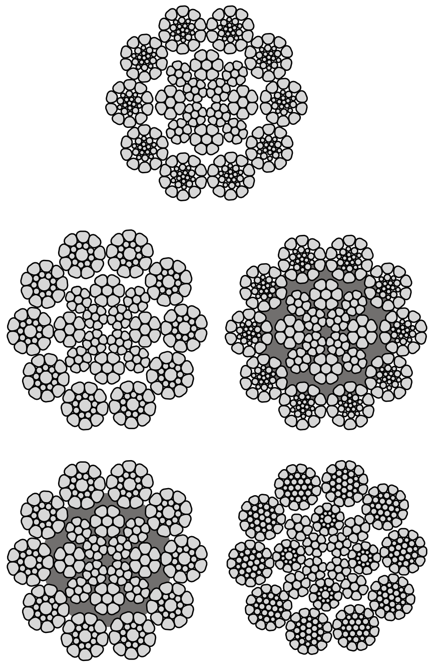
These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

MBF values are referred to 2160 grade, custom values are available on demand.



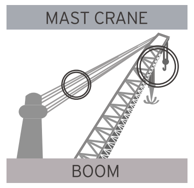
POWERFORM® 10MS/10MPS

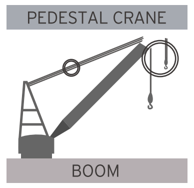
- Smoother contact surface in respect to conventional hoist ropes
- High resistance to side pressure and crushing
- Enhanced resistance to fleet angle if plastic impregnated
- Lower torque factor in respect to traditional hoist ropes
- High radial stiffness
- Excellent resistance to side pressure and crushing
- Enhanced resistance to fleet angles if plastic impregnated

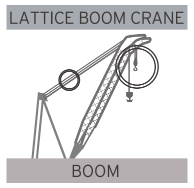


Standard Characteristics Powerform® 10MS/10MPS		
Construction	10xK19S 10xK26SW 10xK31SW	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆

Typical Applications

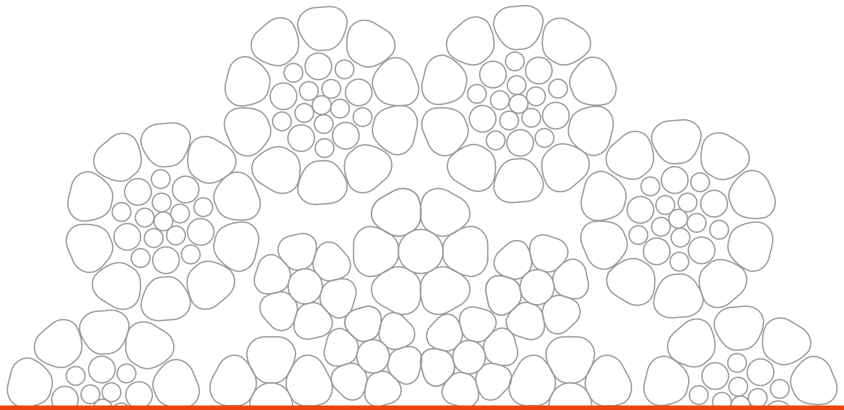






Diameter		Mass				MBF			
Metric	Imperial	Metric		Imperial		Force		Load	
		Air	Water	Air	Water	1770	1960	1770	1960
mm	in.	kg/m	kg/m	lb/ft	lb/ft	kN	kN	tonnes	tonnes
	1	3.03	2.58	2.04	1.74	568	619	57.9	63.1
26		3.18	2.70	2.14	1.82	595	649	60.7	66.2
28		3.68	3.13	2.48	2.11	690	753	70.3	76.8
	1 1/8	3.84	3.26	2.58	2.20	719	784	73.3	79.9
30		4.23	3.60	2.85	2.42	792	864	80.7	88.1
	1 1/4	4.74	4.03	3.19	2.71	887	968	90.4	98.7
32		4.81	4.09	3.24	2.75	901	983	91.8	100
34		5.43	4.62	3.66	3.11	1020	1110	104	113
35	1 3/8	5.73	4.87	3.86	3.28	1070	1170	109	119
36		6.09	5.18	4.10	3.49	1140	1240	116	126
38	1 1/2	6.79	5.77	4.57	3.88	1270	1390	129	142
40		7.52	6.39	5.06	4.30	1410	1540	144	157
41	1 5/8	8.01	6.81	5.39	4.58	1500	1620	153	165
42		8.29	7.05	5.58	4.74	1550	1680	158	171
44		9.10	7.73	6.13	5.21	1700	1840	173	188
	1 3/4	9.29	7.89	6.25	5.31	1740	1880	177	192
46		9.95	8.45	6.70	5.69	1860	2010	190	205
48	1 7/8	10.8	9.20	7.29	6.20	2030	2170	207	221
50		11.8	10.0	7.91	6.72	2200	2350	224	240
	2	12.1	10.3	8.17	6.94	2270	2430	231	248
52		12.7	10.8	8.56	7.27	2380	2540	243	259
54	2 1/8	13.7	11.6	9.23	7.84	2570	2740	262	279
56		14.7	12.5	9.92	8.44	2760	2950	281	301
58	2 1/4	15.8	13.4	10.6	9.05	2960	3130	302	319
60	2 3/8	17.1	14.5	11.5	9.79	3200	3380	326	345

These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.



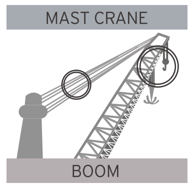
Abbreviated terms used in this brochure

XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

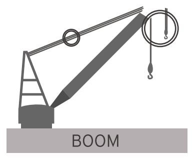
POWERFORM® 10MS/10MPS

Typical Applications

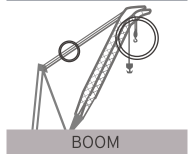
MAST CRANE



PEDESTAL CRANE



LATTICE BOOM CRANE

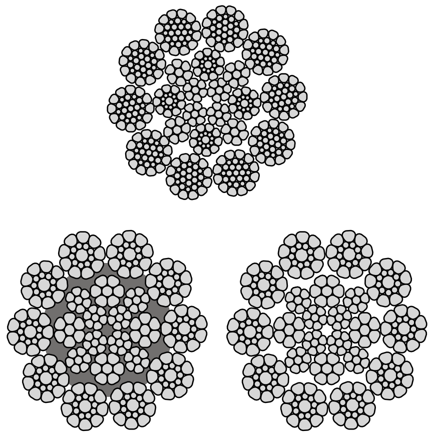


Diameter		Mass				MBF			
Metric	Imperial	Metric		Imperial		Force		Load	
mm	in.	Air kg/m	Water kg/m	Air lb/ft	Water lb/ft	1770 kN	1960 kN	1770 tonnes	1960 tonnes
62		18.1	15.4	12.2	10.3	3150	3570	321	364
64	2 1/2	19.3	16.4	13.0	11.0	3360	3810	343	388
66		20.5	17.4	13.8	11.7	3570	4050	364	413
	2 5/8	20.9	17.8	14.1	12.0	3650	4130	372	421
68		21.7	18.5	14.6	12.4	3790	4300	386	438
70	2 3/4	23.0	19.6	15.5	13.2	4020	4560	410	465
72		24.4	20.7	16.4	13.9	4250	4770	433	486
73	2 7/8	25.1	21.3	16.9	14.3	4370	4910	445	501
74		25.7	21.9	17.3	14.7	4490	5040	458	514
76		27.1	23.1	18.3	15.5	4740	5310	483	541
	3	27.3	23.2	18.4	15.6	4760	5340	485	544
77		27.9	23.7	18.8	15.9	4860	5450	495	556
80	3 1/8	30.1	25.6	20.3	17.2	5250	5890	535	600
82	3 1/4	32.0	27.2	21.6	18.3	5590	6270	570	639
84		33.2	28.2	22.3	19.0	5790	6490	590	662
86	3 3/8	34.8	29.5	23.4	19.9	6060	6800	618	693
88		36.4	30.9	24.5	20.8	6350	7050	647	719
90	3 1/2	38.1	32.4	25.6	21.8	6640	7370	677	751
92	3 5/8	39.8	33.9	26.8	22.8	6950	7710	708	786
94		41.5	35.3	28.0	23.8	7250	8040	739	820
95	3 3/4	42.6	36.2	28.7	24.4	7440	8170	758	833
96		43.3	36.8	29.2	24.8	7560	8290	771	845
98	3 7/8	45.5	38.7	30.7	26.1	7940	8620	809	879
100		47.0	40.0	31.6	26.9	8200	8900	836	907
102	4	48.9	41.6	32.9	28.0	8530	9260	870	944
104		50.8	43.2	34.2	29.1	8870	9410	904	959
105	4 1/8	51.8	44.0	34.9	29.7	9040	9590	922	978
106		52.8	44.9	35.6	30.2	9210	9780	939	997
108	4 1/4	54.8	46.6	36.9	31.4	9560	10000	975	1020
109		55.8	47.5	37.6	32.0	9740	10200	993	1040
110		56.9	48.3	38.3	32.5	9920	10400	1010	1060
112	4 3/8	59.0	50.1	39.7	33.7	10300	10700	1050	1090
114	4 1/2	61.4	52.2	41.3	35.1	10700	11000	1090	1120
115		62.2	52.8	41.8	35.6	10800	11100	1100	1130
117	4 5/8	64.9	55.1	43.7	37.1	11300	11600	1150	1180
119		66.6	56.6	44.8	38.1	11600	11900	1180	1210
120	4 3/4	68.4	58.2	46.1	39.2	11900	12100	1210	1230
122		70.0	59.5	47.1	40.0	12200	12400	1240	1260
124	4 7/8	72.3	61.4	48.7	41.4	12600	12800	1280	1300
125		73.4	62.4	49.4	42.0	12800	13000	1300	1330
126		74.6	63.4	50.2	42.7	13000		1330	
127	5	75.8	64.4	51.0	43.4	13200		1350	
128		77.0	65.5	51.8	44.1	13400		1370	
130	5 1/8	79.6	67.7	53.6	45.6	13900		1420	

These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

POWERFORM® 10S/10PS

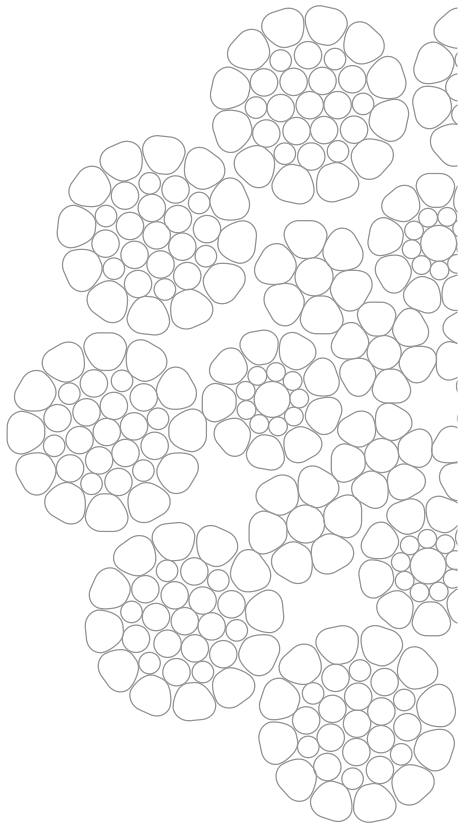
- Lower torque factor in respect to traditional hoist ropes
- High radial stiffness
- Excellent resistance to side pressure and crushing
- Enhanced resistance to fleet angles if plastic impregnated



Standard Characteristics Powerform® 10S/10PS		
Construction	10xK19S 10xK31SW	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆

Diameter		Mass				MBF			
Metric	Imperial	Metric		Imperial		Force		Load	
mm	in.	Air kg/m	Water kg/m	Air lb/ft	Water lb/ft	1770 kN	1960 kN	1770 tonnes	1960 tonnes
	1	3.03	2.58	2.04	1.74	561	613	57.2	62.5
26		3.18	2.70	2.14	1.82	588	642	59.9	65.4
28		3.68	3.13	2.48	2.11	682	745	69.5	75.9
	1 1/8	3.84	3.26	2.58	2.20	710	776	724	79.1
30		4.23	3.60	2.85	2.42	783	855	79.8	87.2
	1 1/4	4.74	4.03	3.19	2.71	877	958	89.4	97.7
32		4.81	4.09	3.24	2.75	891	973	90.8	99.2
34		5.43	4.62	3.66	3.11	1010	1100	103	112
35	1 3/8	5.73	4.87	3.86	3.28	1060	1160	108	118
36		6.09	5.18	4.10	3.49	1130	1230	115	125
38	1 1/2	6.79	5.77	4.57	3.88	1260	1370	128	140
40		7.52	6.39	5.06	4.30	1390	1520	142	155
41	1 5/8	8.01	6.81	5.39	4.58	1480	1600	151	163
42		8.29	7.05	5.58	4.74	1530	1660	156	169
44		9.10	7.73	6.13	5.21	1680	1820	171	186
	1 3/4	9.29	7.89	6.25	5.31	1720	1860	175	190
46		9.95	8.45	6.70	5.69	1840	1990	188	203
48	1 7/8	10.8	9.20	7.29	6.20	2000	2140	204	218
50		11.8	10.0	7.91	6.72	2180	2330	222	238
	2	12.1	10.3	8.17	6.94	2250	2400	229	245
52		12.7	10.8	8.56	7.27	2350	2510	240	256
54	2 1/8	13.7	11.6	9.23	7.84	2540	2710	259	276
56		14.7	12.5	9.92	8.44	2730	2920	278	298
58	2 1/4	15.8	13.4	10.6	9.02	2930	3090	299	315
60	2 3/8	17.1	14.5	11.5	9.79	3170	3350	323	341

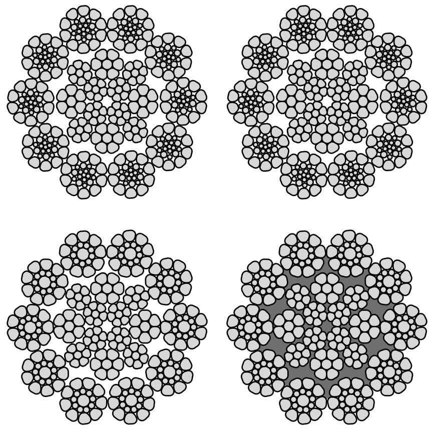
These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.



Abbreviated terms used in this brochure
XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

POWERFORM® 10LS/10LPS

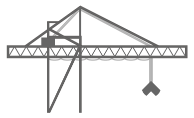
- Lower torque factor in respect to traditional hoist ropes
- Enhanced radial stiffness and diameter stability
- High resistance to side pressure and crushing
- Enhanced resistance to fleet angle if plastic impregnated



Standard Characteristics Powerform® 10LS/10LPS		
Construction	10xK19S 10xK26SW 10xK31SW	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆

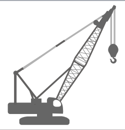
Typical Applications

GRAB UNLOADERS



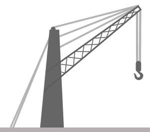
BOOM

CRAWLER CRANES



BOOM

HARBOUR CRANES



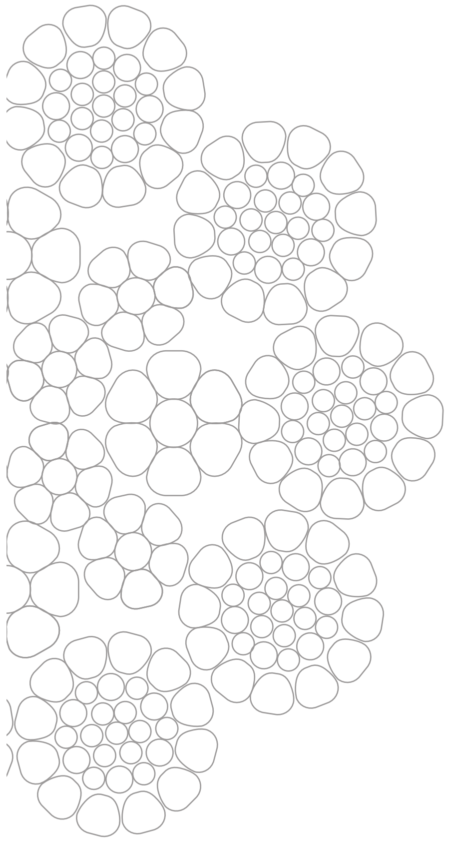
BOOM

LUFFING

Diameter		Metallic area		Mass		MBF		
mm	in.	MM^2	in.^{2}	kg/m	lb/ft	kN	tonnes	kips
32		572	0.887	4.61	3.10	963	98.1	217
34		646	1.00	5.20	3.50	1090	111	245
35	1 3/8	682	1.06	5.49	3.69	1150	117	258
36		724	1.12	5.83	3.92	1220	124	274
38	1 1/2	807	1.25	6.50	4.37	1360	138	305
40		894	1.39	7.20	4.84	1500	153	338
41	1 5/8	938	1.45	7.67	5.15	1600	163	360
42		971	1.51	7.94	5.33	1660	169	373
44		1070	1.65	8.71	5.85	1820	186	410
	1 3/4	1090	1.69	8.87	5.98	1860	189	418
46		1170	1.81	9.52	6.40	1990	203	448
48	1 7/8	1270	1.97	10.4	6.97	2170	221	487
50		1390	2.15	12.0	8.06	2350	240	529
	2	1430	2.22	12.4	8.32	2430	247	546
52		1500	2.33	13.0	8.72	2540	259	572
54	2 1/8	1620	2.51	14.0	9.41	2710	276	610
56		1740	2.70	15.1	10.1	2920	297	656
58	2 1/4	1870	2.89	16.2	10.9	3130	319	704
60	2 3/8	2020	3.13	17.5	11.7	3380	345	762

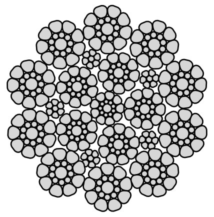
These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

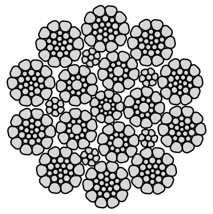
MBF values are referred to 2160 grade, custom values are available on demand.



POWERFORM® 10XLS

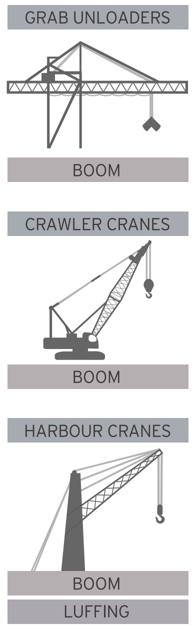
- Extremely high MBF and E modulus
- Enhanced radial stiffness and diameter stability
- High resistance to side pressure and crushing





Standard Characteristics Powerform® 10XLS		
Construction	10xK19S 10xK26SW	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆

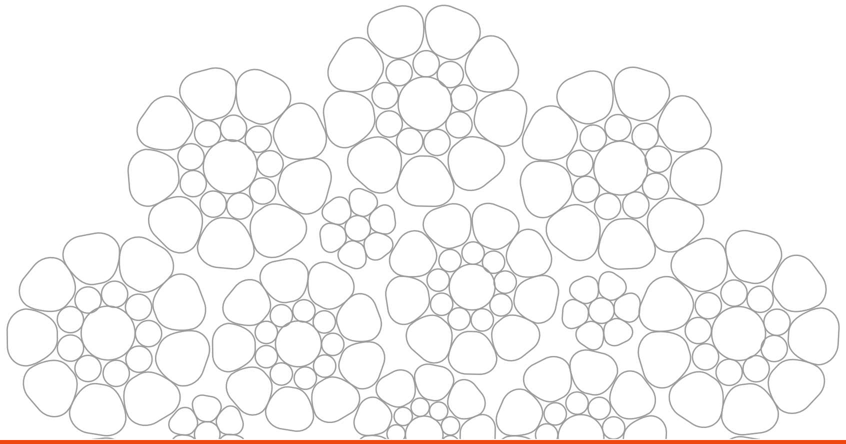
Typical Applications



Diameter		Metallic area		Mass		MBF		
mm	in.	MM^2	$in.^2$	kg/m	lb/ft	kN	tonnes	kips
32		627	0.971	5.12	3.44	1040	107	235
34		707	1.10	5.78	3.88	1180	120	265
35	1 3/8	746	1.16	6.10	4.10	1240	127	280
36		793	1.23	6.48	4.36	1320	135	297
38	1 1/2	884	1.37	7.22	4.85	1470	150	331
40		979	1.52	8.00	5.38	1630	166	367
41	1 5/8	1030	1.59	8.52	5.72	1740	177	391
42		1070	1.65	8.82	5.93	1800	183	405
44		1170	1.81	9.68	6.51	1970	201	444
	1 3/4	1190	1.85	9.88	6.64	2020	205	454
46		1280	1.98	10.6	7.11	2160	220	486
48	1 7/8	1390	2.16	11.5	7.74	2350	240	529
50		1510	2.34	12.5	8.40	2550	260	574
	2	1560	2.41	12.9	8.67	2630	268	592
52		1630	2.53	13.5	9.09	2730	278	615
54	2 1/8	1760	2.73	14.6	9.80	2920	297	656
56		1890	2.93	15.7	10.5	3140	320	706
58	2 1/4	2030	3.15	16.8	11.3	3330	339	749
60	2 3/8	2200	3.41	18.2	12.2	3600	367	811

These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

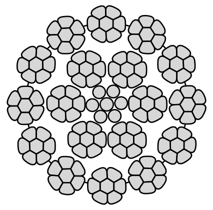
MBF values are referred to 2160 grade, custom values are available on demand.



Abbreviated terms used in this brochure
XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

POWERFORM® 18

- Powerform® 18 is a high strength rotation resistant hoist rope
- A sample of rope from each production batch is tested to destruction in order to confirm
- compliance with catalogue breaking force values
- Good resistance to rotation verified by testing on the in-house torque/turn machine
- Suitable for use on single part and multi-part hoist reeving systems
- High fatigue life resulting from the unique compaction process
- Increased resistance to crushing. Recommended for multi-layer spooling operations.
- Increased abrasion resistance resulting from the unique compaction process
- Fully lubricated in manufacturing



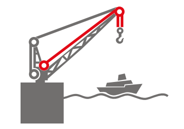
Standard Characteristics Powerform® 18		
Construction	6mm-19mm	18xK7(12xK7:6xK7-1x7)
	20mm-32mm	18xK19S(12xK19S:6xK19S-1x19S)
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆
Average Fill Factor (%)	66.3	
Turn value at 20% of breaking force degrees/rope lay	4	
Nominal rope lay length (NRD = Nominal Rope Diameter)	6.0 - 6.5 x NRD	
Discard Criteria	Refer to ISO 4309:1990	

Typical Applications

MOBILE

MAIN HOIST

DOCKSIDE



MAIN HOIST

OFFSHORE PEDESTAL

MAIN HOIST

WHIP HOIST

MAIN HOIST ■
WHIP HOIST ■

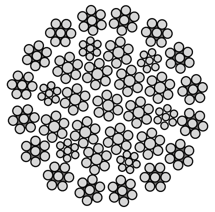
Note : For higher lifting heights consideration should be given to using a 35x7 construction with improved rotational characteristics.

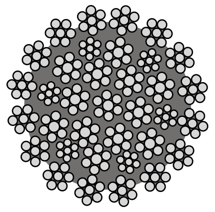
NOM. ROPE DIA. mm	NOM. ROPE DIA. in	APPROX. MASS kg/100m	MINIMUM BREAKING FORCE GALVANISED & UNGALVANISED ROPE GRADE 1960 N/mm² kN	1960 N/mm² tonnes	2160 N/mm² kN	2160 N/mm² tonnes
6		17.5	29.4	3.0		
7		23.8	38.0	3.9		
8		31.0	51.8	5.3		
9		39.3	64.6	6.6		
10		48.5	80.8	8.2		
11		58.7	101.0	10.3	111	11.3
12		69.8	116.0	11.8	127	12.9
	1/2	78.2	135.0	13.8	148	15.1
13		82.0	141.0	14.4	155	15.8
14		95.1	160.0	16.3	177	18.0
15		109.0	182.0	18.6	201	20.5
16	5/8	124.0	209.0	21.3	232	23.6
17		140.0	237.0	24.2	262	26.7
18		157.0	266.0	27.1	295	30.1
	3/4	175.0	291.0	29.7	322	32.8
20		194.0	320.0	32.6	359	36.6
22		235.0	379.0	38.6	424	43.2
	7/8	240.0	387.0	39.4	433	44.1
24		279.0	462.0	47.1	523	53.3
	1	313.0	517.0	52.7	585	59.6
26		328.0	542.0	55.2	613	62.5
28		380.0	632.0	64.4	710	72.4
30		437.0	721.0	73.5	809	82.5
32	1 1/4	497.0	820.0	83.6	920	93.8

Note: Rope Sizes and Breaking Force not shown in the standard table, may be available on request and prior confirmation.

HYFLEX 35/35P

- Hyflex 35 is a high strength flexible hoist rope
- Maximum resistance to rotation verified by testing on the in-house torque/turn machine
- Suitable for use on single part and multi-part hoist reeving systems
- Langs lay construction offers maximum resistance to wear
- A sample of rope from each production batch is tested to destruction in order to confirm breaking load
- Compliance with catalogue breaking force values
- Optional plastic impregnation (P) signifies full plastic impregnation of the steel core
- Fully lubricated in manufacturing

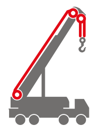




Standard Characteristics Hyflex 35		
Construction	35x7(16x7:6x7+6x7-6x7-1x7)	
Compacted	Yes	No
		◆
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
		◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆
Average Fill Factor (%)	63.5	
Turn value at 20% of breaking force degrees/rope lay	0.2	
Nominal rope lay length (NRD = Nominal Rope Diameter)	6.0 - 6.5 x NRD	
Discard Criteria	Refer to ISO 4309:1990	

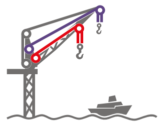
Typical Applications

MOBILE



MAIN HOIST

OFFSHORE PEDESTAL



MAIN HOIST

WHIP HOIST

MAIN HOIST ■

WHIP HOIST ■

NOM. ROPE DIA. mm	NOM. ROPE DIA. in	APPROX.* MASS kg/100m	MINIMUM BREAKING FORCE GALVANISED & UNGALVANISED ROPE GRADE 1960 N/mm² kN	1960 N/mm² tonnes	2160 N/mm² kN	2160 N/mm² tonnes
10		44.8	76	7.7	86.5	8.8
11		54.2	91	9.3	104.0	10.6
12		64.5	107	10.9	125.0	12.7
	1/2	72.0	123	12.5	137.0	14.0
13		76.0	128	13.0	146.0	14.9
14		88.0	148	15.1	168.0	17.1
16	5/8	115.0	194	19.8	221.0	22.5
18		145.0	242	24.7	277.0	28.2
19	3/4	162.0	277	28.2	312.0	31.8
20		179.0	301	30.7	337.0	34.4
21		198.0	335	34.1	370.0	37.7
22		217.0	370	37.7	412.0	42.0
	7/8	221.0	376	38.3	418.0	42.6
24		258.0	441	45.0	498.0	50.8
	1	289.0	491	50.1	546.0	55.7
26		303.0	517	52.7	581.0	59.2
28		351.0	599	61.1	681.0	69.4
	1 1/8	366.0	621	63.3	704.0	71.8
30		403.0	679	69.2	775.0	79.0
32	1 1/4	459.0	769	78.4	865.0	88.2
35	1 3/8	549.0	945	96.3	1044.0	106.0
36		581.0	983	100.0	1085.0	111.0
38	1 1/2	647.0	1078	110.0	1205.0	123.0
40		717.0	1202	123.0	1335.0	136.0
42		790.0	1227	125.0		
44		867.0	1347	137.0		
	1 3/4	885.0	1375	140.0		
46		948.0	1472	150.0		
48		1032.0	1603	163.0		
50		1120.0	1740	177.0		
	2	1156.0	1796	183.0		
52		1211.0	1881	192.0		

* Mass per unit length of HYFLEX 35P increases by approx. 3%

Note:
- HYFLEX 35P is available on special request and prior confirmation.
- Rope Sizes and Breaking Force not shown in the standard table, may be available on request and prior confirmation.

Abbreviated terms used in this brochure

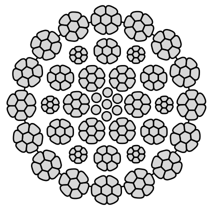
XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load

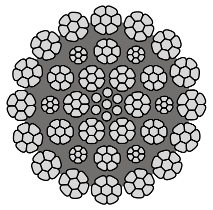
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

Brunton Wire Ropes FZCo.

POWERFORM® 35/35P

- Powerform® 35/35P has the highest strength of all low rotation hoist ropes
- A sample of rope from each production batch is tested to destruction in order to confirm compliance with catalogue breaking force values.
- Maximum resistance to rotation
- Suitable for use on single part and multi-part hoist reeving systems
- High fatigue life resulting from the unique compaction process
- Increased resistance to crushing. Recommended for multi-layer spooling operations.
- Increased abrasion resistance resulting from the unique compaction process
- Optional plastic impregnation. (P) signifies full plastic impregnation of the Steel Core.
- Fully lubricated in manufacturing
- Langs lay construction offers maximum resistance to wear

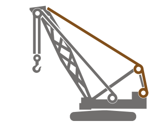




Standard Characteristics Powerform® 35/35P			
Construction	10mm-40mm	35xK7(16xK7:6xK7+6xK7-6xK7-1x7) 28xK7(16xK7: 4xK7+4xK7-4xK7)	
	42mm-60mm	35xK19S(16xK19S:6xK19S+6xK19S-6xK19S-1x19S)	
Compacted		Yes	No
		◆	
Tensile Grade		1960	2160
		◆	◆
Finish		Bright	Galvanised
		◆	◆
Lay Direction		Right Hand	Left Hand
		◆	◆
Lay Type		Ordinary	Langs
		◆	◆
Average Fill Factor (%)		74.5	
Turn value at 20% of breaking force degrees/rope lay		0.2	
Nominal rope lay length (NRD = Nominal Rope Diameter)		6.0 - 7.0 x NRD	
Discard Criteria		Refer to ISO 4309:1990	

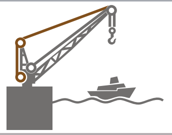
Typical Applications

LATTICE BOOM



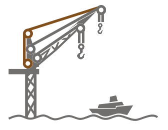
BOOM HOIST

DOCKSIDE



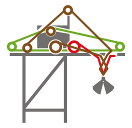
BOOM HOIST

OFFSHORE PEDESTAL



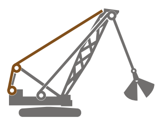
BOOM HOIST

UNLOADER



MAIN HOIST
BOOM HOIST
RACKING

SWIMGRAB

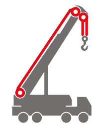


BOOM HOIST

BOOM HOIST ■
MAIN HOIST ■
RACKING/ TROLLEY ■

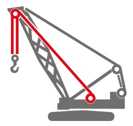
Typical Applications

MOBILE



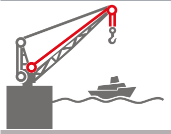
MAIN HOIST

LATTICE BOOM



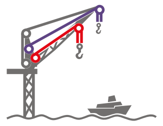
MAIN HOIST

DOCKSIDE



MAIN HOIST

OFFSHORE PEDESTAL



MAIN HOIST
WHIP HOIST

MAIN HOIST ■
WHIP HOIST ■

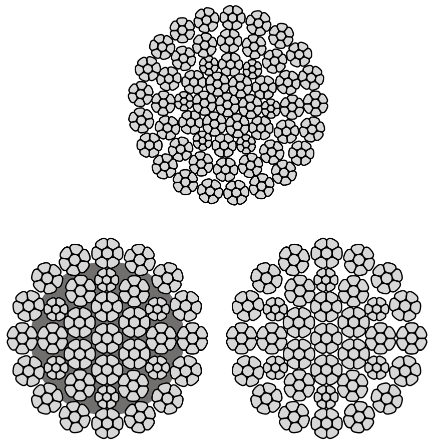
NOM. ROPE DIA. mm	NOM. ROPE DIA. in	APPROX.* MASS kg/100m	MINIMUM BREAKING FORCE GALVANISED & UNGALVANISED ROPE GRADE			
			1960 N/mm²		2160 N/mm²	
			kN	tonnes	kN	tonnes
	1/2	81.1	148	15.1	160	16.3
13		85.0	155	15.8	167	17.0
14		98.6	180	18.3	192	19.6
16	5/8	129	233	23.8	252	25.7
18		163	300	30.6	321	32.7
19	3/4	182	331	33.7	358	36.0
20		201	372	37.9	399	40.7
21		222	402	41.0	434	44.2
22		243	444	45.3	484	49.3
	7/8	249	453	46.2	490	49.9
24		290	531	54.1	572	58.3
	1	325	591	60.2	640	65.2
26		340	621	63.3	661	67.4
28		394	720	73.4	788	80.3
	1 1/8	411	748	76.2	810	82.6
30		453	827	84.3	904	92.2
32	1 1/4	515	944	96.2	1035	106.0
35	1 3/8	616	1125	115.0	1216	124.0
36		652	1185	121.0	1286	131.0
38	1 1/2	726	1326	135.0	1437	146.0
40		805	1477	151.0	1588	162.0
42		887	1485	151.0		
44		974	1618	165.0		
	1 3/4	994	1646	168.0		
46		1064	1765	180.0		
48		1159	1935	197.0		
50		1258	2078	212.0		
	2	1298	2150	219.0		
52		1360	2256	230.0		

* Mass per unit length of POWERFORM 35P increases by approx. 3%

Note:
- POWERFORM 35P is available on special request and prior confirmation.
- Rope Sizes and Breaking Force not shown in the standard table, may be available on request and prior confirmation.

POWERFORM® 35MPS/MS

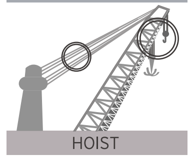
- Top class MBF to weight ratio
- Excellent diameter stability and radial stiffness
- Extended fatigue life and no ageing phenomenon
- Excellent corrosion resistance



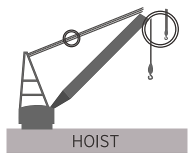
Standard Characteristics Powerform® 35MPS/35MS		
Construction	35xK7 56xK7	
Compacted	Yes	No
	◆	
Tensile Grade	1960	2160
	◆	◆
Finish	Bright	Galvanised
	◆	◆
Lay Direction	Right Hand	Left Hand
	◆	◆
Lay Type	Ordinary	Langs
	◆	◆

Typical Applications

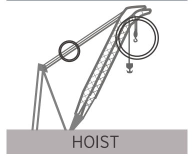
MAST CRANE



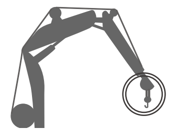
PEDESTAL CRANE



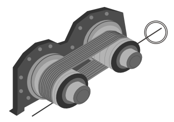
LATTICE BOOM CRANE



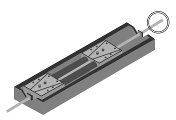
KNUCKLE BOOM CRANE



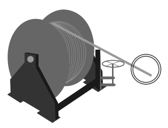
A&R - TRACTION WINCH



LINEAR WINCH



TUGGER WINCH



Diameter		Mass				MBF			
Metric	Imperial	Metric		Imperial		Force		Load	
mm	in.	Air kg/m	Water kg/m	Air lb/ft	Water lb/ft	1960 kN	2160 kN	1960 tonnes	2160 tonnes
	1	3.16	2.69	2.13	1.81	600	645	61.2	65.7
26		3.31	2.82	2.23	1.90	629	676	64.1	68.9
28		3.84	3.27	2.59	2.20	729	784	74.3	79.9
	1 1/8	4.00	3.40	2.69	2.29	759	817	77.4	83.3
30		4.41	3.75	2.97	2.52	837	900	85.3	91.7
	1 1/4	4.94	4.20	3.33	2.83	937	1010	95.5	103
32		5.02	4.26	3.38	2.87	952	1020	97.0	104
34		5.66	4.81	3.81	3.24	1080	1160	110	118
35	1 3/8	5.98	5.08	4.02	3.42	1130	1220	115	124
36		6.35	5.40	4.28	3.63	1210	1300	123	133
38	1 1/2	7.08	6.01	4.76	4.05	1340	1440	137	147
40		7.84	6.66	5.28	4.49	1490	1590	152	162
41	1 5/8	8.35	7.10	5.62	4.78	1580	1670	161	170
42		8.64	7.35	5.82	4.95	1640	1730	167	176
44		9.49	8.06	6.39	5.43	1800	1900	183	194
	1 3/4	9.68	8.23	6.52	5.54	1840	1920	188	196
46		10.4	8.81	6.98	5.93	1970	2050	201	209
48	1 7/8	11.3	9.60	7.60	6.46	2140	2230	218	227
50		12.3	10.4	8.25	7.01	2330	2400	238	245
	2	12.6	10.7	8.51	7.24	2400	2480	245	253
52		13.2	11.3	8.92	7.58	2510	2570	256	262
54	2 1/8	14.3	12.1	9.62	8.18	2710	2770	276	282
56		15.4	13.1	10.3	8.79	2920	2980	298	304
58	2 1/4	16.5	14.0	11.1	9.43	3130	3200	319	326
60	2 3/8	17.8	15.2	12.0	10.2	3130	3380	319	345
62		18.8	16.0	12.7	10.8	3310	3570	337	364
64	2 1/2	20.1	17.1	13.5	11.5	3520	3810	359	388
66		21.3	18.1	14.4	12.2	3750	4050	382	413
	2 5/8	21.8	18.5	14.7	12.5	3820	4130	389	421
68		22.7	19.3	15.3	13.0	3980	4300	406	439
70	2 3/4	24.0	20.4	16.2	13.7	4210	4560	429	465
72		25.4	21.6	17.1	14.5	4460	4820	455	491
73	2 7/8	26.1	22.2	17.6	15.0	4590	4960	468	506
74		26.8	22.8	18.1	15.4	4710	5090	480	519
76		28.3	24.1	19.1	16.2	4970	5370	507	547
	3	28.5	24.2	19.2	16.3	4990	5400	509	550
77		29.1	24.7	19.6	16.6	5100	5510	520	562
80	3 1/8	31.4	26.7	21.1	17.9	5500	5950	561	607
82	3 1/4	33.4	28.4	22.5	19.1	5860	6270	597	639
84		34.6	29.4	23.3	19.8	6070	6490	619	662
86	3 3/8	36.2	30.8	24.4	20.7	6360	6800	648	693
88		37.9	32.3	25.5	21.7	6600	7050	679	719
90	3 1/2	39.7	33.7	26.7	22.7	6970	7290	710	743
92	3 5/8	41.5	35.3	28.0	23.8	7290	7630	743	778
94		43.3	36.8	29.2	24.8	7600	7860	775	801
95	3 3/4	44.5	37.8	29.9	25.4	7800	7980	795	813
96		45.2	38.4	30.4	25.8	7930	8110	808	827
98	3 7/8	47.5	40.3	32.0	27.2	8330	8430	849	859
100		49.0	41.7	33.0	28.0	8600	8700	877	887

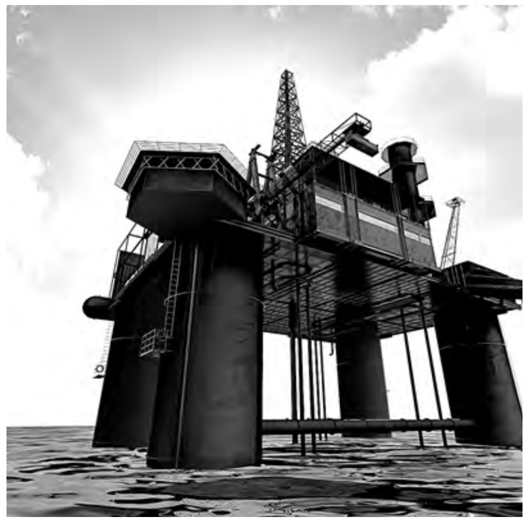
These figures are for guidance only. Other features, such as MBF, dimensions, lay type and plastic fill can be designed on request.

Abbreviated terms used in this brochure

XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

Brunton Wire Ropes FZCo.

TITAN ANCHOR MOORING & PENNANT ROPES



Anchor lines

Deteriorating Forces

- Heavy Loads in six degrees of freedom
- Cyclic loads (Tension & Bending)
- Corrosion
- Torque

Properties required

- High Strength
- Structural Rigidity
- Resistant to abrasion & fatigue
- High elasticity to absorb shock load
- Protection for corrosion

Pennant Ropes

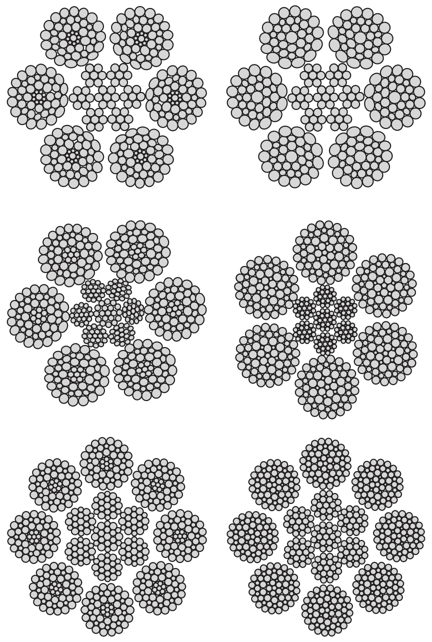
Deteriorating Forces

- Abrasion due to Drum/Sheave under heavy load
- Fatigue
- Corrosion

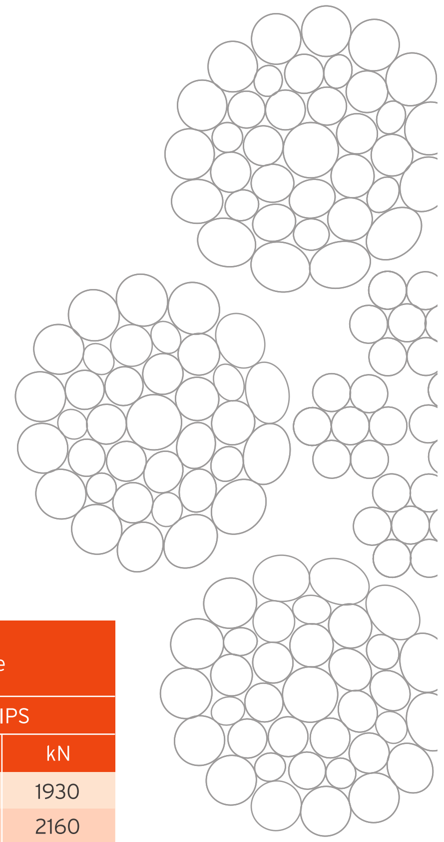
Properties required

Rope with Optimum balance between

- Toughness (Ruggedness) and Abrasion resistance
- Flexibility and fatigue resistance



Construction		Nominal Rope Diameter	
Rope	Strand Laid	in.	mm
6x36SW	14-(7+7)-7-1	2 to 3-1/4	52 to 83
6x41SW	16-(8+8)-8-1	2 to 3-3/8	52 to 87
6x49SWS	16-(8+8)-8-8-1	2 -3/8 to 3-1/4	60 to 83
6x52(46)SW	18-(9+9)-9/6-1	3-3/8 to 4-1/2	87 to 115
6x61SW	20-(10+10)-10-5F-5-1	4-3/4 to 5	121 to 127
8x52SW	18-(9+9)-9/6-1	4-3/4 to 5-1/4	121 to 134
8x61SW	20-(10+10)-10-5F-5-1	5-1/4 to 6	134 to 154



Conventional Rope

Nominal Rope Diameter		Approximate Mass				Minimum Breaking Force			
		lb/ft		kg/m		EIPS		EEIPS	
in.	mm	air	submerged	air	submerged	MT	kN	MT	kN
2.0	52	7.39	6.24	11.0	9.28	179	1760	197	1930
2 1/8	54	8.33	7.06	12.4	10.5	201	1970	220	2160
2 1/4	58	9.34	7.86	13.9	11.7	224	2200	247	2420
2 3/8	60	10.4	8.80	15.5	13.1	245	2400	274	2690
2 1/2	64	11.6	9.81	17.3	14.6	274	2690	301	2950
2 5/8	67	12.8	10.8	19.1	16.1	299	2930	330	3240
2 3/4	71	14.0	11.8	20.8	17.5	333	3270	360	3530
2 7/8	74	15.3	12.9	22.8	19.2	361	3540	392	3840
3.0	77	16.6	14.0	24.7	20.8	389	3810	424	4160
3 1/8	80	18.0	15.2	26.8	22.6	417	4090	458	4490
3 1/4	83	19.5	16.5	29.0	24.5	447	4380	493	4830
3 3/8	87	21.0	17.7	31.3	26.4	487	4780	528	5180
3 1/2	90	22.7	19.2	33.8	28.5	519	5090	563	5520
3 5/8	92	23.8	20.1	35.4	29.9	547	5360	598	5860
3 3/4	96	26.0	21.9	38.7	32.6	585	5740	639	6270
4.0	103	29.6	24.9	44.0	37.1	665	6520	647	6340

TITAN ANCHOR MOORING & PENNANT ROPES

Special Rope

Nominal Rope Diameter		Approximate Mass				Minimum Breaking Force					
		lb/ft		kg/m		TITAN		SUPER TITAN		TITAN MAX	
in.	mm	air	submerged	air	submerged	MT	kN	MT	kN	MT	kN
6 Strand Rope											
2.0	52	7.53	6.35	11.2	9.45	208	2040	227	2222		
2 1/8	54	8.54	7.19	12.7	10.7	234	2295	254	2492		
2 1/4	58	9.54	8.06	14.2	12.0	259	2540	282	2761		
2 3/8	60	10.6	8.87	15.7	13.2	287	2814	312	3063		
2 1/2	64	11.8	9.95	17.5	14.8	316	3099	343	3365		
2 5/8	67	13.0	11.0	19.3	16.3	346	3393	376	3689		
2 3/4	71	14.2	12.0	21.2	17.9	378	3707	410	4025		
2 7/8	74	15.6	13.2	23.2	19.6	411	4030	447	4382		
3.0	77	17.0	14.3	25.3	21.3	446	4373	484	4751	504	4940
3 1/8	80	18.4	15.5	27.4	23.1	480	4707	522	5121	543	5320
3 1/4	83	19.9	16.8	29.6	25.0	517	5070	562	5512	584	5730
3 3/8	87	21.5	18.1	32.0	27.0	542	5315	602	5903	626	6138
3 1/2	90	23.1	19.5	34.4	29.0	578	5668	642	6294	680	6665
3 5/8	92	24.7	20.8	36.8	31.0	611	5991	679	6662	710	6967
3 3/4	96	26.5	22.4	39.5	33.3	645	6325	717	7029	740	7255
4.0	103	29.8	25.1	44.4	37.4	726	7119	806	7908		
4 1/8	105	31.9	26.9	47.4	40.0	745	7305	828	8119		
4 1/4	108	33.7	28.4	50.2	42.3	819	8031	910	8928		
4 1/2	115	37.8	31.9	56.2	47.4	903	8855	1004	9845		
4 3/4	121	42.1	35.5	62.6	52.8	995	9757	1105	10840		
5	127	46.6	39.3	69.4	58.5	1101	10796	1224	12000		
8 Strand Rope											
4 3/4	121	43.1	36.4	64.1	54.1	995	9757	1105	10840		
5	127	47.7	40.3	71.0	59.9	1101	10796	1224	12000		
5 1/4	134	52.6	44.4	78.3	66.0	1238	12140				
5 1/2	140	57.7	48.7	85.9	72.4	1357	13310				
5 3/4	146	63.1	53.2	93.9	79.2	1485	14560				
6	154	68.5	57.8	102	86.0	1615	15840				

Note: * The Wire Rope conforms to the applicable sections of API Specification 9A.
** Rope weights are furnished above, considering lubrication during stranding only.
In case of full lubrication, 1.5% to be added in rope weight.

TITAN COMPACTED MOORING & ANCHOR LINES 6 STRAND ROPE

Anchor lines

Deteriorating Forces

- Heavy Loads in six degrees of freedom
- Cyclic loads (Tension & Bending)
- Corrosion
- Torque

Properties required

- High Strength
- Structural Rigidity
- Resistant to abrasion & fatigue
- High elasticity to absorb shock load
- Protection for corrosion

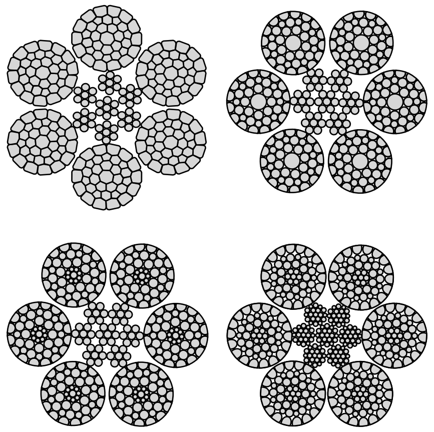
Deteriorating Forces

- Abrasion due to Drum/Sheave under heavy load
- Fatigue
- Corrosion

Properties required

Rope with Optimum balance between

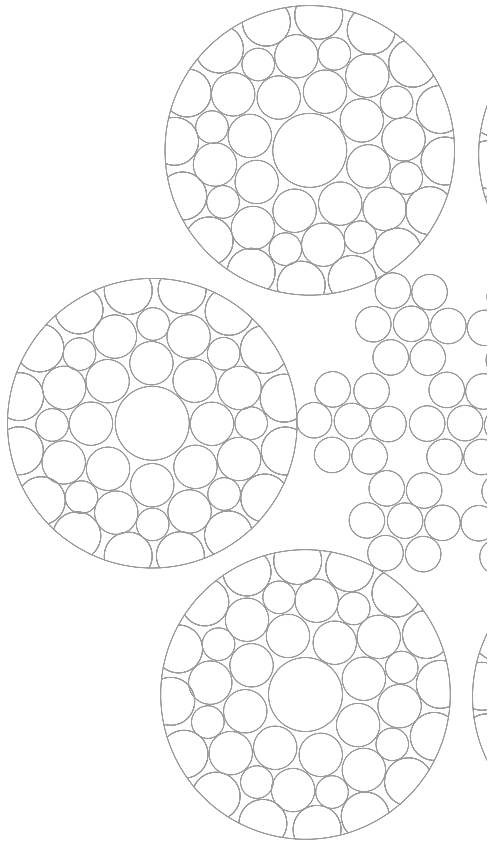
- Toughness (Ruggedness) and Abrasion resistance
- Flexibility and fatigue resistance



Construction	Nominal Rope Diameter	
Rope	in.	mm
6Kx36SW	2 to 2 1/4	52 to 58
6Kx41SW	2 to 2 1/4	52 to 58
6Kx49SW	2 3/8 to 3 1/4	60 to 83
6Kx52SW	3 3/8 to 4	87 to 103

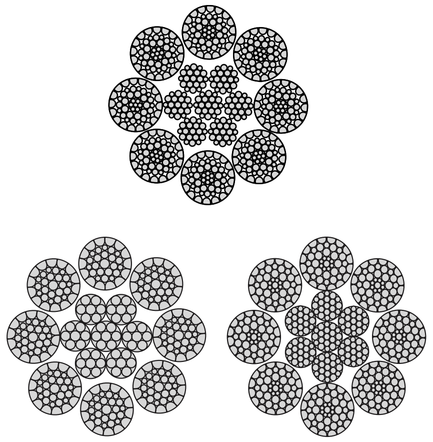
Nominal Rope Diameter		Approximate Mass				Minimum Breaking Force	
		lb/ft		kg/m			
in.	mm	air	submerged Wt	air	submerged Wt	MT	kN
2.0		7.80	6.57	11.6	9.78	234	2295
	52	8.20	6.92	12.2	10.3	245	2402
21/8	54	8.87	7.46	13.2	11.1	264	2589
	56	9.48	8.00	14.1	11.9	284	2785
2 1/4	58	9.95	8.40	14.8	12.5	296	2903
2 3/8	60	10.9	9.21	16.2	13.7	326	3197
2 1/2	64	12.2	10.3	18.2	15.3	365	3579
2 5/8	67	13.5	11.4	20.1	17.0	403	3952
2 3/4		14.8	12.5	22.0	18.6	443	4344
	71	15.3	12.8	22.7	19.1	457	4481
2 7/8		16.1	13.6	24.0	20.2	483	4736
	74	16.6	14.0	24.7	20.8	496	4864
3.0		17.6	14.9	26.2	22.1	526	5158
	77	17.9	15.1	26.7	22.5	537	5266
3 1/8	80	19.1	16.1	28.4	24.0	571	5599
3 1/4	83	20.7	17.5	30.8	26.0	618	6060
3 3/8		22.2	18.8	33.1	27.9	666	6531
	87	22.9	19.4	34.1	28.8	686	6727
3 1/2	90	23.9	20.2	35.6	30.0	716	7021
3 5/8	92	25.7	21.6	38.2	32.2	743	7286
3 3/4	96	27.6	23.3	41.0	34.6	797	7815
3 7/8		29.4	24.8	43.7	36.9	830	8139
4.0		31.3	26.4	46.6	39.3	885	8678
	103	32.1	27.1	47.8	40.3	909	8914

Note: The Wire Rope conforms to the applicable sections of API Specification 9A.



Abbreviated terms used in this brochure
XS - Lower Breaking Load | M - Medium Breaking Load | L - High Breaking Load | XL - Very High Breaking Load
F - Fibre Core | S - Steel Core | P - Plasticated Core | K - Compacted | SW - Seale Warrington Construction

TITAN COMPACTED MOORING & ANCHOR LINES & 8 STRAND ROPE



Anchor lines

Deteriorating Forces

- Heavy Loads in six degrees of freedom
- Cyclic loads (Tension & Bending)
- Corrosion
- Torque

Properties required

- High Strength
- Structural Rigidity
- Resistant to abrasion & fatigue
- High elasticity to absorb shock load
- Protection for corrosion

Deteriorating Forces

- Abrasion due to Drum/Sheave under heavy load
- Fatigue
- Corrosion

Properties required

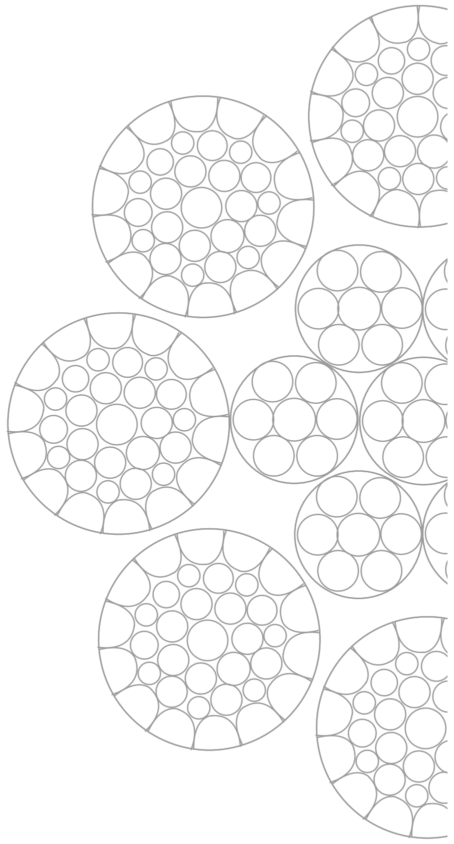
Rope with Optimum balance between

- Toughness (Ruggedness) and Abrasion resistance
- Flexibility and fatigue resistance

Construction	Nominal Rope Diameter	
Rope	in.	mm
8Kx36SW	2 to 2 3/4	52 to 68
8Kx49SW	2 7/8 to 3 7/8	71 to 96
8Kx52SW	4 - 5	103 to 127

Nominal Rope Diameter		Approximate Mass				Minimum Breaking Force	
		lb/ft		kg/m			
in.	mm	air	submerged	air	submerged	MT	kN
2.0		8.00	6.75	11.9	10.04	234	2295
	52	8.33	7.06	12.4	10.5	245	2402
2 1/8	54	9.01	7.59	13.4	11.3	265	2599
	56	9.68	8.13	14.4	12.1	285	2795
2 1/4	58	10.15	8.54	15.1	12.7	297	2912
2 3/8	60	11.2	9.41	16.6	14.0	327	3207
2 1/2	64	12.4	10.5	18.5	15.6	366	3589
2 5/8	67	13.8	11.6	20.5	17.3	404	3962
2 3/4		15.1	12.8	22.5	19.0	444	4354
	71	15.6	13.2	23.2	19.6	458	4491
2 7/8		16.5	13.9	24.5	20.7	484	4746
	74	16.9	14.3	25.2	21.3	497	4874
3.0	74	17.9	15.1	26.7	22.5	527	5168
	77	18.3	15.5	27.3	23.0	538	5276
3 1/8	80	19.5	16.5	29.0	24.5	572	5609
3 1/4	83	21.1	17.8	31.4	26.5	619	6070
3 3/8		22.7	19.2	33.8	28.5	667	6541
	87	23.4	19.8	34.8	29.4	687	6737
3 1/2	90	24.5	20.6	36.4	30.7	717	7031
3 5/8	92	25.6	21.6	38.1	32.1	721	7070
3 3/4	96	27.5	23.2	40.9	34.5	774	7590
3 7/8		29.3	24.7	43.6	36.8	806	7904
4		31.3	26.3	46.5	39.2	859	8423
	103	32.1	27.0	47.7	40.2	883	8659
4 1/8	105	33.2	28.0	49.4	41.7	914	8963
4 1/14	108	35.3	29.8	52.5	44.3	971	9522
4 1/2	115	39.5	33.3	58.8	49.6	1087	10659
4 3/4	121	44.1	37.2	65.6	55.3	1213	11895
5	127	48.8	41.1	72.6	61.2	1342	13160

Note: The Wire Rope conforms to the applicable sections of API Specification 9A.



DRILLING LINE CALCULATIONS

TITAN
Better Value for oil field operations

DRILLING LINE CALCULATIONS

Design/Service factor

Oil ropes service factors

Service Factor results from dividing the minimum breaking load of the rope by the real load on it.

The Service Factor is characteristic of each operation and plays an important role in implementing the run and cutoff program.

Line	SF recommended	SF minimum allowed
Drilling line	5	3 in deep drilling 2 when setting casing
Sand line	5	3
Mast raising line	5	2.5
Auxiliary hoisting winch rope	5	3 (not recommended)
Winch truck rope	5	API does not specify. Experience indicates a minimum of 2.5 with extreme precautions.

Source: API RP 9b Standard

The Design/ Service factor should be determined by the following formula:

Equation (1)

Design/ Service Factor=B/W

where –
B is the nominal strength of the wire rope, lb;
W is the fast line tension

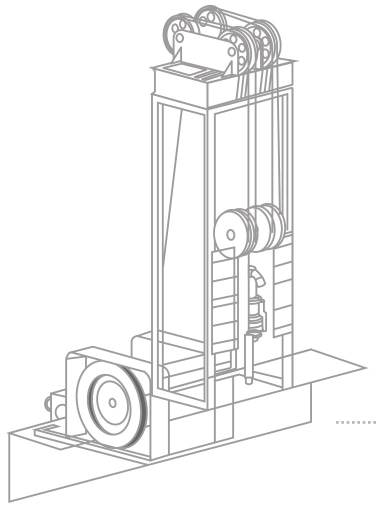
#When a wire rope is operated close to the minimum Design/ Service factor, care should be taken that the rope and related equipment are in good operating condition. At all times, the operating personnel should use diligent care to minimize shock, impact and acceleration or deceleration of loads. Successful field operations indicate that the Design/ Service factors in Table 1 should be regarded as minimum.

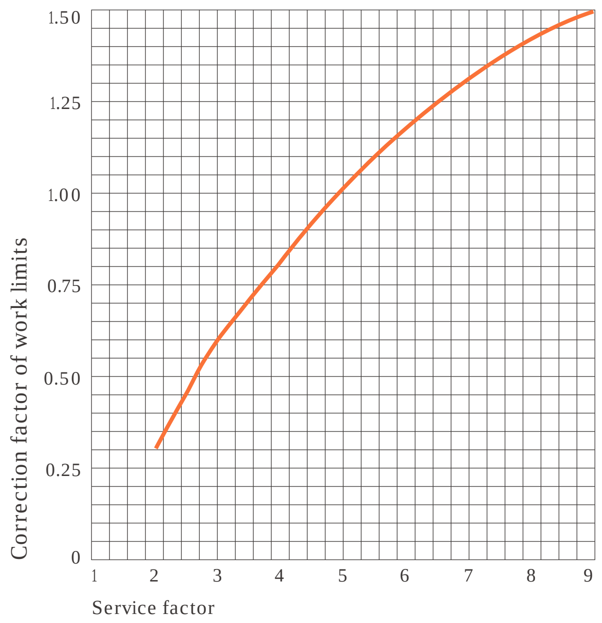
Table 1 – Minimum Design Factors

Operation	Minimum Design Factor
Sand line	3
Rotary drilling line	3
Hoisting service other than rotary drilling	3
Mast raising and lowering line	2.5
Rotary drilling line when setting casing	2
Pulling on stuck pipe and similar infrequent operations	2

Correction factor for T- mile at different Design/Service factor

Wire rope life varies with the Design/ Service factor; therefore, longer rope life can generally be expected when relatively high Design/ Service factors are maintained.





Calculation of Design/Service factor

To calculate the Design/ Service factor for multipart string-ups, use Chart 1 and 2 (on next page) to determine the value of W.

W is the fast line tension and equals the fast line factor times the hook load or weight indicator reading.

Note: The fast line factor is calculated considering the tensions needed to overcome sheave-bearing friction.

EXAMPLE

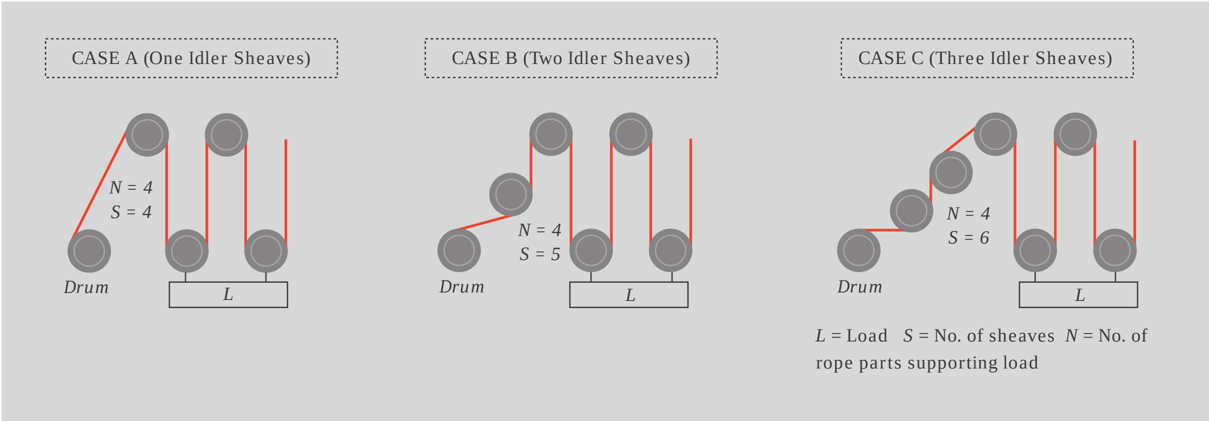
Drilling Line = 1 3/8 in. (35 mm) EIPS

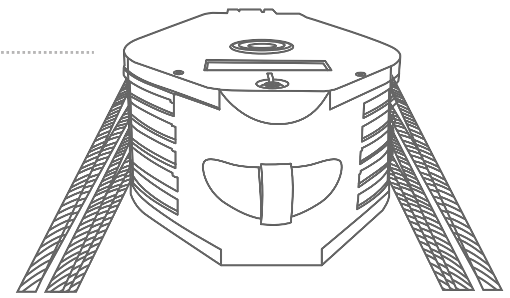
Number of Lines = 10

Hook Load = 400,000 lb (181.4t)

Sheaves are roller bearing type. From Chart 2, Case A, the fast line factor is 0.123. The fast line tension is then 400,000 lb (181.4t) 0.123 = 49,200 lb (22.3t) W. Following the formula in Equation 1, the Design/ Service factor is then the nominal strength of 1-3/8 inch (35 mm) EIPS drilling line divided by the fast line tension or 192,000 lb (87.1t) ÷ 49,200 lb (22.3t) = 3.9.

When working near the minimum Design/Service factor, consideration should be given to the efficiencies of wire rope bent around sheaves, fittings or drums. Chart 1 shows how rope can be affected by bending.





DRILLING LINE CALCULATIONS

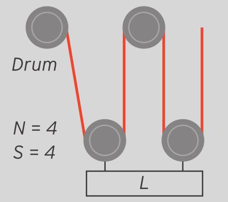
N	Plain Bearing Sheaves K = 1.09*						Roller Bearing Sheaves K = 1.04*					
	Efficiency			Fast Line Factor			Efficiency			Fast Line Factor		
	Case A	Case B	Case C	Case A	Case B	Case C	Case A	Case B	Case C	Case A	Case B	Case C
2	0.880	0.807	0.740	0.568	0.620	0.675	0.943	0.907	0.872	0.530	0.551	0.573
3	0.844	0.774	0.710	0.395	0.431	0.469	0.925	0.889	0.855	0.360	0.375	0.390
4	0.810	0.743	0.682	0.309	0.336	0.367	0.907	0.873	0.839	0.275	0.287	0.298
5	0.778	0.714	0.655	0.257	0.280	0.305	0.890	0.856	0.823	0.225	0.234	0.243
6	0.748	0.686	0.629	0.223	0.243	0.265	0.874	0.840	0.808	0.191	0.198	0.206
7	0.719	0.660	0.605	0.199	0.217	0.236	0.857	0.824	0.793	0.167	0.173	0.180
8	0.692	0.635	0.582	0.181	0.197	0.215	0.842	0.809	0.778	0.149	0.154	0.161
9	0.666	0.611	0.561	0.167	0.182	0.198	0.826	0.794	0.764	0.134	0.140	0.145
10	0.642	0.589	0.540	0.156	0.170	0.185	0.811	0.780	0.750	0.123	0.128	0.133
11	0.619	0.568	0.521	0.147	0.160	0.175	0.796	0.766	0.736	0.114	0.119	0.123
12	0.597	0.547	0.502	0.140	0.152	0.166	0.782	0.752	0.723	0.107	0.111	0.115
13	0.576	0.528	0.485	0.134	0.146	0.159	0.768	0.739	0.710	0.100	0.104	0.108
14	0.556	0.510	0.468	0.128	0.140	0.153	0.755	0.725	0.698	0.095	0.098	0.102
15	0.537	0.493	0.452	0.124	0.135	0.147	0.741	0.713	0.685	0.090	0.094	0.097
16	0.520	0.477	0.437	0.120	0.131	0.143	0.728	0.700	0.673	0.086	0.089	0.093
17	0.503	0.461	0.423	0.117	0.128	0.139	0.716	0.688	0.662	0.082	0.085	0.089
18	0.486	0.446	0.409	0.114	0.124	0.136	0.703	0.676	0.650	0.079	0.082	0.085
19	0.471	0.432	0.396	0.112	0.122	0.133	0.691	0.665	0.039	0.076	0.079	0.082
20	0.456	0.419	0.384	0.110	0.119	0.130	0.680	0.653	0.628	0.074	0.077	0.080

Chart 1 – Efficiency of Wire Rope Reeving for Multiple Sheave Blocks Cases A, B and C (Fast Line and Efficiency Factors for Derricks, Booms etc.)

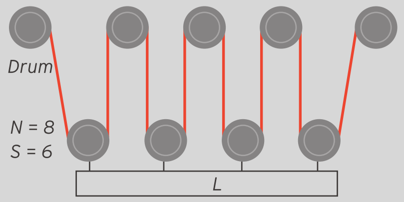
Note: These cases apply also where the rope is dead ended at the lower or travelling block or derrick floor after passing over a dead sheave in the crown.

(*) In these tables, the K-factor for seave friction is 1.09 for plain bearings and 1.04 for roller bearings. Other K-factors can be used if recommended by the equipment manufacturer.

CASE D – Single Drum



CASE E – Double Drum With Equalizer



L = Load

S = No. of sheaves (not counting equalizer)

N = No. of rope parts supporting load

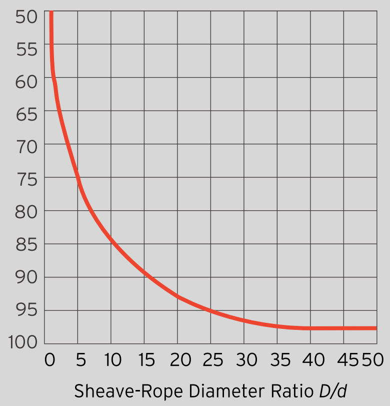
N	Plain Bearing Sheaves K = 1.09*				Roller Bearing Sheaves K = 1.04*			
	Efficiency		Fast Line Factor		Efficiency		Fast Line Factor	
	Case D	Case E	Case D	Case E	Case D	Case E	Case D	Case E
2	0.959	1.000	0.522	0.500	0.981	1.000	0.510	0.500
3	0.920		0.362		0.962		0.346	
4	0.883	0.959	0.283	0.261	0.944	0.981	0.265	0.255
5	0.848		0.236		0.926		0.216	
6	0.815	0.920	0.205	0.181	0.909	0.962	0.183	0.173
7	0.784		0.182		0.892		0.160	
8	0.754	0.883	0.166	0.142	0.875	0.944	0.143	0.132
9	0.726		0.153		0.859		0.129	
10	0.700	0.848	0.143	0.118	0.844	0.926	0.119	0.108
11	0.674		0.135		0.828		0.110	
12	0.650	0.815	0.128	0.102	0.813	0.909	0.102	0.092
13	0.628		0.123		0.799		0.096	
14	0.606	0.784	0.118	0.091	0.785	0.892	0.091	0.080
15	0.586		0.114		0.771		0.086	
16	0.566	0.754	0.110	0.083	0.757	0.875	0.083	0.071
17	0.548		0.107		0.744		0.079	
18	0.530	0.726	0.105	0.077	0.731	0.859	0.076	0.065
19	0.513		0.103		0.719		0.073	
20	0.498	0.700	0.101	0.071	0.707	0.844	0.071	0.059

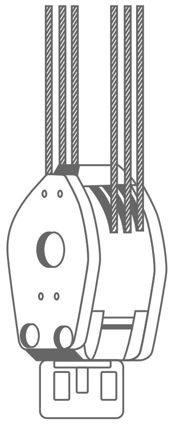
Chart 2 – Efficiency of Wire Rope Reeving for Multiple Sheave Blocks Cases D and E (Fast Line and Efficiency Factors for Derricks, Booms, Etc.)

Note: These above cases apply also where the rope is dead ended at the lower or travelling block or derrick floor after passing over a dead sheave in the crown.

(*) In these tables, the K-factor for seave friction is 1.09 for plain bearings and 1.04 for roller bearings. Other K-factors can be used if recommended by the equipment manufacturer.

Chart 3 – Efficiencies of Wire Ropes Bent Around Stationary Sheaves (Static Stresses Only)





Evaluation of Rotary Drilling Line

Total Service Performed

The total service performed by a rotary drilling line can be evaluated by taking into account the amount of work done by the line in the various drilling operations (drilling, coring, fishing, setting casing etc.), and by evaluating such factors as the stresses imposed by acceleration and deceleration loadings, vibration stresses, stresses imposed by friction forces of the line in contact with drum and sheave surfaces and other even more indeterminate loads. However, for comparative purposes, an approximate evaluation can be obtained by computing only the work done by the line in raising and lowering the applied loads in making round trips and in the operations of drilling, coring, setting casing, and short trips.

Round-trip Operations

Most of the work done by a drilling line is that performed in making round trips (or half-trips) involving running the string of drill pipe into the hole and pulling the string out of the hole. The amount of work performed per round trip should be determined by use of the following formula:

Equation (2)

$$T_r = \frac{D(L_s + D)W_m}{10,560,000} + \frac{D\left(M + \frac{1}{2}C\right)}{2,640,000}$$

where
Tr is the ton-miles [weight in tons (2,000 lb) times distance moved in miles]
D is the depth of hole, in ft
L_s is the length of drill-pipe stand, in ft
N is the number of stands of drill-pipe
W_m is the effective (buoyed) weight per foot of drill-pipe in drilling fluid, in lb/ft
M is the total weight of traveling block-elevator assembly and top drive (if used), in lb
C is the effective (buoyed) weight of drill collar assembly in drilling fluid minus the effective (buoyed) weight of the same length of drill-pipe in drilling fluid, in lb/ft.

The formula for ton-miles per round trip as earlier is based on the following derivation:

In making a round trip, work is done in raising and lowering the traveling block assembly and in running and pulling the drill stem, including the drill collar assembly and bit. The calculations are simplified by considering the drill pipe as extending to the bottom of the hole and making separate calculations for the excess weight of the drill collar-bit assembly over that of the same length of drill pipe.

In running the string, the traveling block assembly, which includes the traveling block, hook, links, and elevator (weight M), moves a distance equal (approximately) to twice the length of the stand (2Ls), for each stand. The amount of work done is equal to 2MLsN. In pulling the string, a similar amount of work is done; therefore, the total amount of work done in moving the traveling block assembly, during one complete round trip is equal to 4MLsN. Because the drill pipe is assumed to extend to the bottom of the hole, making LsN equal to D, the total work can be expressed as 4DM in pound-feet or

Equation (3)

$$\frac{4DM}{5280 \times 2000}, \text{ In ton-miles}$$

In lowering the drill pipe into the hole, the amount of work done is equal to the average of the weights lowered times the distance (D). The average weight is equal to one-half the sum of one stand of drill pipe (the initial load) plus the weight of N stands (the final load). Since the weight of the drill pipe is decreased by the buoyant effect of the drilling fluid, an allowance must be made for buoyancy. The work done in pound-feet is therefore equal to 1/2 (Wm Ls + Wm Ls N)D, or 1/2 (Wm Ls + Wm Ls D)D

Assuming the friction loss is the same in going into the hole as in coming out, the work done in raising the drill pipe is the same as in lowering, so for a round trip, the work done in ton-miles is equal to Equation (4).

Equation (4)

$$\frac{DW_s(L_s + D)}{5280 \times 2000}$$

Because the drill collars and bit weigh more per foot than drill pipe, a correction factor must be introduced for the added work done in lowering and lifting this assembly. This amount is equal to the excess weight of the drill collar assembly, including subs and bits (C), times and distance moved (D). For a round trip the work done (in ton-miles) would be

Equation (5)

$$\frac{2 \times C \times D}{5280 \times 2000}$$

The total work done in making a round trip would be equal to the sum of the amounts expressed in Equations (3), (4), and (5); namely

Equation (6)

$$T_r = \frac{4DM}{5280 \times 2000} + \frac{DW_m(L_s + D)}{5280 \times 2000} + \frac{2CD}{5280 \times 2000}$$

This can be rewritten as

or

Equation (7)

$$T_r = \frac{D(L_s + D)W_m}{5280 \times 2000} + \frac{4D\left(M + \frac{1}{2}C\right)}{5280 \times 2000}$$

Drilling Operations

The ton-miles of work performed in drilling operations is expressed in terms of work performed in making round trips, since there is a direct relationship as illustrated in the following cycle of drilling operations:

a. drill ahead length of the kelly
b. pull up length of the kelly
c. ream ahead length of the kelly
d. pull up length of the kelly to add single or double
e. put kelly in rat hole
f. pick up single or double
g. lower drill stem in hole
h. pick up kelly

Analysis of the cycle of operations shows that for any one hole, the sum of all operations (a) and (b) is equal to one round trip; the sum of all operations (c) and (d) is equal to another round trip; the sum of all operations (g) is equal to one-half a round trip; and the sum of all operations (e), (f), and (h) may, and in this case does, equal another one-half round trip, thereby making the work of drilling the hole equivalent to three round trips to bottom. This relationship can be expressed as follows:

Equation (8)

$$T_d = 3(T_2 - T_1)$$

where
T_d is the ton-miles drilling
T_1 is the ton-miles for one round trip at depth D1 (depth where drilling started after going in hole, in ft)
T_2 is the ton-miles for one round trip at depth D2 (depth where drilling stopped before coming out of hole, in ft)

If operations c and d are omitted, then formula 8 becomes:

Equation (9)

$$T_d = 2(T_2 - T_1)$$

If a top drive is used, formula 8 becomes:

Equation (10)

$$T_d = T_2 - T_1$$

If reaming is done between connections with a top drive then formula 8 becomes:

Equation (11)

$$T_d = 2(T_2 - T_1)$$

Coring Operations

The ton-miles of work performed in coring operations, as for drilling operations, is expressed in terms of work performed in making round trips, since there is a direct relationship that is illustrated in the following cycle of coring operations:

a. core ahead length of core barrel
b. pull up length of kelly
c. put kelly in rat hole
d. pick up single
e. lower drill stem in hole
f. pick up kelly

Analysis of the cycle of operation shows that for any one hole the sum of all operations (a) and (b) is equal to one round trip; the sum of all operations (e) is equal to one-half a round trip; and the sum of all operations (c), (d), and (f) may, and in this case does, equal another one-half round trip, thereby making the work of drilling the hole equivalent to two round trips to bottom. This relationship can be expressed as follows:

Equation (12)

$$T_c = 2(T_4 - T_3)$$

where
T_c is the ton-miles coring

T_3 is the ton-miles for one round trip at depth, D3 (depth where coring started after going in hole, in ft)

T_4 is the ton-miles for one round trip at depth D4 (depth where coring stopped before coming out of hole, in ft)

Note: Extended coring operations are ordinarily not encountered.

Setting Casing Operations

The calculation of the ton-miles for the operation of setting casing should be determined as in 4.2, as for drill pipe, but with the effective weight of the casing being used, and with the result being multiplied by one-half, since setting casing is a one-way (1/2 round-trip) operation. Ton-miles for setting casing can be determined from the following formula:

Equation (13)

Since no excess weight for drill collars need be considered, this formula becomes:

Equation (14)

where

Ts is the ton-miles setting casing

Lcs is the length of joint of casing, in ft

Wcm is the effective weight per foot of casing, in lb.

The effective weight per foot of casing, Wcm, may be calculated as

Wcm = Wca (1 - 0.015B)

where
Wca is the weight per foot of casing in air, in lb;
B is the weight of drilling fluid, in lb/gal.

Short Trip Operations

The ton-miles of work performed in short trip operations, as for drilling and coring operations, is also expressed in terms of round trips. Analysis shows that the ton-miles of work done in making a short trip is equal to the difference in round trip ton-miles for the two depths in question. This can be expressed as follows:

Equation (15)

TST = T6 -T5

where
TST is the ton-miles for short trip
T5 is the ton-miles for one round trip at depth D5 (shallower depth)
T6 is the ton-miles for one round trip at depth D6 (deeper depth)

Other Operations

There are other operations that work the drilling line that need to be accounted for in the ton-mile accumulation. They include operations such as: motion compensation devices, working casing, setting casing with landing string, jarring, pulling on stuck pipe and running riser.

Evaluation of Service

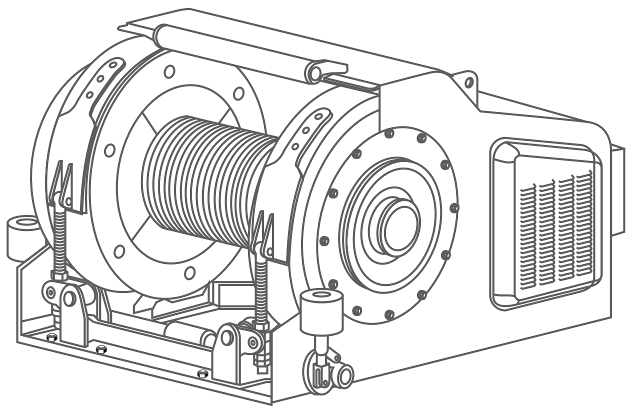
For comparative evaluation of service from rotary drill lines, the ton miles for all operations should be totalled. Divide the total ton miles by the length of drill line purchased minus the string-up length.

Rotary Drilling Line Ton-Mile Calculators

Drilling contractors and wire rope manufactures use or supply different calculators that utilize the API formulas to calculate ton-miles for the different rig operations

Rotary Drilling Line Service Record Form

Chart next is an example of a drilling line service record form. The form should be modified to conform to the needs of the drilling contractor.



ROTARY DRILLING LINE SERVICE RECORD

Sheet .... of .... Sheets

Company .... Well and No.. Rig No.. Make and Type DWKS

Drum Diam........................ Plain or Crown Block Travelling Block Wt. of Travelling Block Size and Weight

Grooved Drum .... Sheave Diam .... Sheave Diam .... Assembly (Factor "M") .... Drill Pipe

Make of Line .... Size and Length .... Construction ....Grade ....Reel No..................................

Date Line Date Line Retired No. of Lines Initial 1st Change 2nd Change Well Depth When 1st Change 2nd Change

Put Into Service.................................. from Service .... Strung .... String-Up Increased ....

....

....

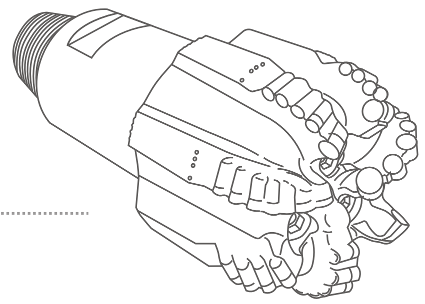
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
						Drill Collars											
Date	Trip No.	Depth of Trip	Orientation to be Performed & Remarks	Mud Weight ib/gal	Effective Wt. of Pipe Fig. 13	O.D. and Bore	Effective Wt., E Flf.14	Excessive Wt. (Col.8 Minus Col.6)	No. of Feet	Factor C (Col. 9-Co.10)	Factor M +1/2 C	Ton-Mile Service This Operation Fig.12	Cumulative Ton-Miles Since Last Slip	Length of Line Slipped, ft.	cumulative Ton-Miles Since Last Cutoff	Length Line Cutoff ft.	Length Line Remaining ft.

Ton-Miles service Ton-Miles Service on Ton-Miles Service Ton-Miles Service Ton-Miles Service

Previous Wells .... Trips......This Well .... Drilling .... This well .... Coring .... This Well .... Setting Casing .... This Well

Total Ton Miles Ton Miles per ft of Directions for filling out this form, including use of charts, are given in the instruction sheets included with each pad, and are

Service-All Wells.................... Initial Length



Cutoff Practice for Rotary Drilling Lines

Service Life

The service life of drilling lines can be greatly increased by the use of a planned cutoff program. A cutoff program removes the most heavily worn wire rope from the string-up by introducing new rope from the storage reel into the system. Using only visual inspection to determine when to cutoff will result in uneven wear, trouble with spooling (line "cutting in" on the drum), and long cuts - thus decreasing the wire rope's service life. A cutoff program, based on accumulated ton-miles, should be used.

Initial Length of Line

The relationship between initial lengths of rotary lines and their normal service life expectancies is shown in chart. Possible savings by the use of a longer line may be offset by an increased cost of handling for a longer line.

Service Goal

The most accurate goal is based on past records of a rig or from similar rigs using the same size drill line and having the same diameter drawworks drum. The goal should be selected by agreement between the drilling contractor and the drill line manufacturer. The goal can be adjusted after each drill line is replaced.

An initial T-Mile goal for different drill line sizes based on drum diameter (T-Mile table given). The diameter of the sheaves may be taken into considerations to slightly adjust the goal.

Variations in Line Services

The T-Mile goals are for normal operations when the drill line is operated around a Design/ Service factor of 5. Continued operations with Design/ Service factors higher than 7.0 or lower than 4.0 will affect the service life of the drill line. The T-Mile goal may have to be lowered to prevent a long cut.

Cutoff Length

The following factors should be considered in determining a cutoff length.

- Load pick up points from reeving diagram
- Drum diameter and crossover point on the drum
- Maximum ton miles accumulated between cuts

Care should be taken to prevent the duplication of crossover points of the drum. This can be accomplished by adding 1/8 of a drum circumference. Cut off lengths should be based on the service goal. The ton-miles accumulated since the last cut divided by the service goal equals the length of the rope to cut. Do not cut the same length each time or make cuts that are multiples of the distance between sheave pick-up points.

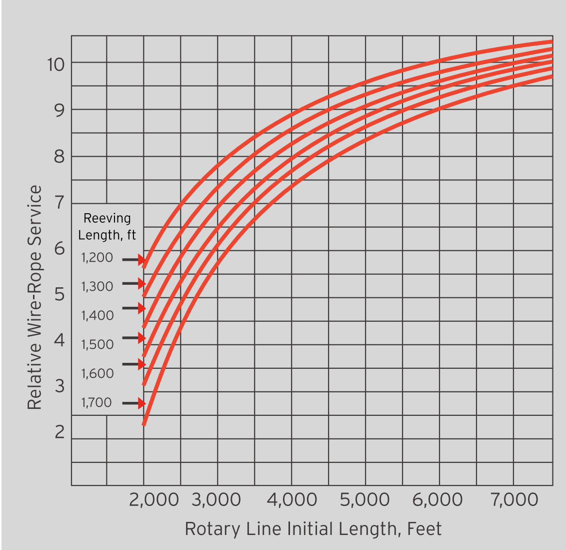
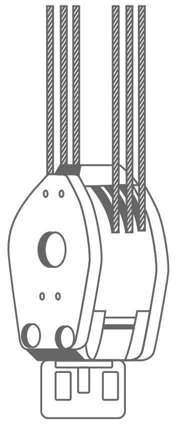


Chart – Relationship between Rotary-line Initial Length and Service Life



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Brunton Wire Ropes FZCo.

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 2

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 2

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	2	4							18
483	2	4							19
508	3	4							20
533	3	4							21
559	3	4							22
584	3	4	5						23
610	3	4	5	7					24
635	3	4	6	7					25
660	4	4	6	7					26
686	4	5	6	7					27
711		5	6	7					28
737		5	6	7					29
762		5	6	8	8				30
787			6	8	8				31
813			7	8	9				32
838			7	8	9				33
864			7	8	10				34
889				8	10				35
914				9	10	11	12		36
1067						12	14	14	42
1219							15	16	48
1524								18	60
1829								20	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 3

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	4	5							18
483	4	5							19
508	4	5							20
533	4	6							21
559	4	6							22
584	5	6	8						23
610	5	6	8	10					24
635	5	6	8	10					25
660	5	7	8	10					26
686	5	7	9	11					27
711		7	9	11					28
737		7	9	11					29
762		8	10	11	12				30
787			10	11	13				31
813			10	12	13				32
838			10	12	14				33
864			11	13	14				34
889				13	15				35
914				13	15	17	18		36
1067						17	20	22	42
1219							22	23	48
1524								27	60
1829								30	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 4

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	5	7							18
483	5	7							19
508	6	7							20
533	6	8							21
559	6	8							22
584	6	8	10						23
610	6	8	10	14					24
635	6	8	11	14					25
660	7	9	11	14					26
686	7	10	12	14					27
711		10	12	14					28
737		10	12	14					29
762		10	13	15	16				30
787			13	15	17				31
813			14	16	18				32
838			14	16	18				33
864			14	17	19				34
889				17	20				35
914				18	20	22	24		36
1067						23	27	29	42
1219							30	31	48
1524								36	60
1829								40	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 5

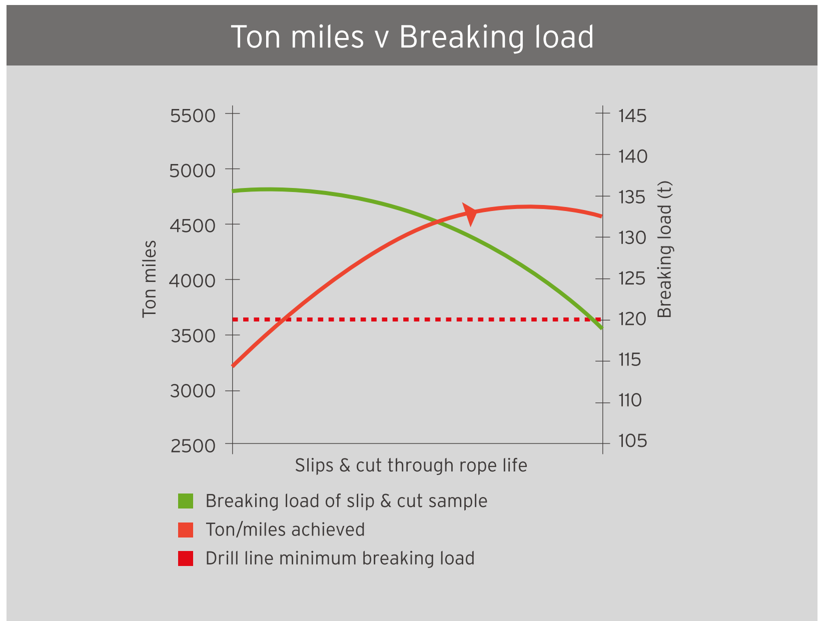
Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	6	9							18
483	6	9							19
508	7	9							20
533	7	10							21
559	7	10							22
584	8	10	13						23
610	8	10	13	17					24
635	8	10	14	17					25
660	9	11	14	17					26
686	9	12	15	18					27
711		12	15	18					28
737		12	15	18					29
762		13	16	19	20				30
787			16	19	21				31
813			17	20	22				32
838			17	20	23				33
864			18	21	24				34
889				21	25				35
914				22	25	28	30		36
1067						29	34	36	42
1219							37	39	48
1524								45	60
1829								50	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 6

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	7	11							18
483	7	11							19
508	8	11							20
533	8	12							21
559	8	12							22
584	10	12	16						23
610	10	12	16	20					24
635	10	12	17	20					25
660	11	13	17	20					26
686	11	14	18	22					27
711		14	18	22					28
737		14	18	22					29
762		16	19	23	24				30
787			19	23	25				31
813			20	24	26				32
838			20	24	28				33
864			22	25	29				34
889				25	30				35
914				26	30	34	36		36
1067						35	41	43	42
1219							44	47	48
1524								54	60
1829								60	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 7

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	8	13							18
483	8	13							19
508	10	13							20
533	10	14							21
559	10	14							22
584	11	14	18						23
610	11	14	18	24					24
635	11	14	20	24					25
660	13	15	20	24					26
686	13	17	21	25					27
711		17	21	25					28
737		17	21	25					29
762		18	22	27	28				30
787			22	27	29				31
813			24	28	31				32
838			24	28	32				33
864			25	29	34				34
889				29	35				35
914				31	35	39	42		36
1067						41	48	50	42
1219							52	55	48
1524								63	60
1829								70	72



RECOMMENDED GUIDELINES FOR ROPES

Brunton Wire Ropes FZCo.

A good steel wire rope can give good performance only when Practices are good.

Practices mean

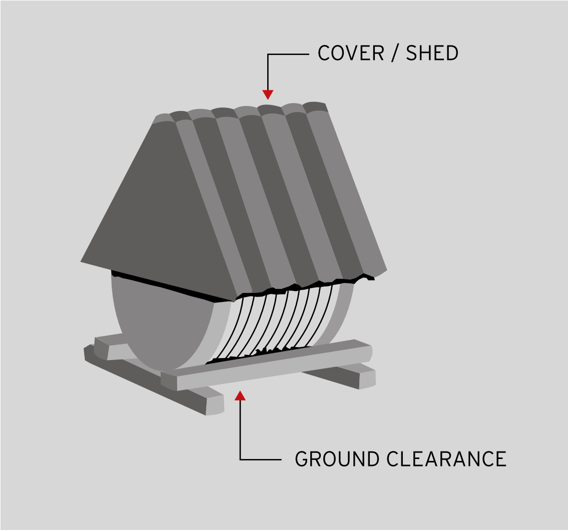
- *Correct selection of rope*
- *Correct manufacturer of rope*

Practices are

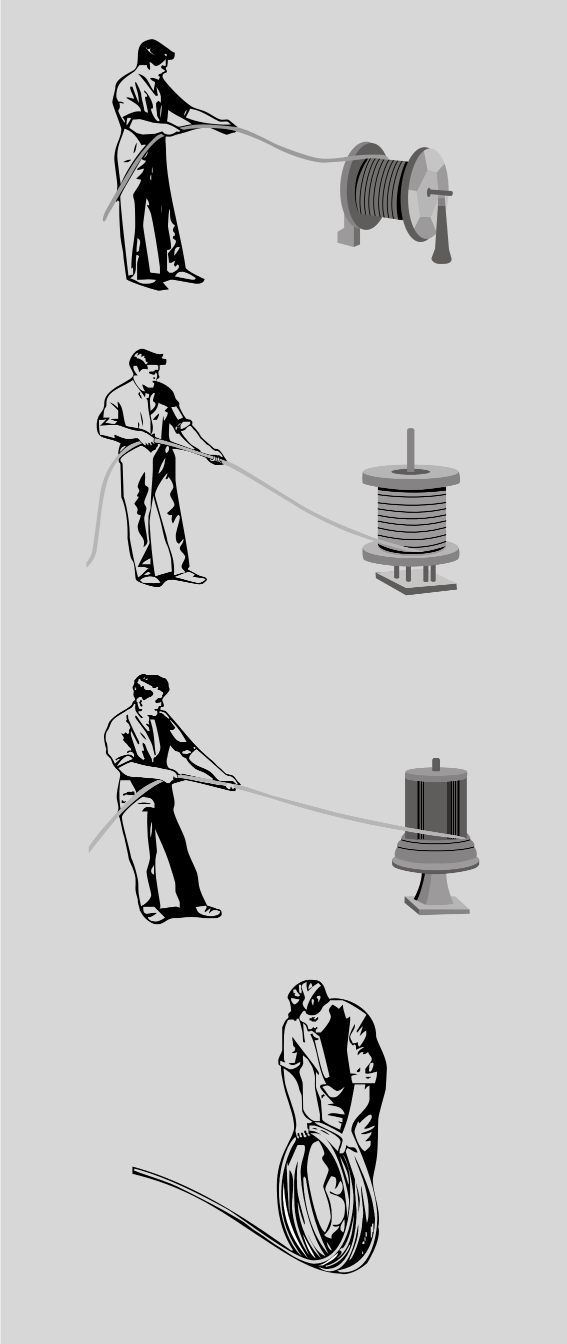
- *Correct storage of rope*
- *Correct Handling of rope*
- *Correct Installation of rope*
- *Correct Inspection of rope*
- *Correct Maintenance of rope*
- *Correct Performance tracking of rope*

STORAGE

- Unwrap the rope and examine the rope immediately after delivery
- Check the rope diameter
- Examine any rope terminations and compatibility with equipment
- Select a clean, well ventilated, dry, undercover location.
- Cover with waterproof material if the delivery site conditions preclude inside storage
- Ensure that the rope does not make any direct contact with the floor and that there is a flow of air under the reel
- Rotate the reel periodically during long periods of storage, particularly in warm environments, to prevent migration of the lubricant from the rope.
- Ensure that the rope does not make any direct contact with the floor and that there is a flow of air under the reel
- Ensure that the rope is stored where it is not likely to be affected by chemical fumes, steam or other corrosive agents and accidents.



HANDLING



Handling of reel

- **Use of Binding or Lifting Chain**

  When handling wire rope on a reel with a binding or lifting chain, wooden blocks should always be used between the rope and the chain to prevent damage to the wire or distortion of the strands in the rope.
- **Use of Bars**

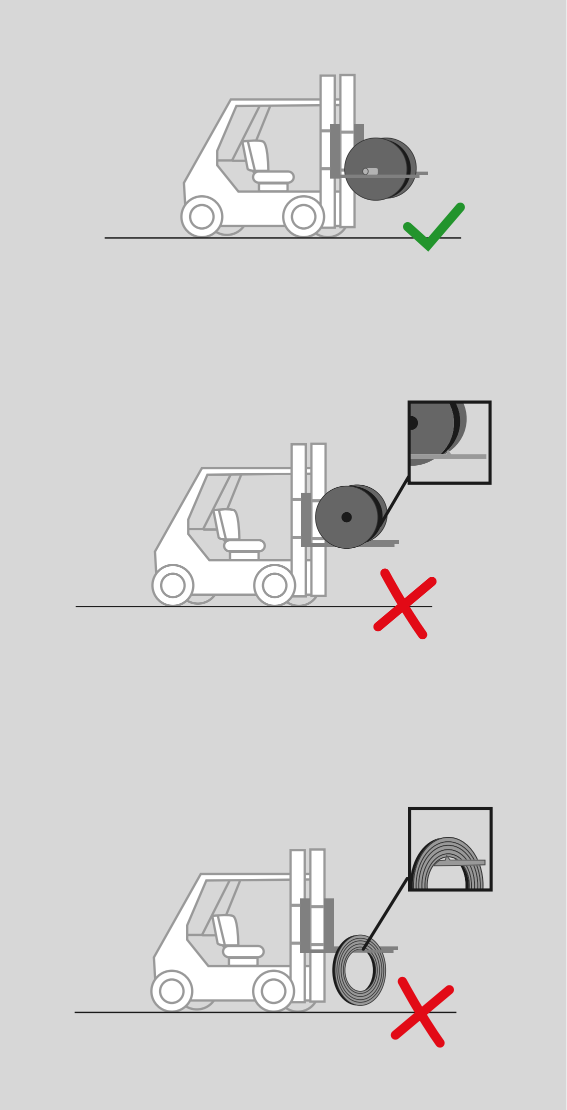
  Bars for moving the reel should be used against the reel flange, and not against the rope.
- **Sharp Objects**

  The reel should not be rolled over or dropped on any hard, sharp object in such a manner that the rope will be bruised or nicked.
- **Dropping**

  The reel should not be dropped from a truck or platform. This may cause damage to the rope as well as break the reel.
- **Mud, Dirt, or Cinders**

  Rolling the reel in or allowing it to stand in any medium harmful to steel such as mud, dirt, or cinders should be avoided. Planking or cribbing will be of assistance in handling the reel as well as in protecting the rope against damage.

HANDLING DURING INSTALLATION



Stringing of Blocks

Blocks should be strung to give a minimum of wear against the sides of sheave grooves.

Changing Lines and Cutoff

It is good practice in changing lines to suspend the traveling block from the crown on a single line. This tends to limit the amount of rubbing on guards or spacers, as well as chances for kinks. This practice is also very effective in pull-through and cut-off procedure.

Rotation of Reel

The reel should be set up on a substantial horizontal axis so that it is free to rotate as the rope is pulled off, and in such a position that the rope will not rub against derrick members or other obstructions while being pulled over the crown. A snatch block with a suitable size sheave should be used to hold the rope away from such obstructions.

Jacking

The use of a suitable apparatus for jacking the reel off the floor and holding it so that it can turn on its axis is desirable.

Tension on Rope

Tension should be maintained on the wire rope as it leaves the reel by restricting the reel movement. A timber or plank provides satisfactory brake action. When winding the wire rope on the drum, sufficient tension should be kept on the rope to assure tight winding.

Swivel-Type Stringing Grip

When a worn rope is to be replaced with a new one, the use of a swivel-type stringing grip for attaching the new rope to the old rope is recommended. This will prevent transferring the twist from one piece of rope to the other. Care should be taken to see that the grip is properly applied. The new rope should not be welded to the old rope to pull it through the system.

Kinking

Care should be taken to avoid kinking a wire rope since a kink can be cause for removal of the wire rope or damaged section.

Striking with Hammer

Wire ropes should not be struck with any object such as a steel hammer, derrick hatchet, or crow bar which may cause unnecessary nicks or bruises.

Even when a soft metal hammer is used, it should be noted that a rope can be damaged by such blows. Therefore, when it is necessary to crowd wraps together, any such operation should be performed with the greatest of care; and a block of wood should be interposed between the hammer and rope.

Cleaning

The use of solvent may be detrimental to a wire rope. If a rope becomes covered with dirt or grit, it should be cleaned with a brush.

Excess or Dead Wraps

After properly securing the wire rope in the drum socket, the number of excess or dead wraps or turns specified by the equipment manufacturer should be maintained.

New Wire Rope

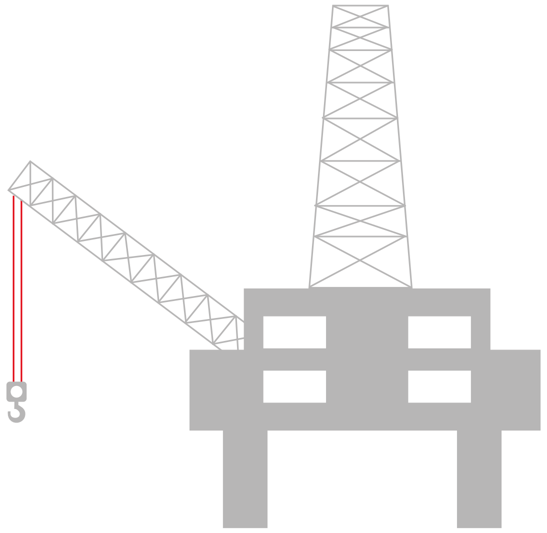
Whenever possible, a new wire rope should be run under controlled loads and speeds for a short period after it has been installed. This will help to adjust the rope to working conditions.

New Coring or Swabbing Line

If a new coring or swabbing line is excessively wavy when first installed, two to four sinker bars may be added on the first few trips to straighten the line.

Lubrication of Wire Rope

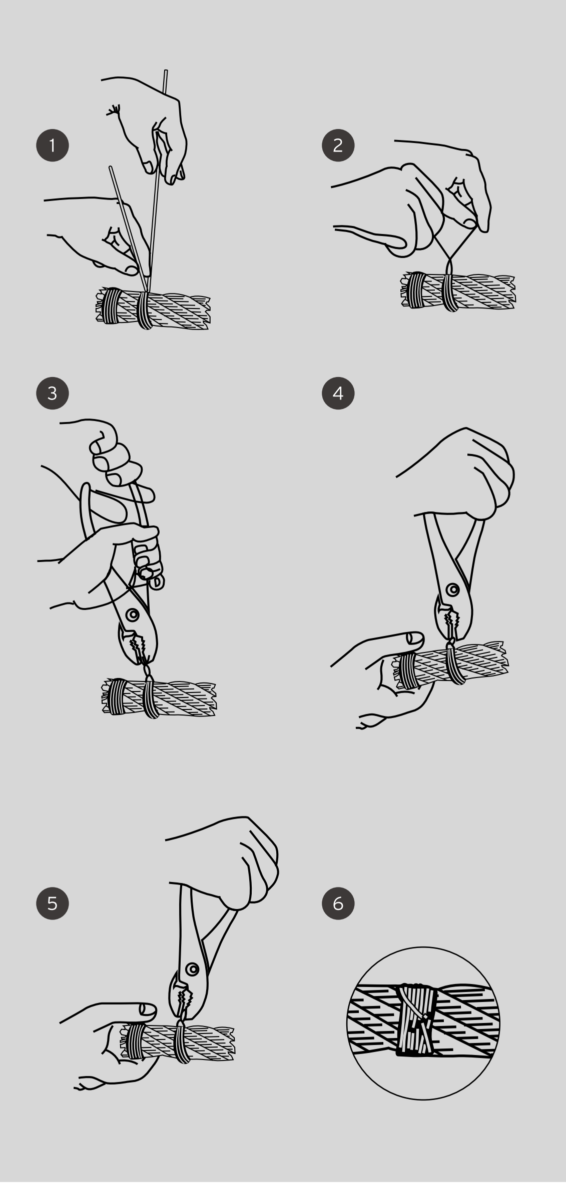
Wire ropes are well lubricated when manufactured; however, the lubrication will not last throughout the entire service life of the rope. Periodically, therefore, the rope will need to be field lubricated. When necessary, lubricate the rope with a good grade of lubricant which will penetrate and adhere to the rope, and which is free from acid or alkali.



INSTALLATION OF DRILL LINE

Installation

- Use a rope connector grip (snake) with a swivel to connect the new drill line to the old drill line. This will relieve twist that may be put in the rope during spooling and handling.
- Never weld the new drill line to the old drill line.
- Try to install the new drill line at a point in the drilling operation when there is a considerable amount of weight available to help seat (break in) the new drill line and assist spooling.
- Remove and inspect the brass inserts on the dead line anchor for proper size and if worn, replace. Rope must be seated properly in the clamp to avoid damage when torque down. Torque the nuts on the dead line anchor clamp to the manufacture's specifications. Torque should be rechecked after one to two hours of operation.
- Special care should be taken during rig moves to prevent damage of the drill line such as kinks and doglegs.
- The optimum service is received when the drill line operates with a design factor ranging from 5 to 7. A high design factor (over 7) wears the drill line out from bending fatigue because t-Miles do not accumulate as fast as at lower design factors.
- The upper layer of the drill line can pull down through lower layers on the drum when setting heavy loads. This occurs because the block goes up empty with very little load. The drill line is not spooled tightly on the drum. The load is then applied to the drill line on the top layer which forces the wraps on the next lower layer apart allowing the top wrap to pull down. Using a heavier block or by adding "cheek" plates to the block will lessen the problem.
- Rope service increases with fewer parts of lines. The fewer the number, the less rope is spooled on the drum so less rope is subjected to the crossover points on the drum. It also allows more rope available to cut. As an example, on a 7500' reel; if 12 lines are strung there is approximately 2200' of rope in the string-up or 5300' of rope available to cut. For 10 lines, there is 1900' of rope in the string-up, or 5600' of rope available to cut. This would increase rope service by over 5%.
- Always make a cut based on t-Miles accumulated prior to and after setting casing.
- If the design factor for setting the casing is approximately 3.0, cut a minimum of 200' from the string-up. Inspect the remaining rope and make another cut if necessary.
- If the design factor is down to 2.0 (the lowest allowed by API), cut a minimum of 600' from the string-up. After inspection, make another cut if necessary.
- For design factors between 2.0 and 3.0, cut between 200' and 600'. Make another cut if needed after inspection.
- Try not to install a new drill line (or slip all new rope into the system) just before setting a heavy load of casing. New or unused rope is more susceptible to crushing than a rope that has been in service.



Seizing of Ropes

Procedure. The recommended procedure for seizing

A wire rope is as follows and is illustrated in Figures:

- The seizing wire should be wound on the rope by hand as shown in Detail 1. The coils should be kept together and considerable tension maintained on the wire.
- After the seizing wire has been wound on the rope, the ends of the wire should be twisted together by hand in a counter Clockwise direction so that the twisted portion of the wires is near the middle of the seizing (see Detail 2).
- Using "Carew" cutters, the twist should be tightened just enough to take up the slack (see Detail 3). Tightening the seizing by twisting should not be attempted.
- The seizing should be tightened by prying the twist away from the axis of the rope with the cutters as shown in Detail 4.
- The tightening of the seizing as explained in 3rd point and 4th point above should be repeated as often as necessary to make the seizing tight.
- To complete the seizing operation, the ends of the wire should be cut off as shown in Detail 5, and the twisted portion of the wire tapped flat against the rope. The appearance of the finished seizing is illustrated in Detail 6.

GUIDELINES FOR ROPE INSPECTION

Wire ropes must be periodically inspected following regulations (e.g. ISO 4309) and internal procedures to assess rope deterioration due to regular use or unexpected events and to ensure safe working conditions.

Inspections can be carried out with the aid of visual or magnetic devices: in this case, it is recommended to perform an initial inspection before rope use to have a baseline for future comparisons.

Each rope shall be inspected along its entire length or, at the discretion of the competent person, along the working length plus at least five wraps on the drum. In this case, if a greater working length is subsequently foreseen to be used, that additional portion should also be inspected.

The frequency of inspections depends on regulations, type of crane and environment, results of previous examinations, load spectrum and experience related to similar ropes and systems.

The main modes of deterioration are: broken wires or stands, decrease in rope diameter, corrosion, deformation, mechanical or heat damage and change in elastic behaviour of rope under load.

The following areas have to be inspected with particular care:

- Drum anchorage and any section close and in correspondence to rope termination
- In case of repetitive operations, any part of the rope that lies over a sheave during crane working
- Rope portion which lies over a compensating sheave
- Cross-over zones on multilayer drums
- Rope sections subjected to reverse bending over sheaves or rollers
- Section subjected to external damage, like abrasion or heat

Terminations, clamps and securing ferrules should be also inspected with special care to detect possible looseness due to vibrations, cracks, distortion, wear or corrosion.

After each periodic inspection, the competent person shall provide a rope inspection record and state a maximum time interval that shall not be exceeded before the next periodic inspection takes place.

The following sketch shows some examples of typical points which require special care during inspection.

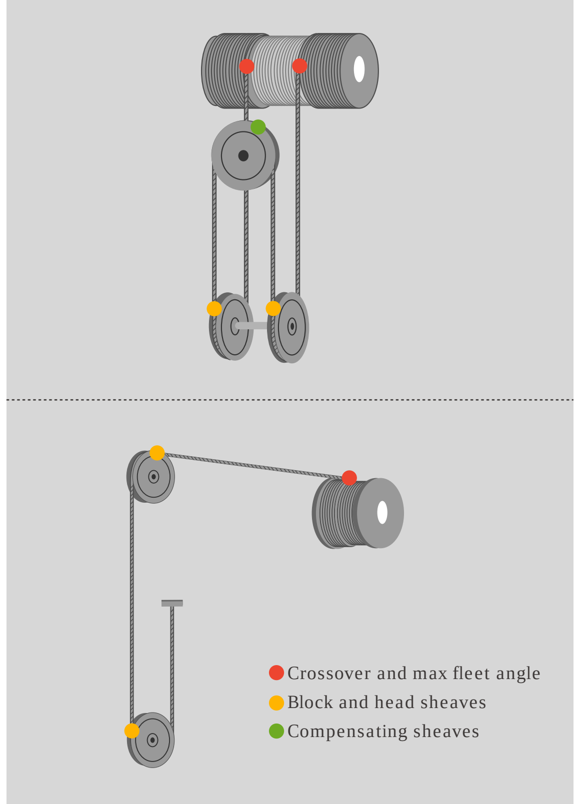


Figure 31 areas requiring detailed inspection

INSPECTION OF DRILL LINE

Rope inspection criteria for drilling operations

All portions of wire rope must be inspected thoroughly for possible deterioration on a regular basis. This starts with a close examination of the rope's critical points. The critical points of an application are those that subject the rope to greater internal stresses or greater external forces. Rope wear is more likely in the following critical areas, so it pays to closely inspect these areas:

Drums

When the rope spools properly, normal wear occurs at the crossover, kickover and change-of-layer points. Look for scrubbing on the side of the rope; in other words, rope that rubs against the preceding wrap on the drum. Crushing may result on rope's top and bottom sides. If severe, remove the rope from service. Both the scrubbing and the crushing normally occur twice with each drum revolution.

Inspection of drums

Check for signs of wear in the drums that could damage wire rope. All drums should be smooth, not corrugated. Check for minimum number of dead wraps remaining on the drum, the spooling characteristics of rope and the condition of flanges.

Sheaves

It's very important to check for broken wires in the wire ropes traveling over the sheaves in your system. Grooves tend to wear smaller over time, especially under heavy loading conditions. With a groove gauge, check each sheave for proper sizes, as well as their smoothness. Grooves that are too small or tight can cause pinching and increased abrasion while grooves that are too wide can cause flattening of the rope – both of which can reduce your rope's life. Also inspect for corrugation, broken or chipped flanges, cracks in hubs and spokes, signs of rope contact with guards, sheave bearings and shaft, an out-of-round condition, and alignment with other sheaves – all criteria for replacement.

End attachments

Rope adjacent to end attachments has its movement restricted and is subject to fatigue as rope vibrations are dampened. Inspect with an awl to expose broken wires, and if more than one broken wire is found, replace the rope. Be sure to also inspect the fitting itself.

Other important areas to inspect:

Pick-up points

The sections of a rope that contact sheaves or drums when the initial load is applied. Heat exposure If an electric arc contacts the rope, remove the entire rope from service immediately. Although the problem may not be visible, electric arcs can affect the rope's properties and the rope needs to be replaced.

- Look for "bright" spots where ropes are subjected to abnormal scuffing and scraping. (abrasion)
- End connections that are corroded, cracked, bent, worn or improperly applied.
- Evidence of kinking, crushing, cutting, bird-caging or a popped out core.
- Wear that exceeds one-third of a wire's original diameter.
- Severe reduction of the rope's diameter. For multilayer construction, if the reduction in diameter is greater than 5%(eg. 6x19, 6x36 etc.) the rope needs to be discarded.
- Evidence of heat damage.
- A significant increase in lay length.

How to find broken wires

One of the most common signs of rope deterioration is broken wires, normally the outside wires on the crowns of the strands.

The rope has to be discarded when total no. of visible broken wires exceed 10% of the total no. of wires in the rope, in a length of 8 x dia. Of rope or 3 or more adjacent broken wires in a strand.

Running ropes

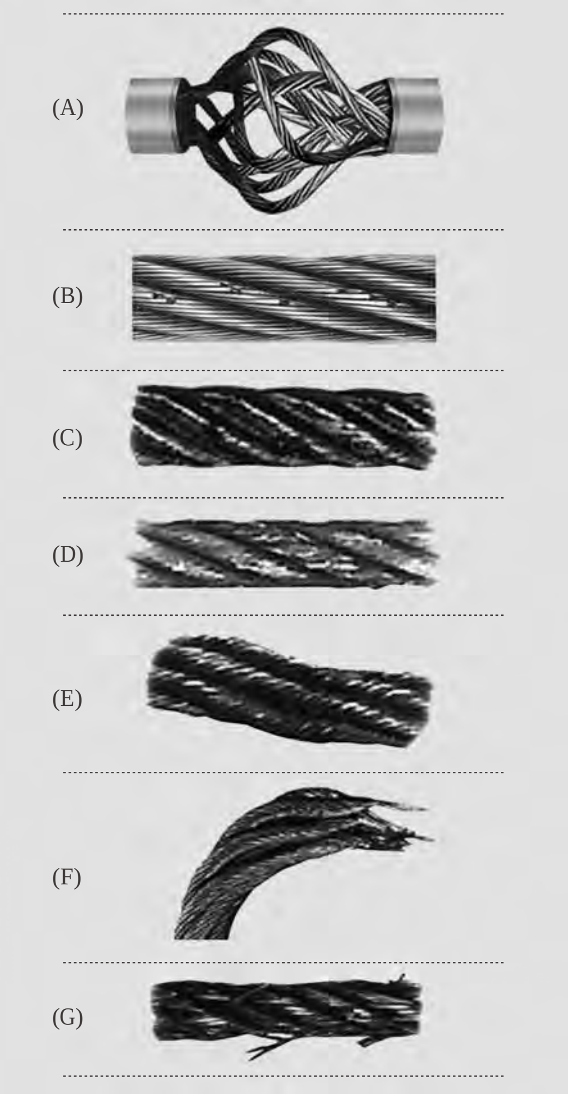
Because of their contact with sheaves and drums, running ropes typically receive heavier external wear than standing ropes. This can result in surface wire breaks – the easiest kind to locate during your inspection. The challenge is to find valley wire breaks. These may occur when ropes are used with small diameter sheaves, sheave grooves that are too small, heavy loads and other poor operating conditions. During your inspection, pay close attention to the areas of the rope in contact with sheaves and drums when loads are picked up. If there is a reason to suspect valley wire breaks, such as a reduction in rope diameter or elongation of rope lay, perform an inspection as outlined below for standing ropes.

Standing ropes

Most wire breaks in standing ropes are internal (or valley) breaks that occur at the points of wire contact. Inspection will reveal no surface wear and therefore nothing to cause external wire breaks. The majority of broken wire problems on standing ropes occur near the end attachments or other points of restriction where vibration is dampened.

Inspection of Drill Lines – Evidence of Wear and abuse

- During operation a non-uniform release of tension can cause "Bird cage". This causes disorientation of the wires and strands and they would never return to its original position. The rope requires immediate replacement. (A)
- This is a failure of a Rotary Drill Line due to poor cutoff practice. The cause of this fatigue type failure can be due to continuous peening. A programmed cutoff schedule can take care of this type of problem. (B)
- This wear is localized while travelling on a sheave. Normally, this condition of the rope is not visible while in operation and thus, requires regular inspection of the operating length. The broken wires need to be found out by inspecting all sides of the rope under operation. (C)
- This is a condition where one of the strands is worn before the adjoining strands caused by in proper socketing or seizing or kink formation. On the upper side one can see a concentration of wear which recurs every 6th strand in a 6 strand rope. (D)
- A kinked wire rope is shown here. During handling, installation, operation if a line is slackened and is pulled down due to force then such formation can occur. A distortion is total in wires and the strands thus, needing an immediate replacement. (E)
- The picture shows a rope that has jumped over a sheave. The tensile breakage of wires in the form of "Cup and Cone" is a result of a curvature path followed by the rope while going over the edge of the sheave. (F)
- The severe wire breakage shown can be due to the rope subjected to heavy loads over under sized sheaves. The "Strand Nicking" has caused the breaks in the valley and Crown. (G)



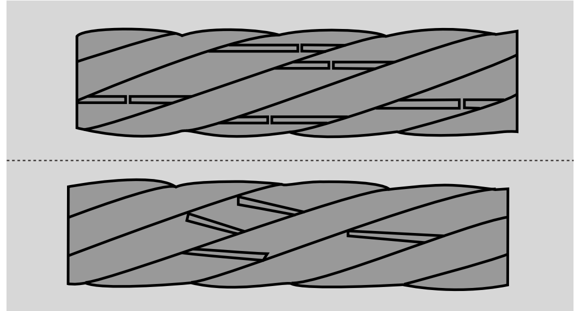
ROPE DISCARD CRITERIA

Discard criteria for visible broken wires

Rope conditions have to be clearly assessed by a competent person based on discard criteria provided by regulations and internal procedures Discard criteria depends on the nature, occurrence and location of broken wires and on the rope construction and are based on number of visible broken wires, diameter variation, corrosion and distortion or a combination of all these factors.

Number of visible broken wires takes in account only the breaks due to regular use, that indicate fatigue pile up and approaching of end of rope safe life, therefore breaks due to improper handling may not be considered in this count if not affecting safety conditions.

Breaks protruding from the rope can be removed if there is the risk that they generate further damage to the equipment or to the rope itself.



If groups of broken wires are found in a section of rope which do not spool on and off the drum and breaks are concentrated in adjacent strands, it might be necessary to discard the rope.

It shall be discarded as well if two or more wire breaks are found at a termination or concentrated in the valleys in a rope lay length, as this could indicate the beginning of fatigue phenomenon.

If breaks occur randomly in rope sections running through sheaves, spooled on and off a single layer drum or on crossover points of a multilayer drum, the maximum amount is determined by specific regulations (e.g. ISO 4309).

Some examples of maximum allowed breaks for different rope use and constructions are shown in the following table.

The numbers depend on the assumption that outer wire breaks correspond to a certain number of inner wire breaks.

Typically, the number of inner broken wires due to use of a Lang lay rope is higher than the number of outer broken wires, therefore damage detection is harder and the number of outer allowed breaks must be low.

On the other hand, in ordinary lay ropes more breaks occur on the outer surface, therefore they are more detectable and the allowed number is higher than the Lang lay value.

For non rotating ropes this difference is not remarkable due to their geometrical structure, therefore there is no distinction due to lay direction.

Breaks distribution along the rope can indicate fatigue beginning, therefore the number of broken wires over a significant rope length (e.g. 30d) is not proportional to the number of localized broken wire in a specific portion (e.g. 6d), which could be due to other causes to be specifically investigated.

Rope Construction	Number of visible broken outer wires					
	On steel sheaves or single layer drum				On multi-layer drum	
	Ordinary lay		Lang lay			
	Over 6d	Over 30d	Over 6d	Over 30d	Over 6d	Over 30d
6 x 19	3	6	2	3	6	12
6 x 25, 8 x 19	5	10	2	5	10	20
6 x 26, 8 x 25	6	13	3	6	12	26
6 x 36, 8 x 26	9	18	4	9	18	36
35 x 7	3	5	3	5	5	10

MAINTENANCE

Discard criteria for diameter decrease, deformation and corrosion

Diameter shall be periodically measured and compared to the initial reference value (i.e. recorded measurement taken immediately after receipt) to detect uniform or localized variations.

Diameter decrease has to be calculated using the following formula

Diameter decrease [%] = 100 (reference diameter - measured diameter)/nominal diameter

In case of uniform decrease, the maximum allowed value is 5% in respect to nominal diameter for non rotating ropes, 7.5% for other rope constructions with steel core, 10% for fibre core ropes.

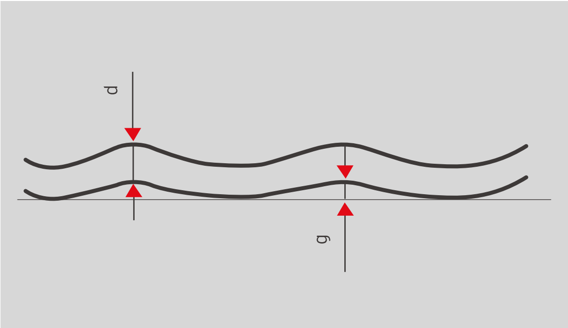
A clear localized decrease indicates a severe failure of rope core and leads to immediate rope discard.

Also in case of break of a complete strand, rope has to be immediately discarded.

Ropes showing deformations like basket, core or strand protrusion or distortion, kink or tightened loop shall be evaluated and can remain in service if the damaged portion can be removed and if the remaining part of rope is still suitable for use.

Other damages, like flattened portion or permanent bend, may not be cause of immediate discard, but they have to be inspected with higher frequency, as the affected portions are likely to deteriorate and show broken wires at faster rate than usual.

Waviness should be assessed using a straight bar and considering the gap between the rope and the cut surface (see figure): the maximum allowed gap is 1/3 the rope nominal diameter if the deformation affects a portion not running over sheaves or spooled on the drum, otherwise it has to be reduced to 1/10.

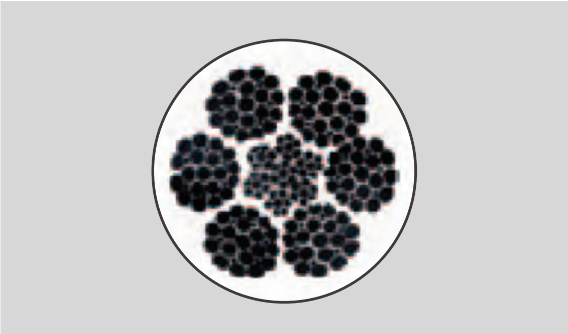


Waviness assessment

Corrosion should be evaluated after having wiped the rope to remove contaminating particles and should be assessed considering type and severity.

Rope should be discarded in case of heavy pitting and slack wires on the external surface, as well as in case of internal corrosion (see figure), indicated by the presence of debris extruding between the outer strands.

Rope should also be discarded in case of severe fretting corrosion, which manifests as a dry red powder and is caused by the continuous rubbing between dry wires and consequent particles oxidation.



Internal corrosion

Inspection - maintenance

Drums

- In the drum , scrubbing of the rope has to be noticed on the side of the rope that may occur due to rubbing with the preceding layer.
- Look for crushing marks on the top and the bottom of the rope.
- Check for signs of wear in the drum so that it does not affect the rope. Drums should be smooth and not corrugated.
- Also the condition of the flanges are to be inspected.

Sheaves

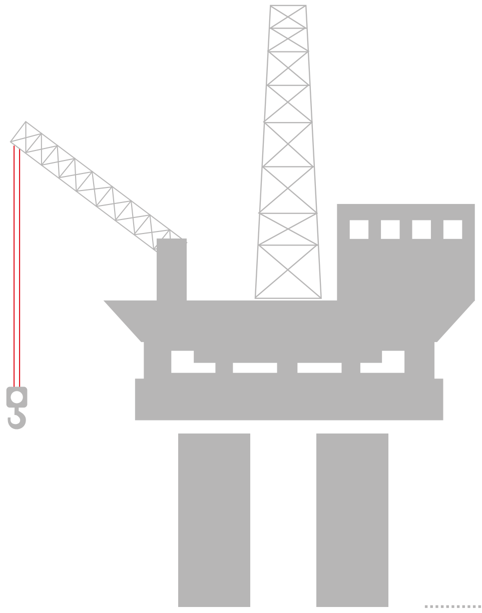
- Check for broken wires that might go underneath the travelling rope.
- Check conditions of the groove with groove gauges. Grooves tend to wear smaller in heavy load conditions & pinching effect is there on the rope.
- Groove condition should also not become wider as that will make the rope flat.
- Check groove bed and the contact surfaces of the grooves . Any corrugation on the surface will effect the rope performance.
- The flanges need to be checked for broken flanges or chipped flanges.
- Check the sheave bearings and the shaft so that it may not cause any misalignment in the drive.
- Alignment check between the sheaves has to be done at regular intervals.

End attachments

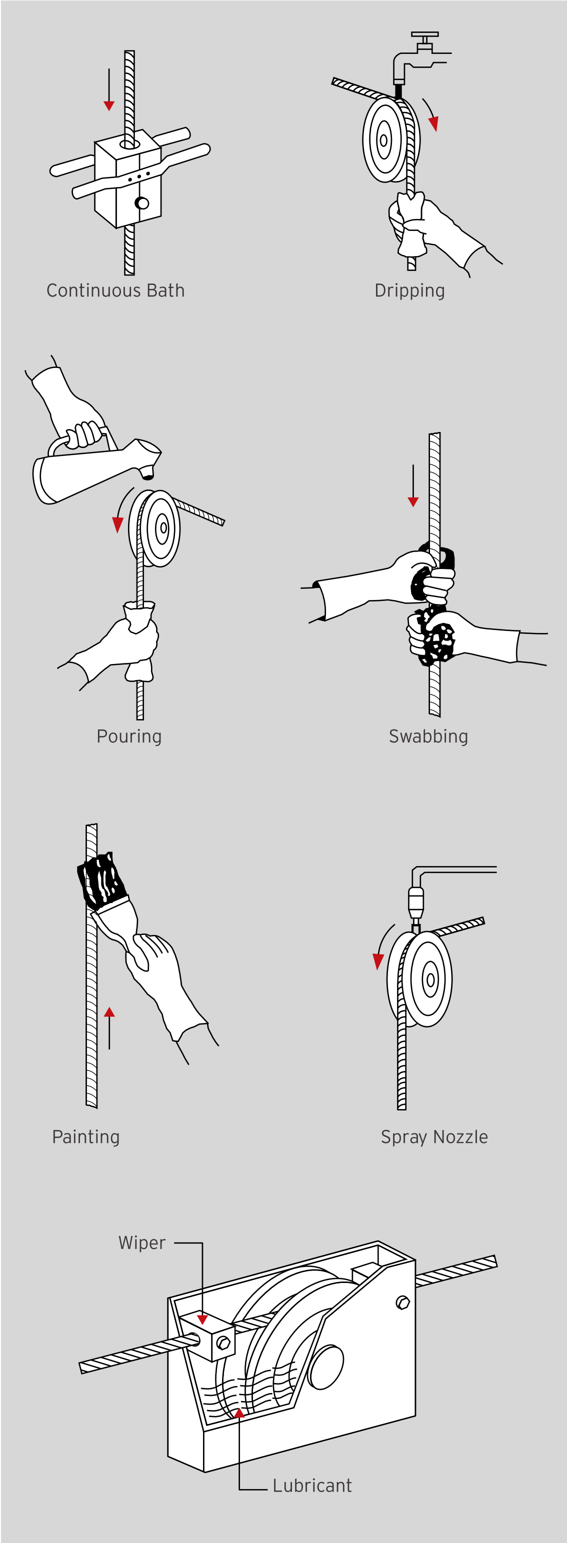
- As rope has restricted movement adjacent to the rope attachment/end fitting, one should see the wires there whether broken or not
- The end-fitting needs to be examined fully for cracks & dents.

Equipment

- Check the traveling block and crown sheaves. If the depth or size of the groove shows excessive wear, the sheaves must be replaced or repaired (especially the fast line sheave).
- The kick back plates, kick back rollers and line guide roller assembly should be inspected periodically..

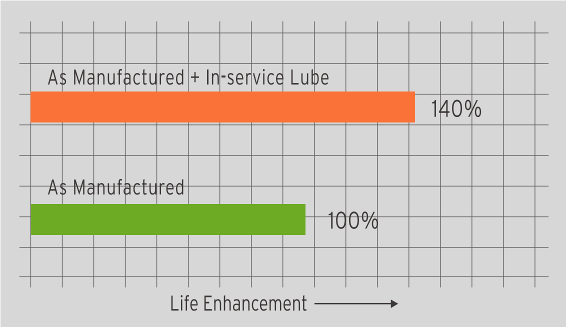


LUBRICATION



Inspection – Maintenance - Lubrication

- A well lubricated rope permits full and unrestricted movement of the wires and strands with a consequent minimum of fatigue and frictional wear.
- Understand the duty cycle for dressing.
- A used rope should be thoroughly cleaned prior to the application of new lubricant. Wire brushes can do an effective job. (High pressure water wash may be done)
- Air dry the rope of any rope prior to dressing in lubricant.
- It may be necessary to soften the old lubricant and accumulation of dirt with a penetrating oil.
- The rope should then be covered and stored in a dry location and protected against mechanical damage.
- Lubrication level should be optimum & not more or less.



In-use lubrication pays rich dividend

SLIP AND CUT PRACTICES

Guide to a drill line cut-off programme

- For the first few cuts, wrap the drill line at the point being cut with duct tape prior to making the cut to prevent unlaying.
- When making a cut and slipping new rope into the string-up, all of the wraps should be removed from the deadline anchor. The rope should never be pulled through a loosened clamp which can put a twist in the rope. The clamp should be completely removed and inspected. If worn or damaged, replace.
- After making a cut, the dead wraps should be spooled on the drum with sufficient tension to prevent excessive drum crushing or "milking" of the bottom layer.
- Take ton-Miles for drag into account.
- Drill ships and semis using a crown motion compensator may operate with a lower ton-mile goal due to additional sheaves and extra rope on the drum.
- Extended drilling between round trips may necessitate making a cut to avoid exceeding maximum allowable ton-Miles.
- Because of the additional weight, top drives accumulate more ton-miles for each rig operation. It has not been determined if ton-mile goals should be changed to accommodate this.
- Short, frequent cuts will shift critical wear points caused by excessive jarring.
- Long cuts are necessary when the amount of rope to be cut doesn't remove all the rope that meets removal criteria. This can be caused by failure to follow the ton-mile goal, improper calculation or recording of ton-miles. Damage at any point may require a long cut.
- To prevent long cuts:

  a. Find the optimal ton-km goal for your drill line; experience may indicate you have to change your ton-km goal. It's important to follow the cut-off program for a new rope. The first few cuts may seem excessive, but they are necessary to move rope through the system at the proper rate.

  b. Ton-Miles must be calculated and recorded accurately for each operation.

  c. Inspect equipment to prevent conditions that adversely affect service life. Equipment problems such as bearing failure in a sheave can cause unusual wear leading to long cuts.

Important Points

The key factor that guides/necessitates the requirement for handling a drill line, in terms of cut and slip operation or introduce a fresh replacement, totally depends on the physical condition of the rope.

It is known by all that the method in practice to determine the service life of the rope is by calculating the ton miles. However, it is necessary to point out that the ton-miles is expected to be kept as a general guideline only and never to be considered as the only criteria for understanding the rope condition. It is mandatory to continuously monitor whether the conditions of the rope fall within the discard criteria or not. If the condition exceeds the discard criteria with respect to ISO 4309, then it should be overruling the results of the ton-miles calculation.

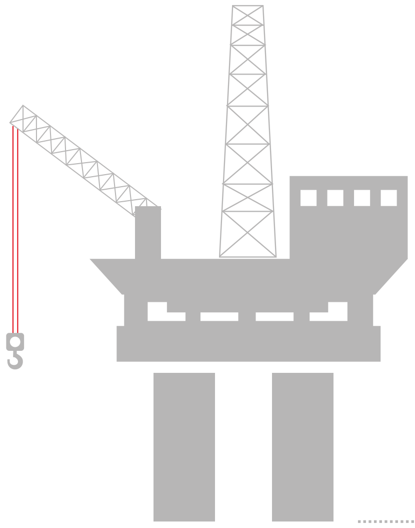
If the working conditions lead to long durations before slip and cut operation then it is an unsafe working condition. Thus, it is preferred to have a slip and cut programmed with regularity.

In case the rope, after inspection, is found to be in good condition then the ton-mile slip and cut programme may be extended to increase the rope's service life.

It is essential to attach a lot of importance to the above guidelines in order to ensure a safe working condition and derive the best possible rope service life with respect to a specific working area.

Measures in SLIP & CUT – to improve rope performance

- While the cut is proposed after inspection, proper seizing has to be done to ensure that life does not get into the length of the rope.
- During the cut & slipping the new rope into the string-up, all the layers should be opened up from the deadline anchor.
- The rope should be pulled out only after the clamp is fully removed & not after it is half loosened as that will cause twist/kink in the rope.
- After making a cut, the dead layers should be spooled on the drum with sufficient tension to prevent excessive drum crushing of the bottom layer.
- To avoid exceeding maximum allowable t-Miles, it may be required to make another cut while extended drilling between round trips are done.
- To avoid rope damage to propagate & give poor ton-km, we should practice periodic rope inspection.
- Too much of shock causes critical wear points & therefore, short , frequent cutting helps to shift these points and help operation.
- The length of the cut will depend on the find of the inspection of the rope. Damage at any point may require a long cut.



ROPE BEHAVIOUR UNDER LOAD

When a rope is subjected to axial loads, the elasticity of the material will cause elongation and consequential diameter reduction.

This behaviour is summarized in the first figure, which shows the relationship between stress (the ratio between applied load and metallic area) and strain (ratio between elongation and initial sample length), while the slope of the curve represents Young modulus "E".

In the first phase of its use (up to point 1), rope shows a certain permanent stretch due to the stabilization of the individual wires. After this step, the trend is basically linear up to the achievement of yield point (points 3 and 4), from which point permanent plastic deformation takes place, until the load reaches the actual rope breaking force.

As already mentioned in the section "Strength & Breaking Force ", a good rope composed of ductile wires must have a long elastic area to ensure safe working conditions.

Rope diameter shows a permanent reduction after the first utilization cycles; the trend is shown in the second figure.

ROPE ROTATION AND TORQUE

ROPE ROTATION AND TORQUE

Being composed of several helically laid components with elastic characteristics, each wire rope has the tendency to turn when subjected to load. This tendency is represented by rope torque factor, which is dependent on rope construction, previous working conditions and applied load.

In a similar way, rope will also oppose forced rotation, depending on its rotational stiffness.

Ropes can be classified on the basis of torque factor, as spin resistant, low rotation or rotation resistant.

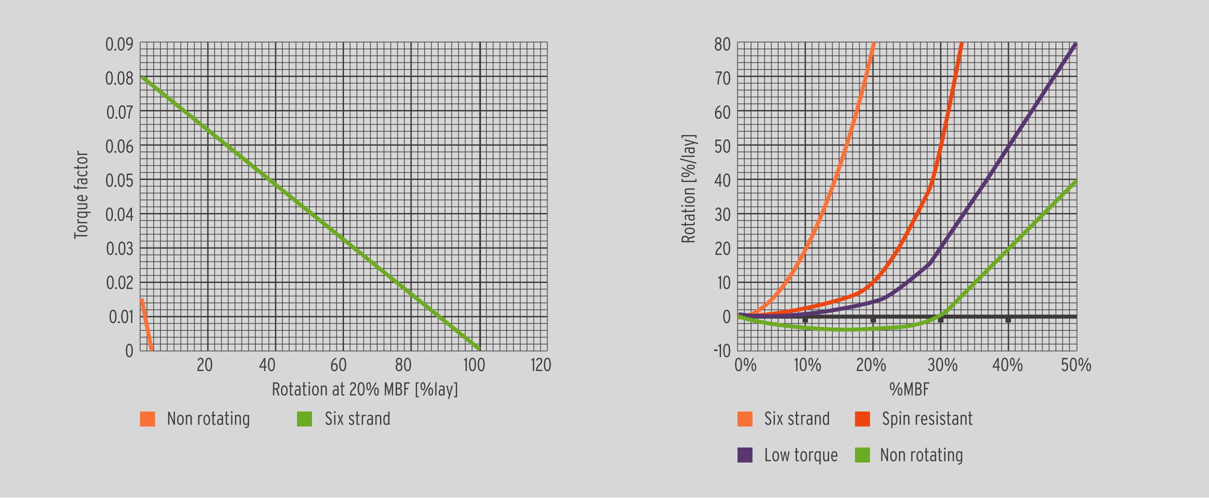
Since torque factor depends primarily on rope construction, this has to be selected on the basis of the reeving structure and lifting or deployment height, in order to ensure block and load stability.

Non rotating ropes are strongly recommended for high lifting heights in single fall mode, while for multiple fall other constructions can be considered depending on block configuration.

During the first use of rope wound over a drum, the portion of wire rope coming out from the winch will start to rotate depending on rope construction and applied load.

When the rope is rewound over the drum, the rotation obtained during deployment will be stored into the winch: therefore, if the rope is used to deploy the same load at the same height, no additional rotation will take place.

If the rope conditions are not the same, different behaviour will occur.



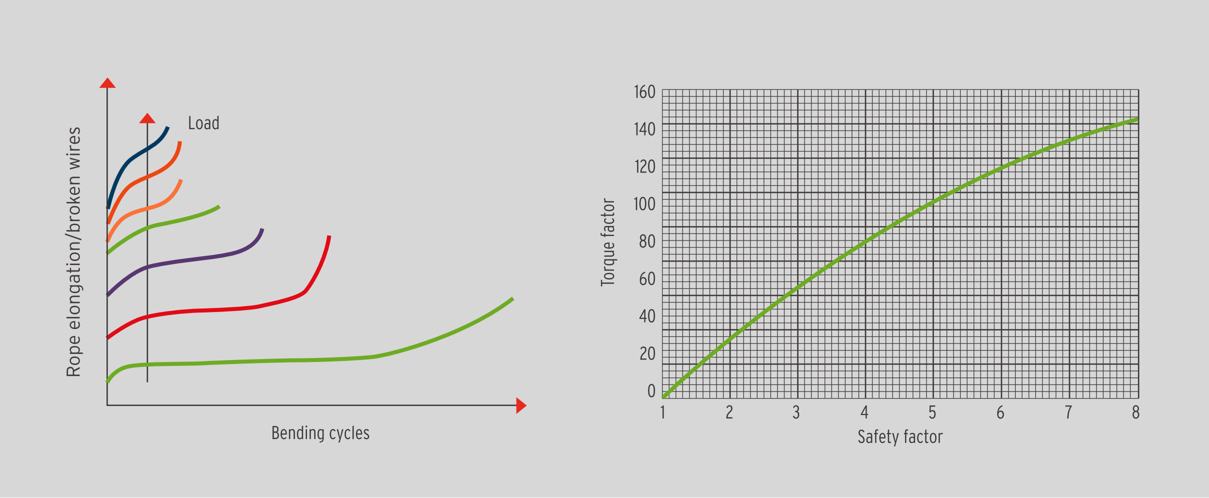
BENDING FATIGUE

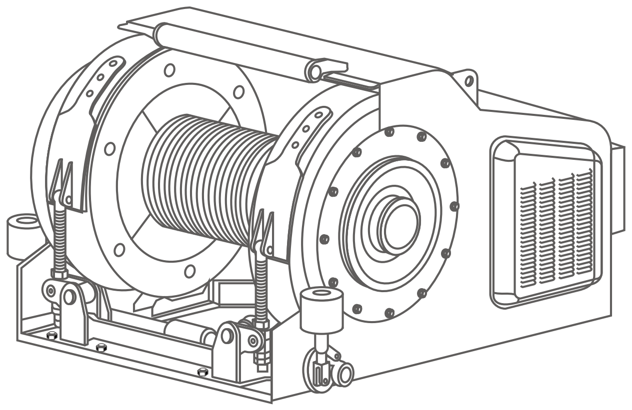
Fatigue damage is a typical phenomenon which is not caused by a single event, but by repeated bending, tension and rotational stresses: since the working life of wire ropes generally involves repeated passages over drum and sheaves, this damage has to be carefully considered during operations.

The first factor to be considered with respect to fatigue damage is the working load: taking a safety factor of five as a reference point, relative service life of rope operating in the same system with different loads is shown in the first figure.

Fatigue damage occurs gradually, and becomes evident when it reaches a point where it has caused a high number of broken wires and consequent wire elongation, which rapidly increase to reach wire rope discard criteria.

The typical trend of fatigue growth is shown in the second graph: it is clear that there is a rapid increase in the curve slope after a certain threshold, and this is strongly affected by working load.





FACTORS AFFECTING BENDING FATIGUE

Since fatigue is an inherent phenomenon, it cannot be eliminated, however it can be slowed down by adopting, when possible, particular features with respect to rope design and system layout.

With respect to rope design, the most effective way to reduce fatigue evolution is by avoiding the use of extremely high strength wires (over 2160 kN/mm2). As already mentioned, this improves steel ductility allowing a better resistance to repeated bending cycles.

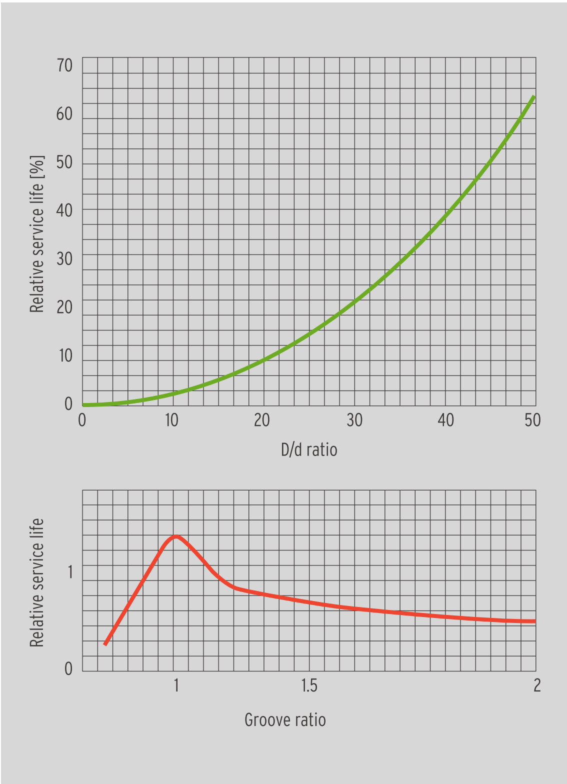
Contrary to expectation, rope composed of many small wires may not have higher fatigue resistance, especially when working at low safety factor. In terms of system design, there are several strategies that can be adopted to preserve rope life.

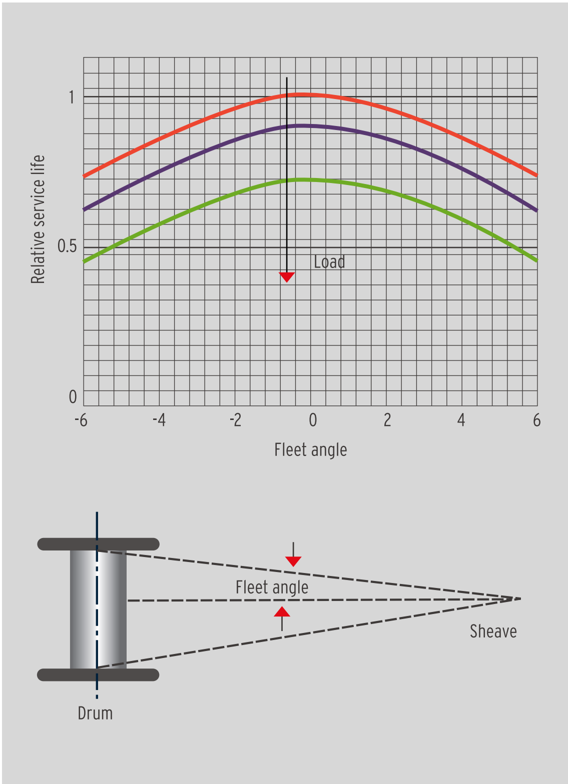
The first tool is to increase the bending ratio of the component over which the rope is running. This can have some practical limitations, especially when dealing with large size ropes, however it has to be emphasised that the typical recommended ratio for good fatigue performance is approximately 20.

Another approach which can be adopted without major expense is the selection of proper groove size. The recommended value is approximately 1.08 times the nominal rope diameter, depending on rope type and possible fleet angle.

Fleet angle must be always considered and limited, as it creates a stress within the structure of the rope and contributes to fatigue build up: it should not exceed 2°, or 4° for ropes having plastic impregnated cores.

In case of fleet angle, groove oversize should be increased to 1.10 or more in order to facilitate the passage of the rope through the groove.





ROPE WINDING OVER SHEAVES

When a rope runs over the reeving, its strands are forced to modify their relative position to maintain contact with the system. If the reeving arrangement is not properly designed, the strands cannot recover their natural location in the passage between adjacent components, therefore the rope can suffer premature fatigue or localized damage.

This particularly applies in case of reverse bending configuration, where the strands are stretched and compressed between two sheaves (see sketch below). To avoid permanent damage, for complete reverse bending (see left sketch) the minimum recommended distance is about 100 times the rope diameter.

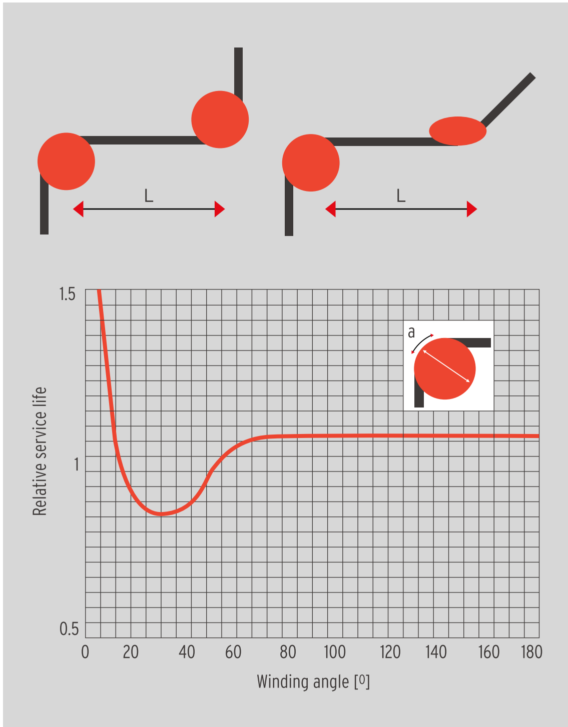
For partial reverse bending (see right sketch), a lower distance could be accepted.

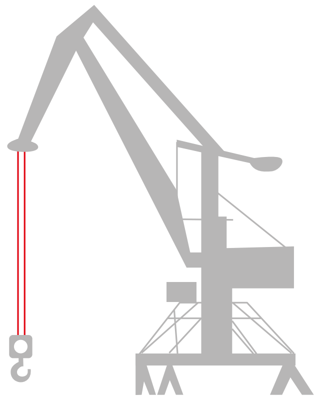
Both in the case of reverse and simple bending, the sheaves have to be properly designed in terms of size, groove configuration and hardness.

As already mentioned, the minimum recommended bending ratio is 20 times the rope nominal diameter, while the recommended groove oversize can vary from 1.06 to 1.1 times the rope diameter.

In order to allow a smooth contact surface, the rope should be in touch with the sheave for at least 1.5 times its lay length, which corresponds approximately to a 60° winding angle for a sheave having a bending ratio of 20. For very small winding values the stress induced to the rope is not very relevant, while in the intermediate range, from 10° 45°, significant damage can occur, especially if the component is located in the high tension side of the reeving.

This figure does not apply in case of rollers or sheaves with reduced bending ratio (up to 10), since the rope has to deal with a relatively small bending ratio. In this case, it is always recommended to adopt a minimum bending ratio equal to the winding angle (e.g. 2 D/d minimum in case of 2° winding angle).





CONTACT PRESSURE BETWEEN REEVING COMPONENTS

When the rope is bent over a component, it generates pressure which is dependent on its diameter, the diameter of the component over which the rope is bent and the applied tension.

Pressure, $P = \frac{2T}{Dd}$

P = pressure [N/mm^2]

T = rope tension [N]

D = diameter of sheave or drum [mm]

d = diameter of rope [mm]

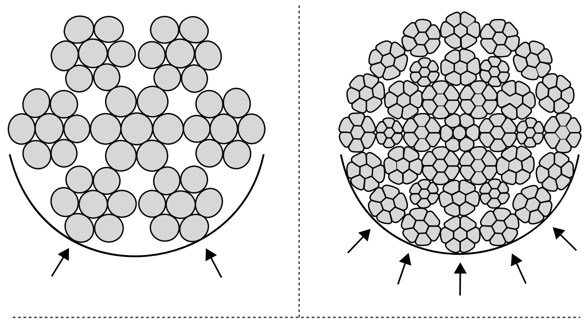
Multistrand and non rotating ropes ensure a better pressure distribution than six strand ropes, as the higher number of outer strands generates a wider contact surface (see figures below).

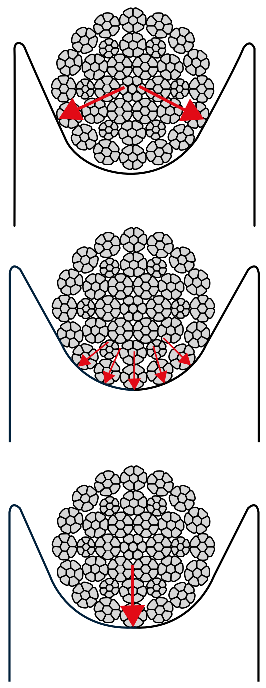
Compacted strands and Lang's lay ropes further extend the contact surface.

In order to ensure proper performance, the groove material should ensure a smooth and hard contact: in case of inadequate hardness, the steel will be locally hardened, with consequent embrittlement and detachment of steel flakes, which can damage both the rope and the component itself. The typical recommendation is to use hardened steel with approximate 300 HB value.

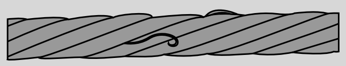
In case of synthetic sheaves, the yield point of the material should be higher than the exerted pressure, calculated using the formula above.

A good groove dimension is also important to achieve a reduced pressure. The diagram below shows different configurations depending on various groove oversize: narrow, well dimensioned and large groove.

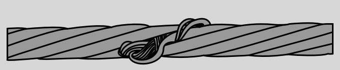




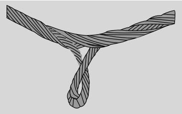
TYPICAL ROPE DAMAGE



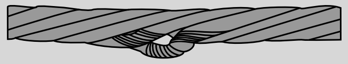
Wire protrusion
Cause Improper rope handling
Ref. ISO 4309 - 6.6.5
Action Discard (can be removed for limited extension)



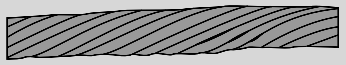
Core protrusion
Cause Fleet angle, shock loading
Ref. ISO 4309 - 6.6.4
Action Immediate discard



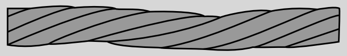
Protrusion of inner rope
Cause Fleet angle, shock loading
Ref. ISO 4309 - E.4 c)
Action Immediate discard



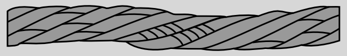
Strand protrusion or distortion
Cause Forced twist
Ref. ISO 4309 - 6.6.4
Action Immediate discard



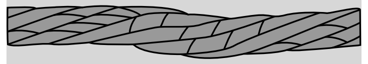
Local increase in rope diameter
Cause Fleet angle
Ref. ISO 4309 - 6.6.6
Action Remove the cause and monitor the evolution



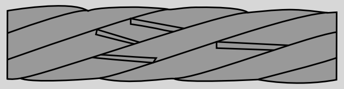
Local reduction in diameter
Cause Core break
Ref. ISO 4309 - 6.3
Action Immediate discard



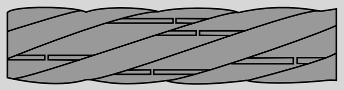
Kink (positive)
Cause Fleet angle, forced rotation
Ref. ISO 4309 - 6.6.8
Action Immediate discard



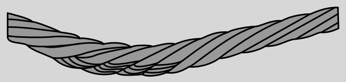
Kink (negative)
Cause Fleet angle, forced rotation
Ref. ISO 4309 - 6.6.8
Action Immediate discard



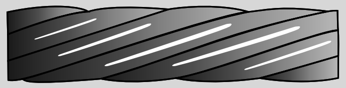
Valley wire breaks
Cause Fatigue and improper rope design
Ref. ISO 4309 - 6.2
Action Discard (can be removed for limited extension)



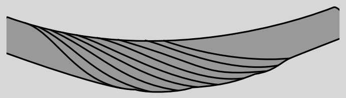
Crown wire breaks
Cause Fatigue
Ref. ISO 4309 - 6.2
Action Discard (can be removed for limited extension)



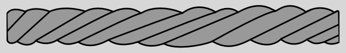
Flattened portion
Cause Rope derailing over the sheave
Ref. ISO 4309 - 6.6.7
Action Immediate discard



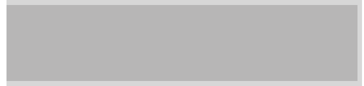
External wear
Cause Normal use
Ref. ISO 4309 - 5.3.1, E2
Action Keep monitored



Basket deformation (birdcage)
Cause Improper installation, narrow grooves
Ref. ISO 4309 - 6.6.3
Action Immediate discard



Waviness
Cause Reverse bending, rope rotation
Ref. ISO 4309 - 6.6.2
Action Keep monitored



External corrosion
Cause Environment conditions
Ref. ISO 4309 - 6.5
Action Keep monitored

QUICK CALCULATOR

Quick calculation for general purpose evaluations or for preliminary design feasibility can be made using the following formulas and tables, which provide a set of relevant nominal values.

MBF [kN] = k•d^2 (d = nominal diameter [mm])
Mass [kg/m] = km•d^2
Metallic area (A) [mm^2] = 0.785•f•d^2
Axial stiffness (EA) [MN] = E•0.785•f•d^2/1000
Elastic elongation ___ = Load [mN]/(EA•1000)
Rope torque [Nm] = t•d•load [kN]

Rope type	Fill factor (f)	MBF factor (K)	Mass factor (km)	Emodulus [kN/mm^2]	Torque factor (t)*		Ref. lay factor (kL)	Turn [degrees/lay]*	
					Lang	Reg		Lang	Reg
Non rotating (d upto 40 mm)	0.725	0.86-1.00	0.0049	127	0.02	0.009	7	2.5	2
Non rotating (d upto 100 mm)	0.740	0.86-0.98	0.0049	130	0.012	0.007	7	1.5	1
Non rotating (d over 100 mm)	0.725	0.83-0.86	0.0049	128	0.008	0.001	7	0.75	0.5
10 strands compacted spin	0.695	0.81-0.95	0.0047	125	0.05	0.045	6.5	12	8
10 strands compacted	0.695	0.82-0.96	0.0047	127	0.12	0.090	6.5	140	100
8 strands compacted	0.680	0.80-0.95	0.0046	125	0.11	0.085	6.5	120	90
6 strands compacted	0.670	0.79-0.92	0.0045	122	0.1	0.078	6.5	100	80
6 strands not compacted IWRC	0.590	0.71-0.85	0.0042	122	0.1	0.078	6.5	100	80

*Nominal values at 20% MBF for trained rope

Typical rope properties

1	kg/m	=	0.672	lbs/ft	1	lbs/ft	=	1.49	kg/m
1	m	=	3.28	ft	1	ft	=	0.305	m
1	mm	=	0.039	inch	1	inch	=	25.4	mm
1	kg	=	2.205	lbs	1	lbs	=	0.454	kg
1	lb	=	0.0005	short t (ton)	1	short t (ton)	=	2000	lb
1	metric t (tonne)	=	1.10	short t (ton)	1	short t (ton)	=	0.907	metric t (tonne)
1	metric t (tonne)	=	0.984	long t	1	long t	=	1.016	metric t (tonne)
1	kN	=	0.102	metric tf	1	metric tf	=	9.81	kN
1	N/mm^2 (MPa)	=	145	psi	1	psi	=	0.0069	N/mm2 (MPa)

Conversion factors

SAFETY INFORMATION

- Wire rope will fail if worn out, shock loaded, overloaded, misused, damaged, improperly maintained or abused.
- Always inspect wire rope for wear, damage or abuse before use.
- Never use a wire rope which is worn out, damaged, corroded or abused.
- Never overload or shock load a wire rope.
- Use the correct design factor for the application.
- Inform yourself : Read and understand the machinery manufacturers handbook and guidance from the wire rope manufacturer.
- Refer to applicable directives, regulations, standards and codes concerning inspection, examination and rope removal criteria.

All statements, technical information and recommendations contained herein are believed to be reliable, but no guarantee is given as to their accuracy and/or completeness. The user must determine the suitability of the product for his own particular purpose, either alone or in combination with other products and shall assume all risk and liability in connection therewith.

Whilst every attempt has been made to ensure accuracy in the content of the tables, the information contained in this catalogue does not form any part of a contract.

METRIC - IMPERIAL DIAMETER CONVERSION

in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
5/32	3.97	1/2	12.7	15/16	23.8	1 1/2	38.1	2 1/2	63.5	4 1/4	108.0
3/16	4.76	9/16	14.3	1	25.4	1 5/16	41.3	2 3/4	69.9	4 1/2	114.3
7/32	5.56	5/8	15.9	1 1/16	27.0	1 3/4	44.5	3	76.2	4 3/4	120.7
1/4	6.35	11/16	17.5	1 1/8	28.6	1 7/8	47.6	3 1/4	82.6	5	127.0
5/16	7.94	3/4	19.0	1 3/16	30.2	2	50.8	3 1/2	88.9		
3/8	9.53	13/16	20.6	1 1/4	31.8	2 1/8	54.0	3 3/4	95.3		
7/16	11.1	7/8	22.2	1 3/8	34.9	2 1/4	57.2	4	101.6		

CONVERSION TABLE

Length	1m	= 1000 mm	= 3,281ft	= 39,37 inch
Force	1kN	= 101,97kp	= 0,10197 t metric-f	= 224lbs-f
Tensile Strength	1N/mm^2	= 0,10197 kp/mm^2	= 145,04 p.s.i.	= 10 bar
Cross Section	1 mm^2	= 0,00155 sq.inch		
Weight	1 metric t	= 1000 kg = 1,102 short t	= 0,9842 long t	= 2204,6 lbs
Weight per Unit Length	1 kg/m	= 0,672 lbs/ft