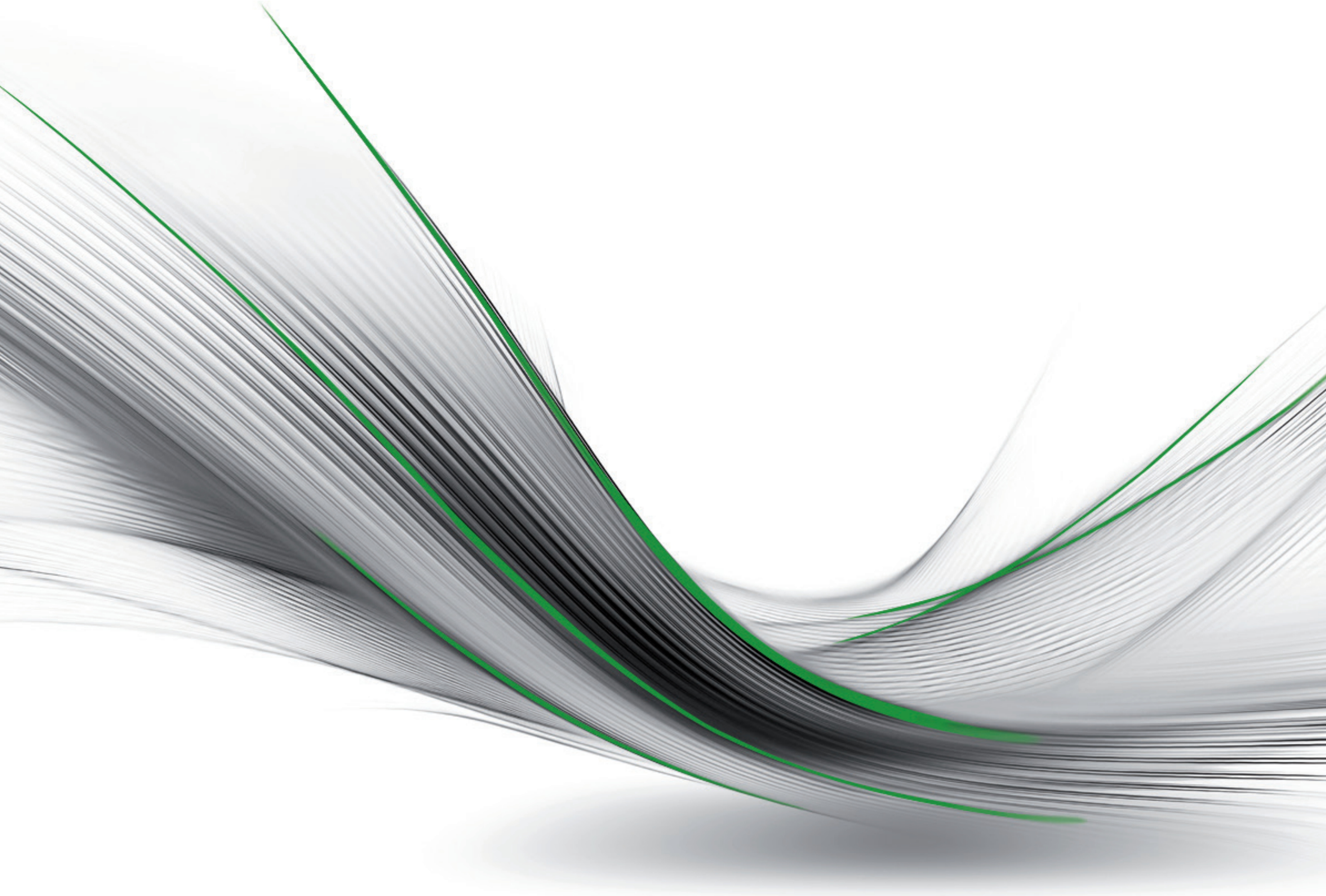
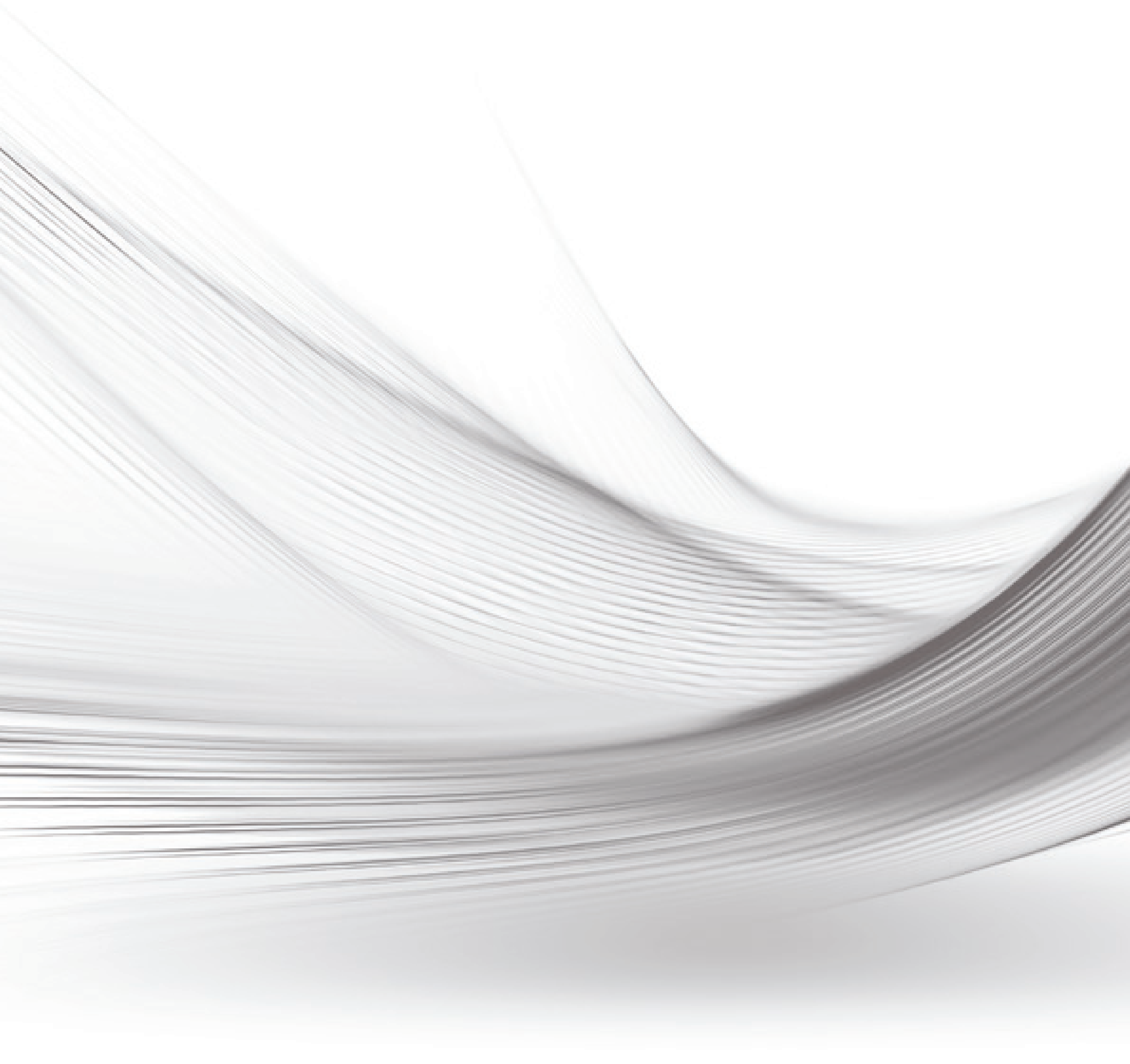
ELSTAR



ROPES FOR ELEVATORS

BruntonShaw
STRENGTH IN SERVICE



CONTENTS

LATEST GENERATION STEEL WIRE ROPES FOR ELEVATORS - MADE IN EUROPE

With a vast experience and complete dedication to manufacturing high-tech steel wire ropes, Brunton Shaw has developed into a preferred supplier of steel wire ropes for the elevator industry. Through close cooperation with our customer base, Brunton Shaw presents its latest generation of ELSTAR steel wire ropes.

Brunton Shaw is a world leading provider of high-quality wire ropes and for more than 140 years, the company is well-known for its focus towards excellence and continuous improvement. Due to its stringent process controls, Brunton Shaw is the preferred choice for any application containing safety, durability and unrivalled operational performance.

Our range of elevator ropes are designed and aimed at safely moving people in a secure and comfortable manner. In close coordination with our customer base, we design, produce, and test our elevator ropes to meet the toughest safety and quality requirements known today. Our highly competent and customer focused teams work in close cooperation with our customers to bring highly innovative solutions to the most challenging problems faced in rope applications.

ROPE TECHNOLOGY

The ELSTAR range is designed, manufactured and optimized to the very strict technical specifications demanded by our customers for today's challenging conditions.

Brunton Shaw continues to invest in new technology, state of the art machinery and new product development that is required to meet the exacting demands of elevator ropes and, to further support our high-quality philosophy, the Global Design Centre was formed.

The technical direction of Brunton Shaw is coordinated in close cooperation with its group's partner company Global Design Center (GDC), based in Italy. GDC is responsible for all strategic marketing objectives, such as, rope design, application engineering, life cycle optimization and R&D. In addition, GDC functions as an additional support center regarding inspection and installation services.

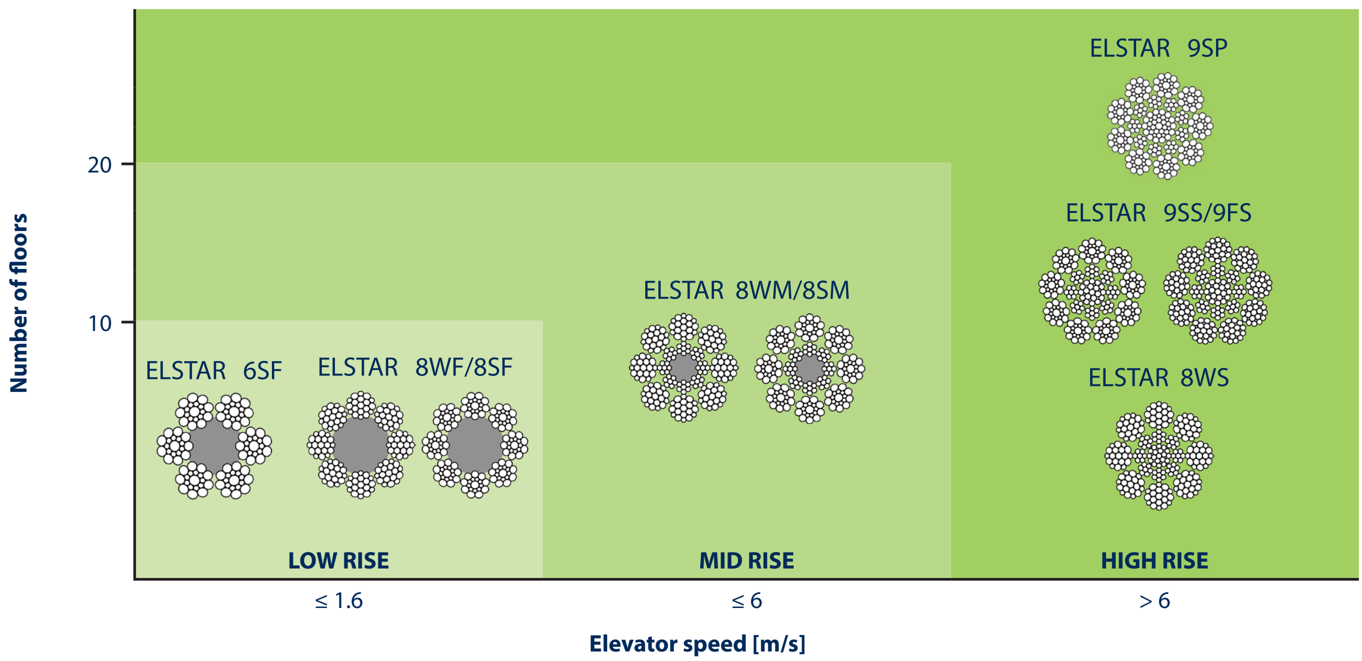
Being part of a vertically integrated group, Brunton Shaw will act as your one-stop-shop solution provider for all steel wire rope solutions.

WIRE ROPE APPLICATION SELECTOR

Key

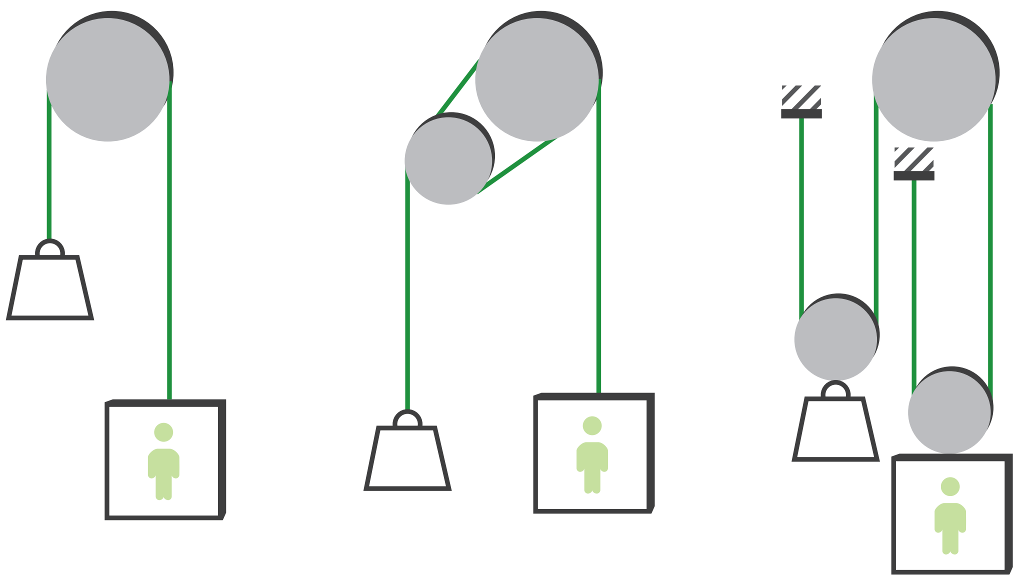
- Recommended
- Allowed
- Non recommended

	Core type	Typical strand construction	Typical grade	Typical initial stretch [%]	Typical elastic elongation [%]
Elstar 6G/8G	SFC	19S, 19W	1960	0.22	0.08
Elstar 6SF	NFC	19S	1370/1770	0.22	0.22
Elstar 8WF/8SF	NFC	19W, 19S	1370/1770	0.26	0.12
Elstar 8WS/8SS	IWRC	19W, 19S	1570, 1770	0.18	0.12
Elstar 8FS	IWRC	25F	1370/1770	0.18	0.12
Elstar 8WM/8SM	Mixed	19W, 19S	1570	0.25	0.12
Elstar 9SS/9FS	IWRC	19S, 25F	1570, 1770	0.16	0.11
Elstar 9SP	PWRC	19S	1570	0.13	0.1
Elstar 6C	SFC	19S	1570/1770	N/A	N/A



Type of elevator			Speed [m/s]	Traction	Compensating	Governor
	Mid rise	High rise				
N/A	N/A	N/A	N/A	✗	✗	✓
✓	✗	✗	≤ 1.6	✓	!	✗
✓	✗	✗	≤ 1.6	✓	✗	✗
✓	✓	✓	> 6	✓	✗	✗
✓	✓	✓	> 6	✓	✗	✗
✓	✓	✗	≤ 6	✓	✗	✗
✓	✓	✓	> 6	✓	✗	✗
✓	✓	✓	> 6	✓	✗	✗
N/A	N/A	N/A	N/A	✓	✓	✗

Examples of overhead elevators

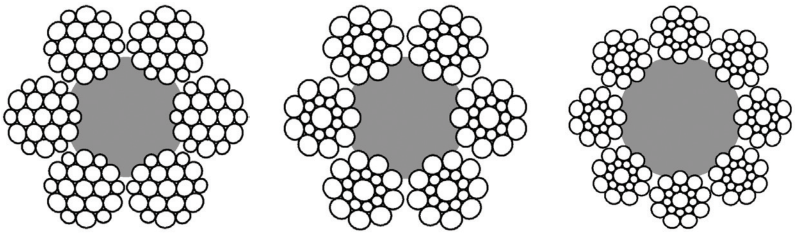


Single wrap 1:1   Double wrap 1:1   Single wrap 2:1

ELSTAR 6G/8G
GOVERNOR ROPES

Diameter	Construction	Grade	Mass		Minimum Breaking Force	
Metric			Metric	Imperial	Force	Load
mm			kg/m	lb/ft	kN	ton
6*	6x19S-IWRC	1770	0.150	0.101	25.8	2.63
6	6x19S-SFC	1960	0.129	0.087	21.0	2.14
6.3	6x19S-SFC	1960	0.152	0.102	23.2	2.36
6.5	6x19S-SFC	1960	0.152	0.102	24.7	2.52
6.5	6x19W-SFC	1960	0.160	0.108	25.8	2.63
7	6x19S-SFC	1960	0.176	0.118	28.6	2.92
7	6x19S-SFC	1960	0.186	0.125	29.9	3.05
8	6x19S-SFC	1960	0.230	0.155	33.2	3.38
8	8x19S-FC	1960	0.220	0.148	36.8	3.75

This product is by default galvanized, dry. Specific features can be agreed.
*6mm, 6x19S IWRC is provided ungalvanized.



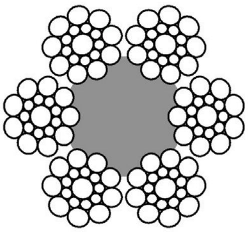
- Excellent diameter stability due to the enhanced core
- Damp proof protection against swelling and deterioration
- Galvanized wires with high corrosion resistance

ELSTAR 6SF

HOIST ROPE

Diameter		Construction	Grade	Mass		Minimum Breaking Force	
Metric	Imperial			Metric	Imperial	Force	Load
mm	in			kg/m	lb/ft	kN	ton
	5/16	6x19S-NFC	1370/1770	0.223	0.150	31.7	3.23
8		6x19S-NFC	1370/1770	0.230	0.154	32.0	3.26
9		6x19S-NFC	1370/1770	0.291	0.195	40.5	4.13
	3/8	6x19S-NFC	1370/1770	0.327	0.220	44.7	4.56
10		6x19S-NFC	1370/1770	0.359	0.241	50.0	5.10
11		6x19S-NFC	1370/1770	0.434	0.292	60.5	6.17
	7/16	6x19S-NFC	1370/1770	0.442	0.297	61.7	6.29
12		6x19S-NFC	1370/1770	0.517	0.347	72.0	7.34
	1/2	6x19S-NFC	1370/1770	0.580	0.390	79.8	8.13
13		6x19S-NFC	1370/1770	0.607	0.408	84.5	8.61
14		6x19S-NFC	1370/1770	0.704	0.473	98.0	9.99
15		6x19S-NFC	1370/1770	0.808	0.543	113	11.5
	5/8	6x19S-NFC	1370/1770	0.906	0.609	127	12.9
16		6x19S-NFC	1370/1770	0.919	0.618	128	13.0

This product is by default ungalvanized. Specific features can be agreed.



- Excellent flexibility and fatigue resistance
- Lubricated during manufacturing
- Provided with line marking for easy installation

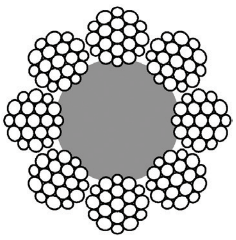
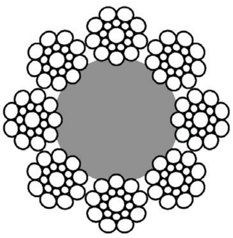
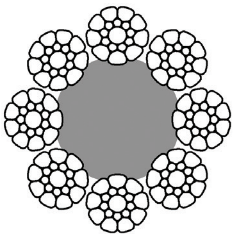
ELSTAR 8WF/8SF

HOIST ROPE

BruntonShaw
STRENGTH IN SERVICE

Diameter		Grade	8x19W-NFC				8x19S-NFC			
			Mass		Minimum Breaking		Mass		Minimum Breaking	
Metric	Imperial		Metric	Imperial	Force	Load	Metric	Imperial	Force	Load
mm	in		kg/m	lb/ft	kN	ton	kg/m	lb/ft	kN	ton
7		1370/1770	0.172	0.115	24.5	2.50	0.167	0.112	23.5	2.40
	5/16	1370/1770	0.223	0.150	28.1	2.87	0.217	0.145	27.0	2.75
8		1370/1770	0.224	0.151	32.0	3.26	0.218	0.146	30.7	3.13
9		1370/1770	0.284	0.191	40.5	4.13	0.275	0.185	38.9	3.96
	3/8	1370/1770	0.306	0.206	41.4	4.22	0.300	0.202	39.7	4.05
10		1370/1770	0.350	0.235	50.0	5.10	0.340	0.228	48.0	4.89
11		1370/1770	0.410	0.276	60.5	6.17	0.411	0.276	58.1	5.92
	7/16	1370/1770	0.420	0.280	61.7	6.29	0.421	0.283	59.2	6.03
12		1370/1770	0.504	0.339	72.0	7.34	0.490	0.329	69.1	7.05
	1/2	1370/1770	0.550	0.370	70.9	7.23	0.548	0.369	77.4	7.89
13		1370/1770	0.592	0.397	84.5	8.61	0.575	0.386	81.1	8.27
14		1370/1770	0.686	0.461	98.0	9.99	0.666	0.448	94.1	9.59
15		1370/1770	0.788	0.529	113	11.5	0.765	0.514	108	11.0
	5/8	1370/1770	0.870	0.585	103	10.5				
16		1370/1770	0.896	0.602	125	12.7	0.870	0.585	120	12.2
	11/16	1370/1770	1.07	0.720	153	15.6	1.04	0.699	123	12.5
	3/4	1370/1770	1.23	0.827	145	14.8				

This product is by default ungalvanized. Specific features can be agreed.
12.7 mm also available in 8x19S, 1770 grade, 77.8kN MBF. 15.88mm & 19.05 mm are in 8x25F construction.
For compacted strand construction 8xK19S, 6% MBL increase can be considered. See page 15 for additional details.

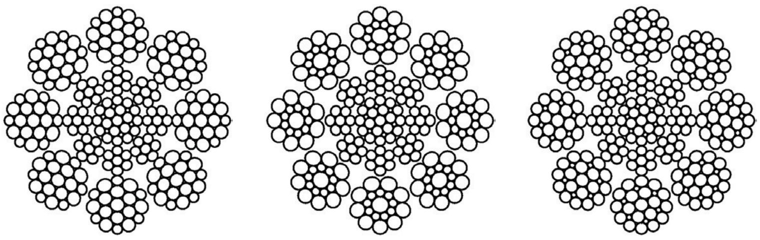




- Also available with compacted strands for enhanced roundness and load capacity
- Lubricated during manufacturing
- Provided with line marking for easy installation

ELSTAR 8WS/8SS/8FS
HOIST ROPE

Diameter		Construction	Grade	Mass		Minimum Breaking Force	
Metric	Imperial			Metric	Imperial	Force	Load
mm	in			kg/m	lb/ft	kN	ton
6.5		8x19W-IWRC	1770	0.172	0.116	30.4	3.10
	5/16	8x19W-IWRC	1570	0.253	0.170	35.8	3.65
8		8x19W-IWRC	1570	0.260	0.175	44.6	4.55
8		8x19W-IWRC	1770	0.260	0.175	46.1	4.70
9		8x19W-IWRC	1770	0.330	0.222	58.3	5.94
	3/8	8x19S-IWRC	1370/1770	0.372	0.250	50.4	5.14
10		8x19W-IWRC	1570	0.407	0.274	69.5	7.08
10		8x19W-IWRC	1770	0.407	0.274	72.0	7.34
11		8x19W-IWRC	1770	0.492	0.331	87.1	8.88
	7/16	8x19W-IWRC	1770	0.498	0.335	87.1	8.88
12		8x19W-IWRC	1770	0.586	0.394	104	10.6
	1/2	8x19S-IWRC	1570	0.620	0.417	98.3	10.0
13		8x19S-IWRC	1570	0.580	0.390	103	10.5
13		8x19W-IWRC	1770	0.688	0.462	122	12.4
14		8x19W-IWRC	1770	0.798	0.536	141	14.4
15		8x19W-IWRC	1770	0.916	0.615	162	16.5
	5/8	8x19S-IWRC	1570/1770	1.03	0.690	155	15.8
16		8x19W-IWRC	1770	1.04	0.700	184	18.8

This product is by default ungalvanized. Specific features can be agreed.



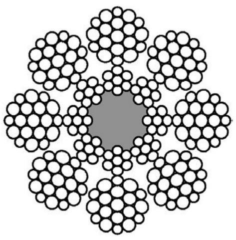
- Elstar 6.5 8WS TUV approved - CA 564
- Lower stretch and elongation than fiber core ropes
- Lubricated during manufacturing and with line marking for easy installation

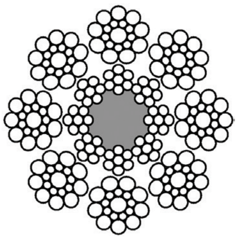
ELSTAR 8WM/8SM
HOIST ROPE

BruntonShaw
STRENGTH IN SERVICE

Diameter	Grade	8x19W - Mixed core				8x19S - Mixed core			
		Mass		Minimum Breaking		Mass		Minimum Breaking	
Metric		Metric	Imperial	Force	Load	Metric	Imperial	Force	Load
mm		kg/m	lb/ft	kN	ton	kg/m	lb/ft	kN	ton
8	1570	0.260	0.175	40.6	4.14	0.249	0.167	38.7	3.95
9	1570	0.330	0.222	51.4	5.24	0.315	0.212	49.0	5.00
10	1570	0.407	0.274	63.5	6.47	0.389	0.261	60.5	6.17
11	1570	0.492	0.331	76.8	7.83	0.471	0.316	73.2	7.46
12	1570	0.586	0.394	91.4	9.32	0.560	0.376	87.1	8.88
13	1570	0.688	0.462	107	10.9	0.657	0.442	102	10.4
14	1570	0.798	0.536	124	12.7	0.762	0.512	119	12.1
15	1570	0.916	0.615	143	14.6	0.875	0.588	136	13.9
16	1570	1.042	0.700	163	16.6	0.996	0.669	155	15.8

This product is by default ungalvanized. Specific features can be agreed.



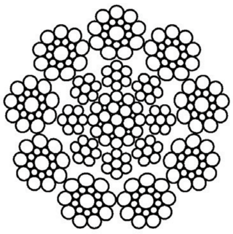


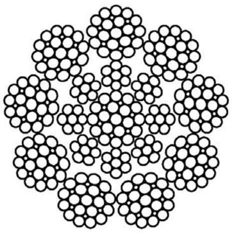
- Excellent diameter stability
- Lower stretch and elongation than fiber core ropes
- Lubricated during manufacturing and with line marking for easy installation

ELSTAR 9SS/9FS
HOIST ROPE

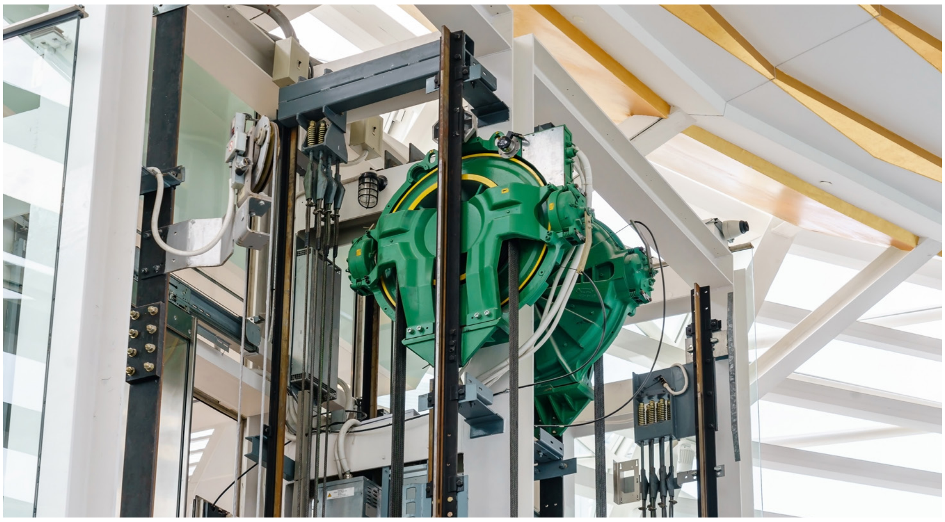
Diameter		Construction	Grade	Mass		Minimum Breaking	
Metric	Imperial			Metric	Imperial	Force	Load
mm	in			kg/m	lb/ft	kN	ton
	5/16	9x19S-IWRC	1570	0.278	0.187	39.6	4.03
8		9x19S-IWRC	1770	0.283	0.190	44.6	4.55
	3/8	9x19S-IWRC	1570	0.387	0.260	55.8	5.69
10		9x25F-IWRC	1770	0.435	0.292	69.7	7.10
11		9x25F-IWRC	1570	0.435	0.292	80.2	8.18
11		9x25F-IWRC	1770	0.526	0.354	84.3	8.60
	7/16	9x25F-IWRC	1770	0.537	0.361	86.0	8.77
12		9x25F-IWRC	1770	0.626	0.421	100	10.2
	1/2	9x25F-IWRC	1570	0.702	0.471	110	11.2
13		9x25F-IWRC	1770	0.735	0.494	118	12.0
14		9x25F-IWRC	1770	0.853	0.573	137	13.9
15		9x25F-IWRC	1770	0.979	0.658	157	16.0
	5/8	9x25F-IWRC	1570	1.11	0.746	174	17.7
16		9x25F-IWRC	1770	1.11	0.748	178	18.2

This product is by default ungalvanized. Specific features can be agreed.





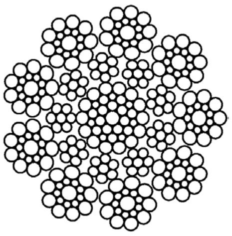
- Superior diameter stability and surface roundness
- Lower stretch and elongation than fiber core ropes
- Lubricated during manufacturing and with line marking for easy installation



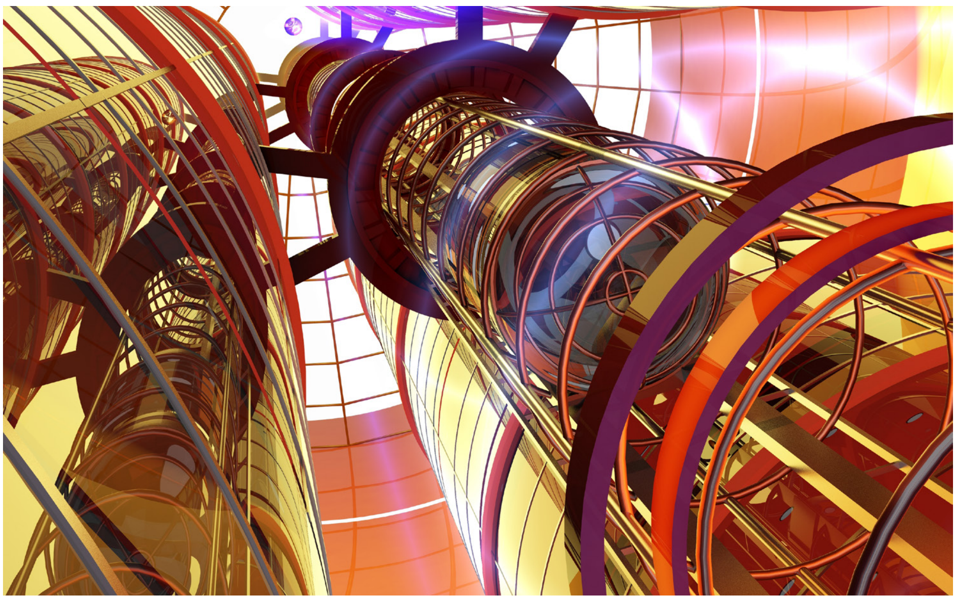
ELSTAR 9SP
HOIST ROPE

Diameter	Construction	Grade	Mass		Minimum Breaking Force	
Metric			Metric	Imperial	Force	Load
mm			kg/m	lb/ft	kN	ton
8	9x19S-PWRC	1570	0.285	0.184	44.2	4.50
9	9x19S-PWRC	1570	0.360	0.233	55.9	5.70
10	9x19S-PWRC	1570	0.445	0.288	69.0	7.03
11	9x19S-PWRC	1570	0.538	0.348	83.5	8.51
12	9x19S-PWRC	1570	0.641	0.414	99	10.1
13	9x19S-PWRC	1570	0.752	0.486	117	11.9
14	9x19S-PWRC	1570	0.872	0.564	135	13.8
15	9x19S-PWRC	1570	1.00	0.647	155	15.8
16	9x19S-PWRC	1570	1.14	0.736	177	18.0

This product is by default ungalvanized. Specific features can be agreed.
See page 20 for additional details about sheaves compatibility.



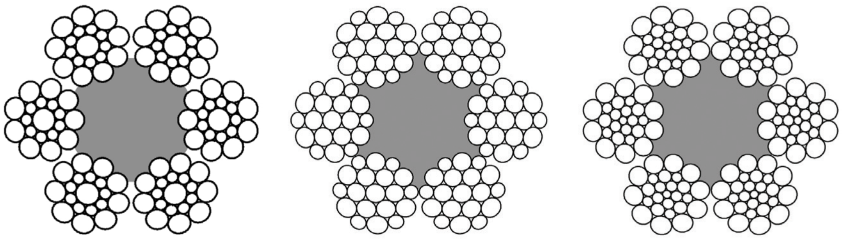
- Designed for precise stopping and loading conditions
- Superior diameter stability and smooth contact surface
- Excellent crushing resistance and sheaves interaction



ELSTAR 6C
COMPENSATION ROPE

Diameter		Construction	Grade	Mass		Minimum Breaking Force	
Metric	Imperial			Metric	Imperial	Force	Load
mm	in			kg/m	lb/ft	kN	ton
14		6x19S-SFC	1570/1770	0.696	0.468	111	11.3
	5/8	6x19S-SFC	1570/1770	0.909	0.611	145	14.8
18		6x19S-SFC	1570/1770	1.15	0.773	184	18.7
20		6x19S-SFC	1570/1770	1.42	0.954	227	23.1
22		6x19S-SFC	1570/1770	1.72	1.15	274	28.0
24		6x19S-SFC	1570/1770	2.04	1.37	327	33.3
26		6x19S-SFC	1570/1770	2.40	1.61	383	39.1

This product is by default ungalvanized. Specific features can be agreed.
Also available in 19W and 26WS construction.



- Designed to balance the weight of hoist ropes and ancillaries
- Damp proof protection against swelling and deterioration
- Customisable strand construction

WIRE ROPES FOR ELEVATORS

BruntonShaw STRENGTH IN SERVICE

A rope is a complex system composed by individual wires helically laid capable to combine load capacity and flexibility.

The structure of the rope makes it intrinsically safe, as each component is redundant in respect to the other ones and a failure of an individual wire does not affect the safety of the overall system. Moreover, the progress of rope deterioration in normal working conditions can be clearly assessed by regulated inspection criteria, which allow to detect the approaching of the end of useful service life.

Each rope can be specifically designed to meet the application requirements: the typical parameters to be considered are size and tolerance, rope and strands construction, strength of the wires. Ropes are designed and manufactured following specific regulations, which describe the relevant features:

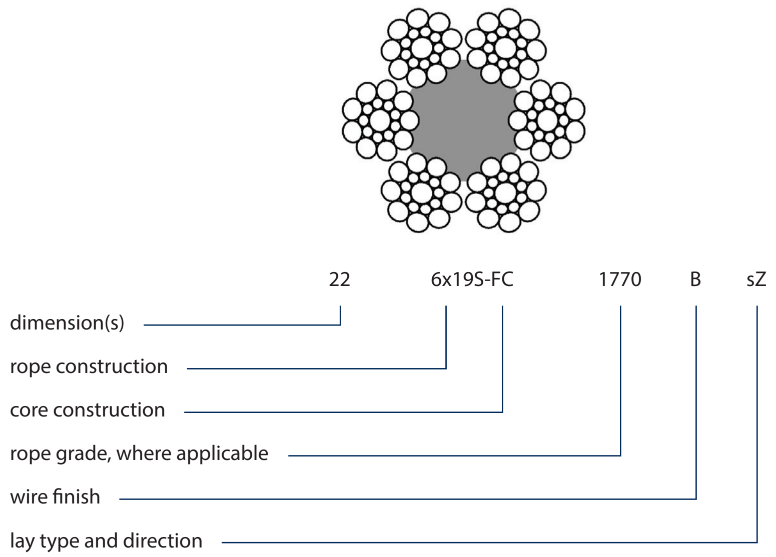
- EN12385 Steel wire ropes – Safety – Part 1: General requirements
- EN12385 Steel wire ropes – Safety – Part 2: Definition, designation and classification
- EN12385 Steel wire ropes – Safety – Part 3: Information for use and maintenance
- EN12385 Steel wire ropes – Safety – Part 5: Stranded ropes for lifts
- ISO4344 Steel wire ropes for lifts – Minimum requirements
- ASME A18.1:2020 – Safety Standard for Platform Lifts and Stairway Chairlifts
- ASME A17.6-2010 – Elevator Suspension, Compensation, and Governor Systems

Rope designation is described in EN 12385-2 and ASME A18.1 and covers all the relevant characteristics of the rope, as shown in the following example.

The first values indicate the nominal diameter in millimeters, the geometrical arrangement in terms of number and construction of the outer strands and the type of core.

The following values indicate the grade of the rope and the surface finish, where "B" stands for bright or ungalvanized wires.

The final letters identify the lay direction of the strands and of the rope, where "S" stands for left hand and "Z" stands for right hand.



Definitions

Stranded rope:	an assembly of several strands laid helically in one or more layers around a core (single-layer rope) or centre (rotation-resistant or parallel-closed rope).
Rope class:	a grouping of ropes of similar mechanical properties and physical characteristics.
Rope construction:	the detail and arrangement of the various elements of the rope.
Finish & quality of coating:	the condition of the surface finish of the wire e.g. uncoated (bright), zinc coated, zinc alloy coated or other protective coating and the class of coating, e.g. class B zinc coating, defined by the minimum mass of coating and the adherence of the coating to the steel below.

ROPE CONSTRUCTION

BruntonShaw
STRENGTH IN SERVICE

Each rope is composed by a certain number of strands helically laid around a core using right or left direction depending on the type of design and application.

Rope lay type is defined based on the direction of wires and strands: a rope having strands and wires laid in the same direction is defined Lang's lay, while if strands and wires have opposite direction it is defined regular or ordinary lay. The most common lay type for elevator ropes is right hand, regular lay construction, which is identified by "sZ" letters.

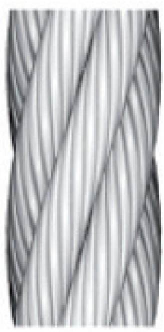
The core can be composed by natural or synthetic fibers, steel, steel based composite, like a combination of steel and fiber, or non-metallic material other than fibers.

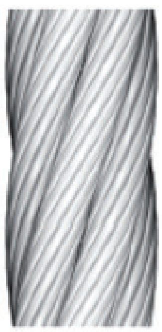
The construction together with the type of material used in the core affects the mechanical characteristic of ropes: for example, ropes with steel core have higher radial stiffness and less elongation in service, particularly in case of parallel laid ropes.

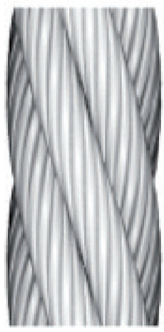
The typical number of outer strands for elevator ropes can vary from 6 to 9 and depends on the requirement of the application: generally speaking, ropes with higher number of outer strands provide a smoother contact surface with the sheaves, more metallic area and more flexibility if considering the same strands construction and rope size, as the individual wires will result to be smaller.

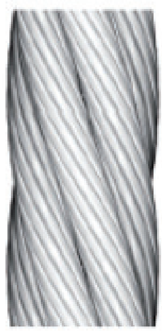
8 strand fiber core ropes can also be provided with strands compaction. Although not covered by Regulations, this construction is very common for basement machine arrangements, as it helps to absorb possible sheaves misalignments. To facilitates the rope's sliding into the grooves, they are usually provided with ordinary lay.

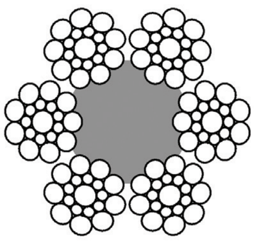
The following figures show the possible lay types and some typical rope constructions.

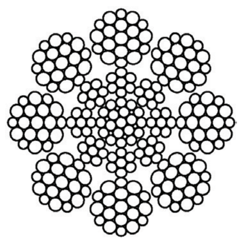

Right Hand Regular Lay sZ

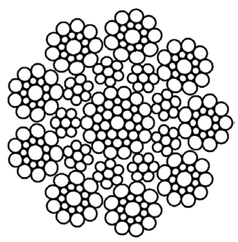

Right Hand Langs Lay zZ


Left Hand Regular Lay zS


Left Hand Langs Lay sS


6 strand Fiber Core


8 strand
Independent Wire Rope Core


9 strand
Parallel Wire Rope Core

Definitions

Lay direction: the direction right [Z or RH] or left [S or LH] corresponding to the direction of lay of the outer strands in a stranded rope in relation to the longitudinal axis of the rope.

Rope lay length (H): that distance (H) parallel to the longitudinal rope axis in which the outer wires of a spiral rope, the outer strands of a stranded rope or the unit ropes of a cable-laid rope make one complete turn (or helix) about the axis of the rope.

STRANDS CONSTRUCTION

Strands are laid according to specific arrangements in order to optimise the performance of the rope.

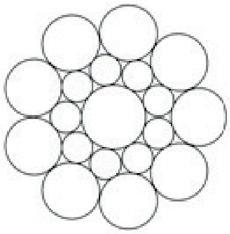
The four most typical constructions are Seale, Warrington, Filler and Warrington-Seale.

Seale construction is composed of a king wire, an intermediate layer typically composed of eight or nine wires and an outer layer composed of the same number of wires. This results in a thick outer layer, which provides higher wear resistance when running over traction sheaves.

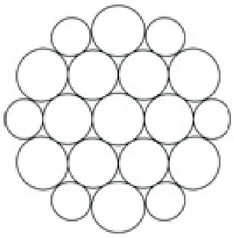
Warrington construction is composed of a king wire, an intermediate layer typically composed of a certain number of wires (e.g. six) and an outer layer composed of a double number of wires (e.g. twelve). This results in thinner outer wires, which are beneficial in terms of fatigue resistance when the rope is bent over small sheaves. This type of construction is particularly popular in elevators with double wrap drives and in hydraulic elevators.

Filler construction is composed of a king wire, an intermediate layer typically composed of four to six wires, a filler layer composed of the same number of wires with very small size and an outer layer composed of a double number of wires. This construction combines the benefits of Seale and Warrington, having large wires on the outer layer for abrasion resistance and small wires in the inner part to maintain flexibility. Filler wires also increase the metallic section, allowing to have higher breaking force and making this construction particularly suitable for high rise and high speed applications.

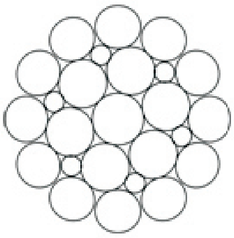
Warrington-Seale construction is the combination of the first two configurations and it is used for large size ropes, where the dimensions of the wires would become relevant and would affect the bending capability.



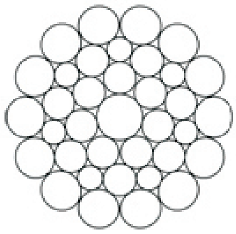
19 Seale



19 Warrington



25 Filler



36 Warrington-Seale

Definitions

Strand:	an element of rope consisting of an assembly of wires of appropriate shape and dimensions laid helically in the same direction in one or more layers around a centre.
Compacted strand rope:	rope in which the strands, prior to closing of the rope, are subjected to a compacting process such as drawing, rolling or swaging.

GRADE AND BREAKING FORCE

BruntonShaw STRENGTH IN SERVICE

An accurate selection of raw material is essential to get the desired rope mechanical characteristics, Minimum Breaking Force and service life.

Steel ropes are made by wires obtained by cold drawing process, which consists of the passage of high carbon rod through a series of dies with gradual diameter reduction.

This generates an alignment in the structure of the steel, giving an increase both in strength and in ductility.

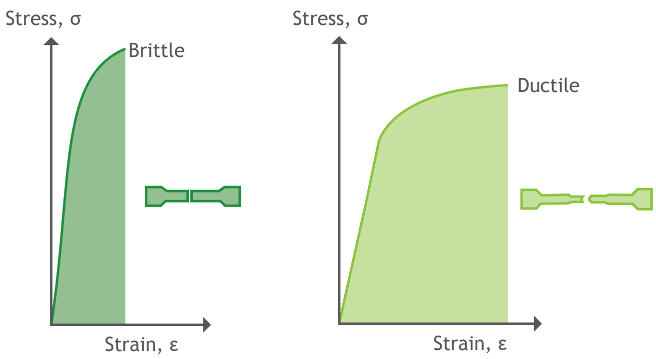
The use of ductile wires is essential to get the required Minimum Breaking Force and, at the same time, to ensure good rope performances in service and safe working conditions.

This is due to the fact that, considering the behavior at break, ductile materials show a relevant plastic deformation, while brittle materials have the tendency to break with no notice.

Depending on the carbon content of the rod and on the type of drawing, the wire is assigned a specific grade, which is a requirement of breaking force designated by a value in MPa (e.g. 1570MPa, 1770MPa).

In a similar way, also the rope will be designated by a grade, which is a number with no units (e.g. 1570, 1770) indicating the level of minimum breaking force: the rope can be composed by wires having the same grade or by two different grades (dual tensile ropes).

The rope grade shall be in accordance with rope application, as shown in the table.



Allowed rope grade	Dual 1180/1770	Dual 1370/1770	Dual 1570/1770	1570	1770	1960
Traction drive ropes, fiber core	x	x	-	x	x	-
Traction drive ropes, steel core	-	x	x	x	x	-
Hydraulic lifts ropes, fiber core	-	x	-	x	x	-
Hydraulic lifts ropes, steel core	-	x	x	-	x	-
Governor ropes	x	x	x	x	x	x
Compensating ropes	x	x	x	x	x	x

Definitions

Minimum breaking force: specified value in kN, below which the measured breaking force is not allowed to fall in a prescribed breaking force test and normally obtained by calculation from the product of the square of the nominal diameter, the rope grade and the breaking force factor.

Rope grade: a level of requirement of breaking force which is designated by a number (e.g. 1770, 1960). NOTE - it does not imply that the actual tensile strength grades of the wires in the rope are necessarily of this grade.

Wire tensile strength grade: a level of requirement of tensile strength of a wire and its corresponding range. It is designated by the value according to the lower limit of tensile strength and is used when specifying wire and when determining the calculated minimum breaking force or calculated minimum aggregate breaking force of a rope, expressed in N/mm^2.

ROPE ELONGATION IN SERVICE

BruntonShaw
STRENGTH IN SERVICE

When subjected to axial loads, the elasticity of the material and the helical arrangement of the individual wires cause ropes elongation.

There are two different components of the elongation which have to be taken into consideration:

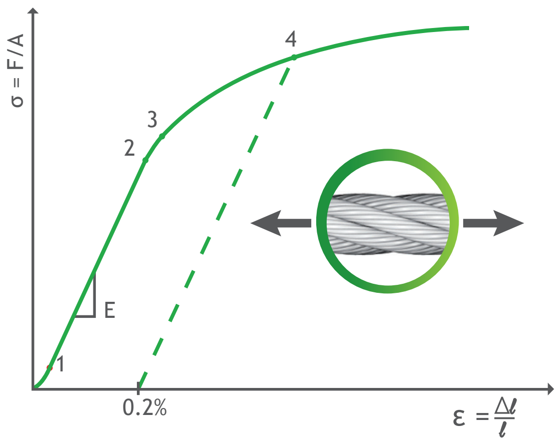
- constructional stretch, which is due to the initial stabilisation of the elements composing the rope. This phenomenon occurs immediately after the rope is put in service and mostly disappears after the first period of use
- elastic elongation, which is due to the axial load applied during rope use and which is reversible if the rope does not exceed the yield point

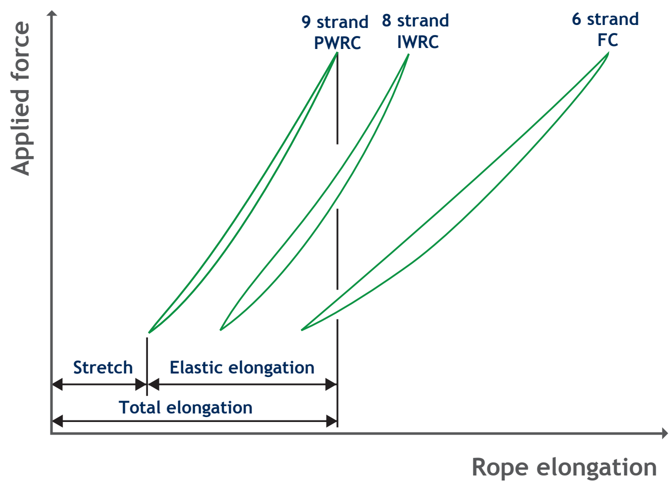
The amount of rope elongation depends on the construction and in particular on the metallic area, lay length and type of core: ropes with high fill factor of steel, like the nine strand parallel laid, have a much lower elongation in respect to six strand with fiber core when subjected to the same axial load. Other constructions, like ropes with Independent Wire Rope Core or Mixed Core, have an intermediate trend.

Rope behavior when subjected to axial loads is summarised in the below graph, which shows the relation between stress (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".

The first phase (up to point 1) is related to the constructional stretch, after this step the trend is basically linear up the achievement of yield point (point 3 and 4), from which permanent plastic deformation takes place, until the load reaches the actual breaking force.

The second graph represents the E modulus for three different rope types (9 strand PWRC, 8 strand IWRC and 6 strand FC): even if E modulus is conventionally taken as a constant, the actual value varies depending on the amount and direction of the applied force (loading or unloading).





Definitions

Fill factor: the ratio between the sum of the nominal metallic cross-sectional areas of all the wires in the rope (A) and the circumscribed area (A_u) of the rope based on its nominal diameter (d).

Elastic/Young Modulus (E): the ratio of the stress (force per unit area) along an axis to the strain (ratio of deformation over initial length) along that axis in the range of stress in which Hooke's law holds.

WIRE ROPE FATIGUE

Fatigue damage is a typical phenomenon which is not caused by a single event, but by repeated bending, tension and rotational stresses.

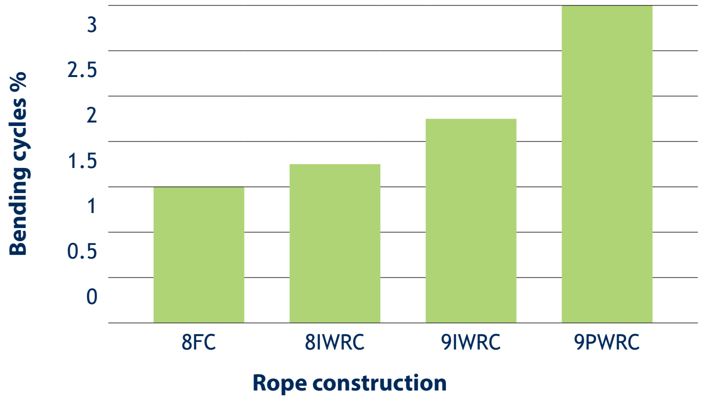
Since the working life of wire ropes involves several passages over drum and sheaves, this phenomenon has to be carefully considered during operations.

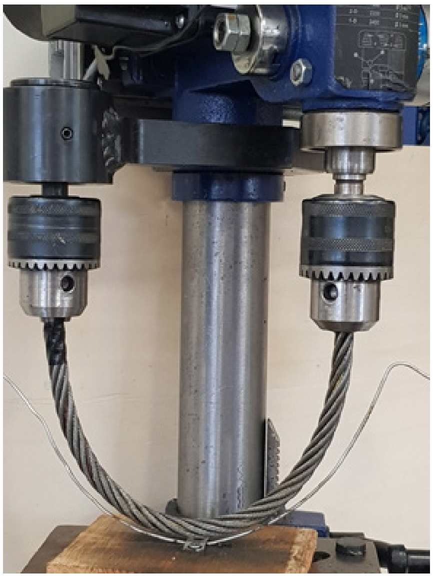
Fatigue damage occurs gradually and it strongly depends on the safety factor of the system. It becomes evident when it causes a relevant number of broken wires and consequent wire elongation, which quickly evolves until the rope reaches discard criteria.

Fatigue is an inherent phenomenon and therefore it cannot be eliminated, however it can be slowed down by adopting proper rope inspection and maintenance.

Brunton Shaw can perform extensive fatigue tests following the most typical customers' request and also using rotary fatigue test beds.

The results of the comparative tests performed on a selection of Elstar ropes are shown in the following graph.





INTERACTION BETWEEN ROPES AND SHEAVES

A proper matching between ropes and sheaves is essential to preserve their service life and to improve the operational conditions of the elevator.

The sheaves can have different grooves design, i.e. round or V-shaped and with optional undercut, which imply different contact with the rope.

Rope construction has a big effect in respect to contact surface: for example, a nine strand rope has a higher number of contact points in respect to a six strand rope, thus reducing vibrations and giving smoother operational conditions.

Particular attention shall be taken when utilizing 9 strand parallel laid ropes: although very convenient from roundness and breaking force point of view, they shall be carefully handled during the installation to prevent rotation and consequent birdcaging in service. Their usage should be limited to round grooves with no or very limited undercut, V grooves are generally not allowed.

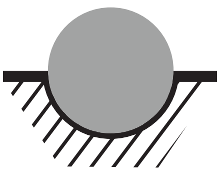
The typical material used for sheaves is cast iron, which is often hardened to prevent imprinting due to the contact pressure with the rope. Plastic lined sheaves are also used in some specific applications.

Since the ropes continuously run over the sheaves, wear and imprinting can occur after a certain period of use and can also be speeded up by:

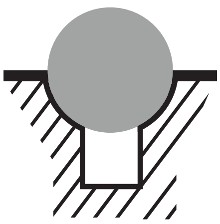
- inadequate sheave material or heat treatment
- lack of lubrication in the rope, which causes steel over steel friction
- issues during installation, in particular rope untwisting
- uneven rope tensioning, which makes some ropes slack and others heavily loaded
- improper seating of the rope in the groove, caused by lack of maintenance

When sheave wear or imprinting is noticed, it is highly recommend that you identify the cause of the issue to determine whether this is due to normal operational conditions or to anomalies in the system.

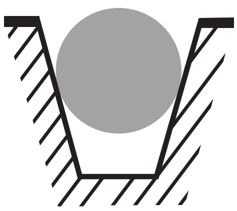
Worn sheaves should then be replaced or machined in order to restore the original configuration.



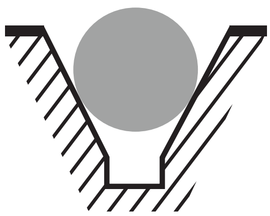
Round groove
no undercut



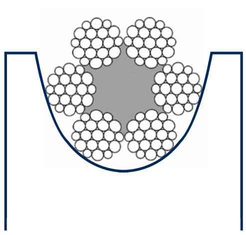
Round groove
with undercut



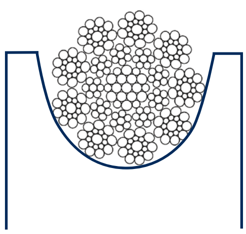
V-groove
no undercut



V-groove
with undercut



6 strand fiber core



9 strand parallel laid

STORAGE AND HANDLING

Ropes are generally supplied on coils or wooden or steel reels which are designed for the purpose of transportation and storage.

Immediately after receipt, the rope should be checked in order to verify its identity and condition to ensure that the rope itself and its terminations are compatible with the equipment to which they are to be attached in service.

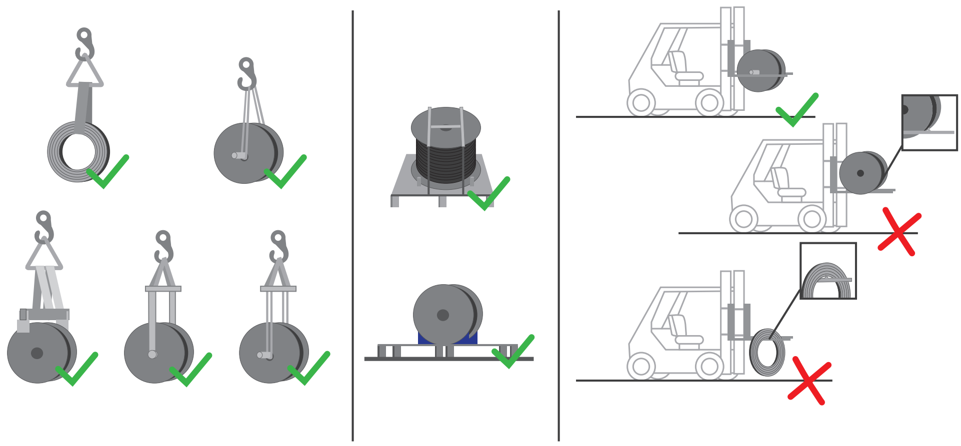
The Certificate of conformity issued by the rope manufacturer should be kept in a safe place, for identification of the rope when carrying out periodic thorough examinations in service.

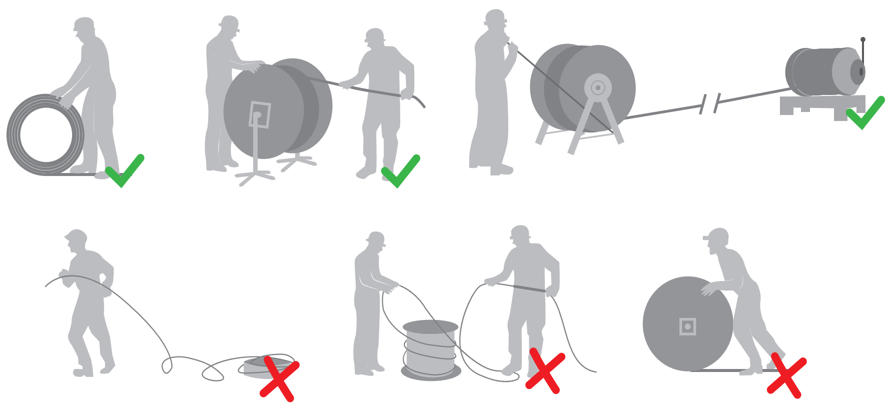
When moving the coil or the reel it is important to avoid the reel or the rope coming into contact with any part of the lifting device, such as crane hooks or forks, as this could damage the reel flanges and the rope itself.

Ropes should be stored in a dry and clean environment, avoiding overheating and direct contact with the ground, particularly in presence of dust or abrasive media.

As the rope has the natural tendency to untwist, rope uncoiling from the reel shall be made in a controlled way, using suitable stands and equipment.

Before cutting the rope to the desired length, rope ends shall be properly seized to avoid strands opening up and rope deformation.





Definitions

Serving: wrapping, usually made of wire or strand, for the purpose of securing a rope end to prevent its unlaying.

INSTALLATION AND MAINTENANCE

Proper installation procedures and accurate periodical maintenance are essential to preserve the service life of the rope.

The rope should be checked upon delivery to verify that no damage has occurred during handling, then it should be monitored carefully as it is being pulled into the system, ensuring that it is not obstructed by any part of the structure or mechanism that may damage it.

End terminations shall be properly applied to the rope ends to ensure a safe and stable connection between the rope and the elevator. Any issue during this phase, such as formation of slack strand due improper seizing or relative movement between the rope and the termination, shall be promptly detected and recovered.

Any rope has the tendency to turn when subjected to axial loads (i.e. working load or own weight), therefore it is essential that the rope ends are carefully secured during the installation phase.

To help the installation, Brunton Shaw ropes are usually supplied with a colored straight line which helps during installation.
A limited amount of turns into the new delivered rope (around 1 each 10 meters) shall be considered normal and not affecting the final performance.

The ropes shall be equally tensioned in order to ensure good operational conditions. Typically, the maximum allowed tension deviation against the average value is +/-5% .

Hoist ropes are lubricated during manufacturing, therefore when supplied they already contain an adequate amount of lubricant to protect them during the first period of storage and use.

However, in order to obtain optimum performance, it is recommended to perform a periodical application of a service lubricant, depending the environmental conditions, rate of usage, material of the sheaves and any peculiar event. If not otherwise required, the typical relubrication interval is around every 250.000 cycles.

The amount of lubricant should be such to penetrate in the rope and ensure a smooth interaction between the individual wires and strands, and at the same time to avoid the risk of rope slippage on the traction sheaves.

The type of service lubricant should be compatible with the one applied by the rope maker in order to avoid unexpected interactions between the two materials and it should be suitable for traction applications.

Before relubrication it is also recommended to clean the rope to remove possible debris and contaminating particles, which could cause abrasion or premature wear.

Definitions

Rope torque: torsional characteristic, the value of which is usually expressed in Nm, at a stated tensile loading and determined by test when both rope ends are prevented from rotating.
NOTE Torsional characteristics can also be determined by calculation.

Rope turn: rotational characteristic, the value of which is usually expressed in degrees or turns per unit length at a stated tensile loading and determined by test when one end of the rope is free to rotate.

INSPECTION AND DISCARD CRITERIA

Rope conditions must be periodically checked by a competent person capable to assess where the rope is still fit and safe for use or if specific actions, like discard, are required.

The most common causes for discard are broken wires, wear, corrosion, excessive stretch or localized damages such as local diameter reduction or waviness.

In case a single rope reaches discard criteria, the whole set shall be replaced, unless this has occurred during installation or before being put in service.

In these cases it is possible to replace the single rope only, provided that the wire rope data of the replacement one correspond to the certificate data of the original set, the rope termination is the same and the diameter of the new rope does not vary from the other ropes of the set by more than 0.5% of the nominal diameter.

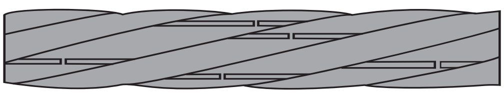
Possible variations in the rope diameter shall be taken under control: replacement should be considered if its value reduces over 6% the nominal diameter.

Other local variations in the rope structure or surface shall be promptly detected: for example, red dust protruding from the strands or wires indicating fretting corrosion shall be carefully checked.

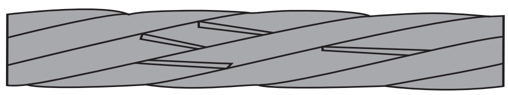
A distributed presence of broken wires could be due to rope fatigue, which typically shows a fast deterioration rate as soon as the ropes reaches the end of its service life. The presence of broken wires should be periodically monitored, in case the number exceeds the prescribed values the rope should be replaced or be subjected to further examinations at periodical intervals as stated by the competent person.

Some guidelines for discard criteria for the maximum allowed number of visible broken wires are shown in the following table.

	6x19 Fiber core		8x19 and 8x25 Fiber, mixed and steel core		9x19 and 9x25 Steel core	
Type of broken wires	Follow expert's indications	Discard immediately	Follow expert's indications	Discard immediately	Follow expert's indications	Discard immediately
Randomly distributed in outer strands	12/lay	24/lay	15/lay	30/lay	17/lay	34/lay
Predominantly in one or two strands	6/lay	8/lay	8/lay	10/lay	9/lay	11/lay
Adjacent in two strands	4	Over 4	4	Over 4	6	Over 6
In the valleys between the strands	1/lay	1/lay	1/lay	1/lay	1/lay	1/lay



Distributed crown wire breaks



Valley wire breaks

Definitions

Competent person: designated person, suitably trained, qualified by knowledge and experience and with the necessary instruction to ensure that the required operations are correctly carried out.

REFERENCES

BruntonShaw
STRENGTH IN SERVICE

The following list includes the main reference documents for wire ropes for elevators.
The list is not exhaustive, as there may be additional customer standards, local legislation and internal guidance to be considered.

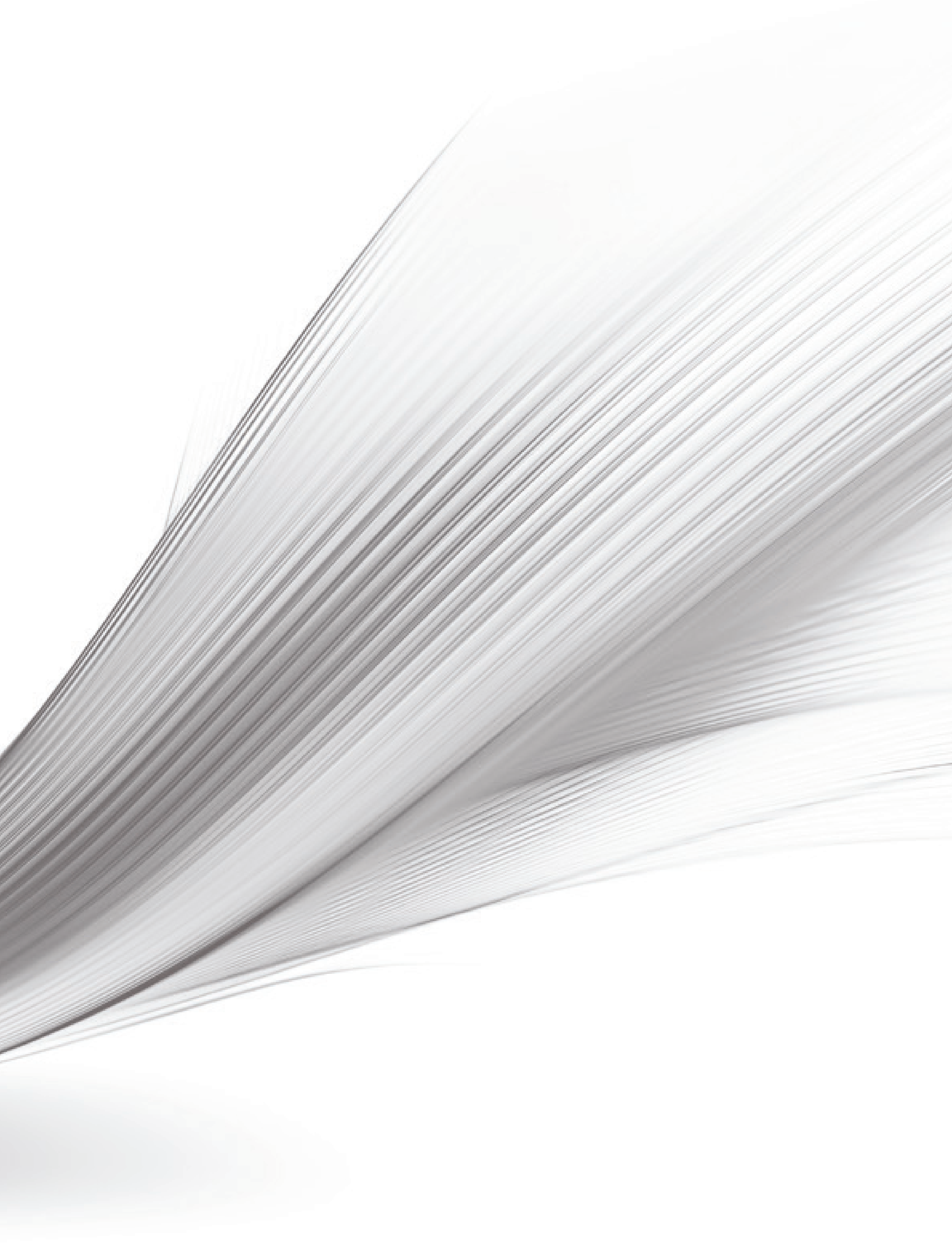
All the definitions included in this catalogue are based on the listed documents.

- EN 12385-1:2009 – Steel wire ropes – Safety Part 1: General requirements
- EN 12385-2:2008 – Steel wire ropes – Safety Part 2: Definitions, designation and classification
- EN 12385-3:2008 – Steel wire ropes – Safety Part 3: Information for use and maintenance
- EN 12385-5:2008 – Steel wire ropes – Safety Part 5: Stranded ropes for lifts
- ISO 4344:2004 – Steel wire ropes for lifts – Minimum requirements
- EN 10264-1:2002 – Steel wire and wire products – Steel wire for ropes – General requirements
- EN 10264-2:2002 – Steel wire and wire products – Steel wire for ropes – Cold drawn non-alloyed steel wire for ropes for general applications
- ISO 4101:1983 – Drawn steel wire for elevator ropes – Specifications
- EN 13411-3:2011 – Terminations for steel wire ropes – Safety Part 3: ferrules and ferrule-securing
- EN 13411-5:2011 – Terminations for steel wire ropes – Safety Part 5: U-bolt wire rope grips
- EN 13411-6:2011 – Terminations for steel wire ropes – Safety Part 6: Asymmetric wedge socket
- EN 13411-7:2011 – Terminations for steel wire ropes – Safety Part 7: Symmetric wedge socket
- EN 13411-8:2011 – Terminations for steel wire ropes – Safety Part 8: Swage terminals and swaging
- ISO18265:2013 – Metallic materials – Conversion of hardness values
- EN81-20:2014 – Safety rules for the construction and installation of lifts – Lifts for the transport of persons and goods – Part 20: Passengers and goods passenger lifts
- EN81-50:2014 – Safety rules for the construction and installation of lifts – Examinations and tests – Part 50: Design rules, calculations, examinations and tests of lift components
- ASME A18.1:2020 – Safety Standard for Platform Lifts and Stairway Chairlifts
- ASME A17.6-2010 – Elevator Suspension, Compensation, and Governor Systems.

Conversion factors

1	kg/m	=	0.672	lbs/ft
1	m	=	3.28	ft
1	mm	=	0.039	inch
1	kg	=	2.205	lbs
1	lb	=	0.0005	short t (ton)
1	metric t (tonne)	=	1.10	short t (ton)
1	metric t (tonne)	=	0.984	long t
1	kN	=	0.102	metric ft
1	N/mm^2 (MPa)	=	145	psi

1	lbs/ft	=	1.49	kg/m
1	ft	=	0.305	m
1	inch	=	25.4	mm
1	lbs	=	0.454	kg
1	short t (ton)	=	2000	lb
1	short t (ton)	=	0.907	metric t (tonne)
1	long t	=	1.016	metric t (tonne)
1	metric ft	=	9.81	kN
1	psi	=	0.0069	N/mm^2 (MPa)



Prysmian Group

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STRENGTH IN SERVICE

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