ArcelorMittal ROPES

ENGINEERING EXCELLENCE

Hoisting Ropes

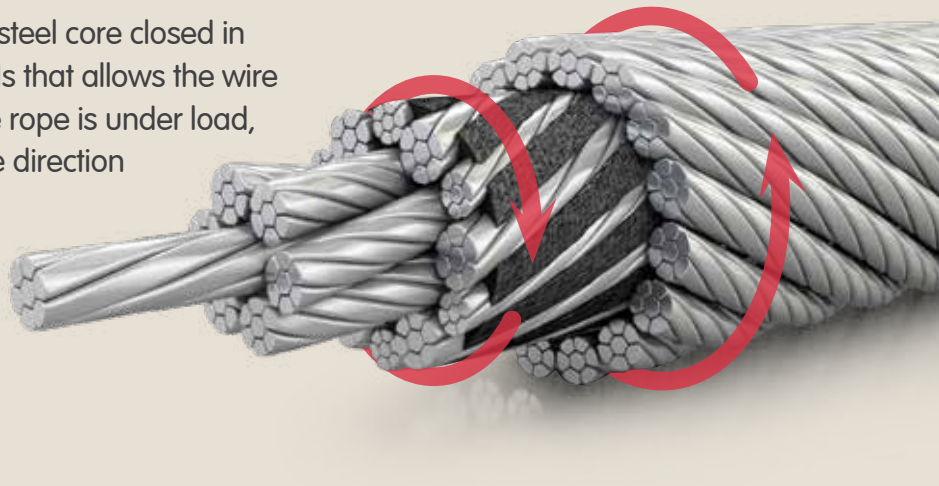
Technical Information

ArcelorMittal

Technical Information

Non-rotating properties

Non-rotating ropes are designed with a steel core closed in the opposite direction to the outer strands that allows the wire rope to be well balanced. When the wire rope is under load, the strands of the core are twisted in one direction while the outer strands tend to rotate in the opposite direction.

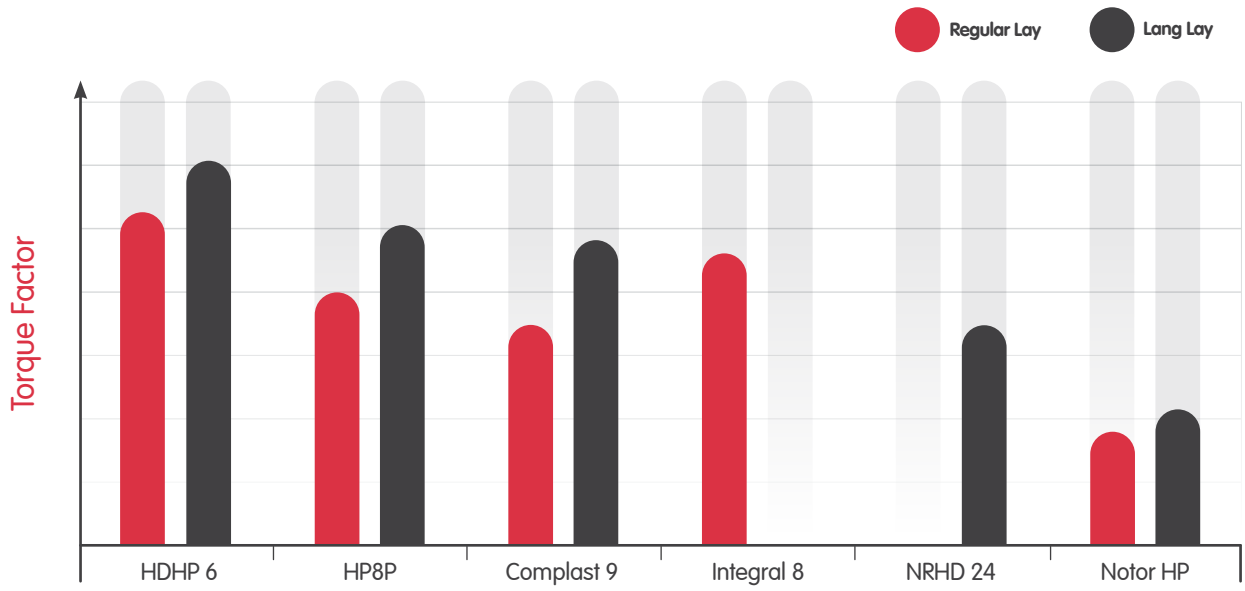


Torque factor

$$ftorque = \frac{C}{F \; x \; d}$$

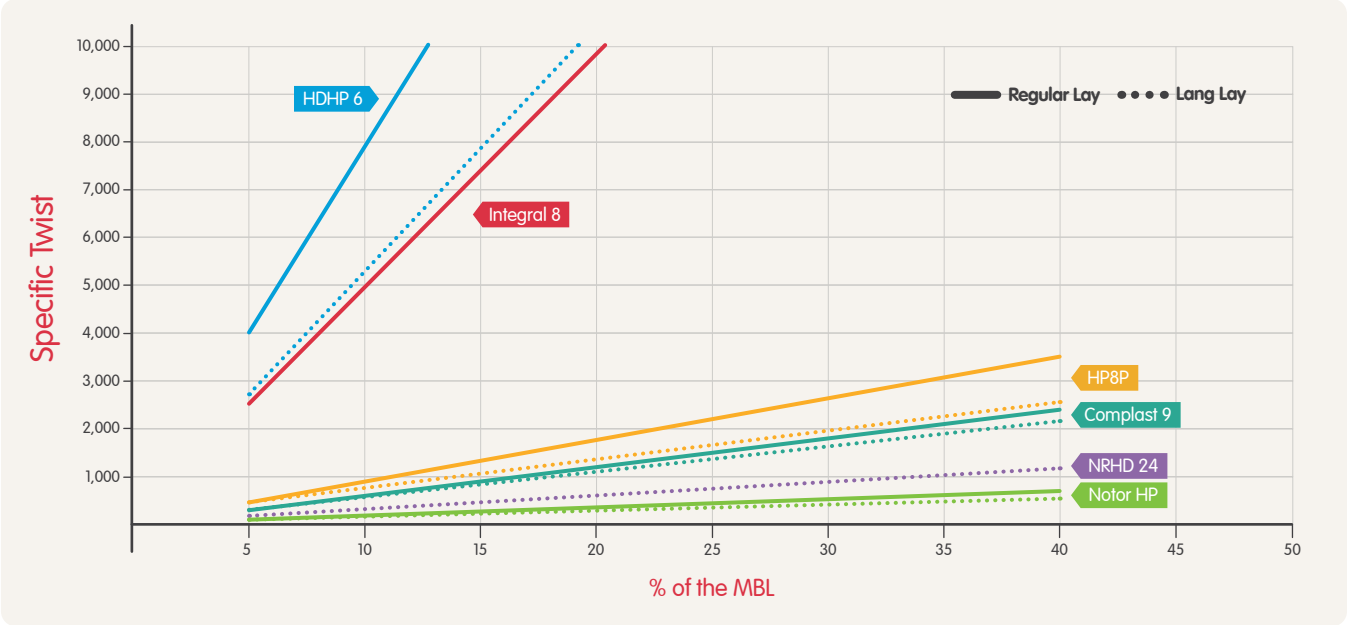
With:

- ftorque = torque factor [Nm/mm/kN]
- C = moment of torsion [N.m]
- F = load [kN]
- d = rope diameter [mm]



Technical Information

Specific twist

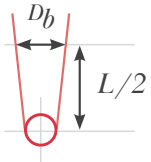


Stability of blocks

The boundary condition of stability with rotation of the block of an angle α corresponds to a maximum work height L:

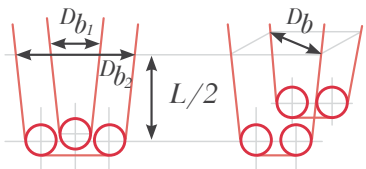
For 2 falls:

$$L_{2\ falls} \leq \frac{D_b^2 \, x \, sin\ \alpha}{4000 \, x \, d \, x \, f_{torque}}$$



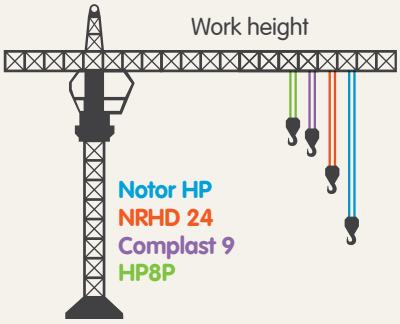
For 4 falls:

$$L_{4\ falls} \leq \frac{D_b^2 \, x \, sin\ \alpha}{8000 \, x \, d \, x \, f_{torque}}$$



With:

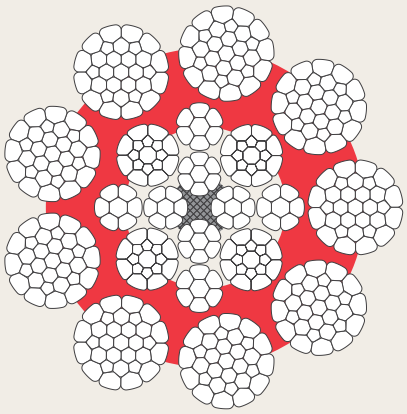
- D_b = distance between the falls [mm] (for 4 falls in the same plane, $D_b=(D_{b1}+D_{b2})/2$)
- α = admissible rotation angle [°] (generally equal to 56°)
- d = nominal rope diameter with 0/+4% tolerances [mm]
- f_{torque} = rope torque factor [Nm/mm/kN]



Technical Information

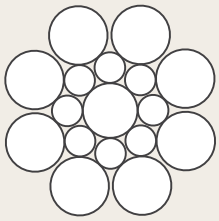
Plastic impregnation

The plastic impregnation couples the core and the outer strands, which delays the appearance of basket deformation/bird cage when the fleet angle is higher than 1.5°. Moreover, the wire rope behaviour is more homogenous, because the pressure between the core and the outer strands is slightly decreased.

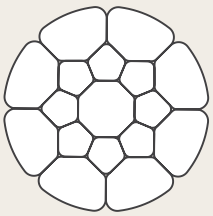


Compaction

Thanks to the rope compaction, the metallic section is increased, which leads to a higher breaking load than a non compacted wire rope of the same diameter. The outside strand area is also increased and smoother, which decreases the contact pressure between the rope and the drum/sheaves, and thus increases the fatigue properties.



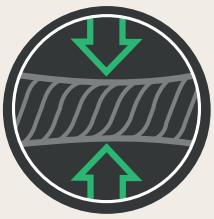
Round Wire Rope



Compacted Rope

Crush resistance

Crushing is the effect of external pressure on a rope which damages the rope by distorting the cross-sectional shape of the rope, its strands or core or all three. Crush resistant ropes withstand or resist external forces.



Technical Information

Regular Lay or Lang Lay

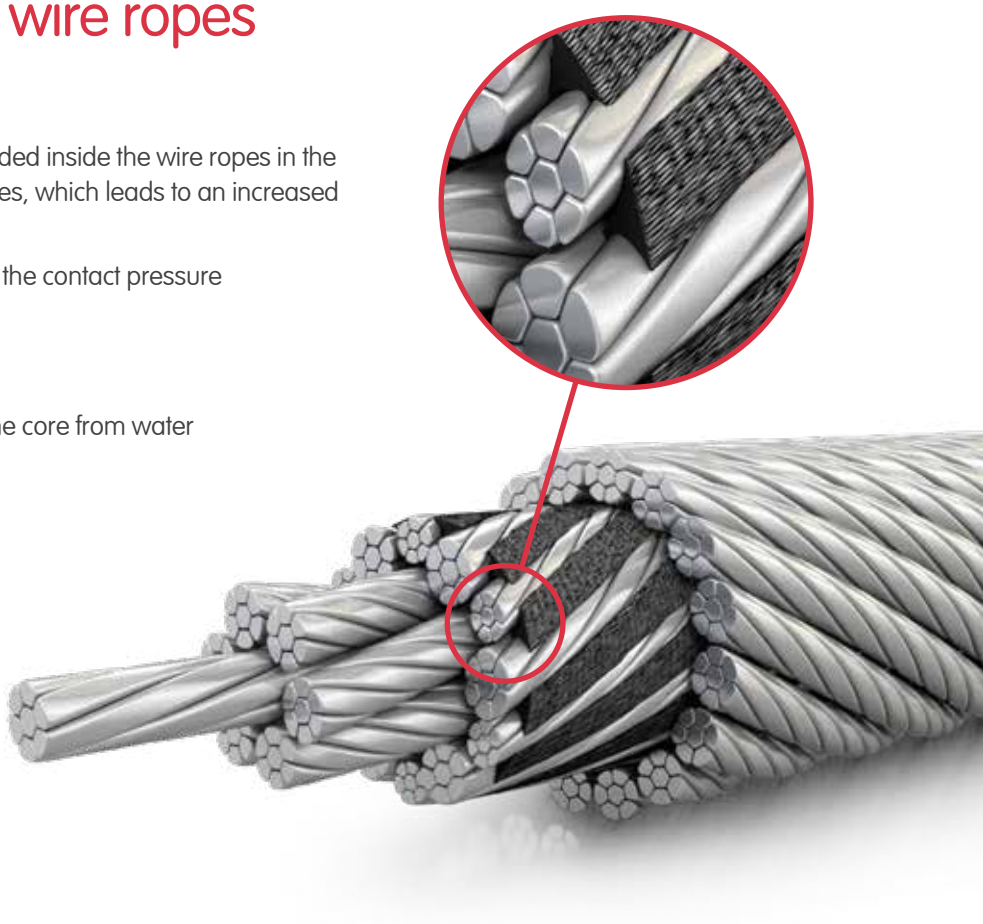
	Lang Lay	Regular Lay
		
Advantage	Wear resistance Flexibility	Core sensitivity Non-rotation property
Disadvantage	Core sensitivity Non-rotation property	Wear resistance

Textile strands inside wire ropes

In Notor HP and NRHD, textile strands are added inside the wire ropes in the core valleys. These strands bring 2 advantages, which leads to an increased lifetime of the rope:

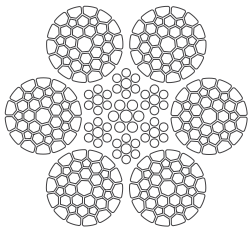
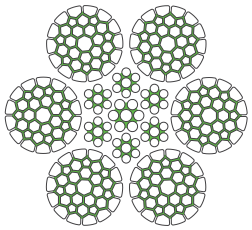
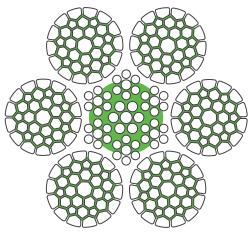
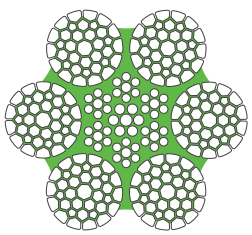
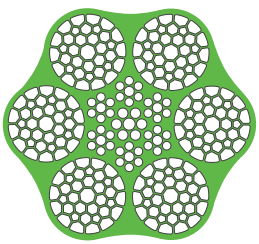
- A densification of the core, that decreases the contact pressure generated by the outer strands.
- A lubricant tank.

Moreover it is also noticed that they protect the core from water ingress and consequently against corrosion.



Lubrication and coatings

Lubrication types on ArcelorMittal steel wire ropes

Type of Lubrication	Lubrication Method		% mass	Note	Illustration
Dry	Closing	No grease slight oil only	0.0	For stainless wire ropes and specific demands (oil is applied to avoid trouble in the die during assembly)	
	Core				
	Stranding				
A-1	Closing	No grease, oil only	0.5	For ropeway ropes, mining ropes on Koepe sheave and plastified wire ropes	
	Core	No lubrication			
	Stranding	Lubrication + tight wipe			
A-2	Closing	No grease, oil only	0.75	Specific demands on plastified ropes	
	Core	Lubrication + tight wipe			
	Stranding	Lubrication + tight wipe			
A-3	Closing	Lubrication + wipe	1.5 - 1.75	Hoisting applications	
	Core	Lubrication + wipe			
	Stranding	Lubrication + wipe			
A-4	Closing	Lubrication + no wipe	2.0 - 2.5	Not available direct from the mill. (Can be performed by our distributors on specific demand)	
	Core	Lubrication + no wipe			
	Stranding	Lubrication + no wipe			

3 Grades of grease are available:

- Classic grease for onshore standard applications
- Improved grease for special applications
- Premium grease for aggressive environments

Groove characteristics for sheaves and grooved drums

Grooves in sheaves and drums should be circular and smooth.

Sheaves

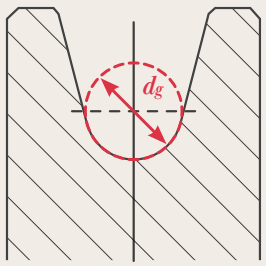
To ensure good support, the rope must contact the groove for approx 130-140° of arc, which leads to the following recommendation for the groove diameter:

$$1.05d < d_g < 1.1d$$

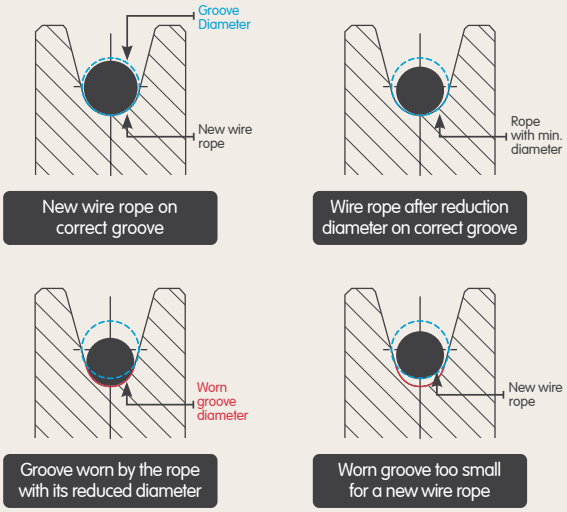
Optimal value = 1.075

With:

- d = nominal rope diameter with 0/+4% tolerances;
- d_g = groove diameter.



During a wire rope's lifetime, the rope diameter will decrease. This is due to first the elongation of the rope and then the wear on the rope wires. This diameter variation begins quickly but then slows down. The wire rope will create a new groove in the sheave which corresponds to the reduced diameter. If a new wire rope is installed in a worn sheave, without resurfacing, the new rope will wear more quickly. The lifetime can be divided by 10.



Grooved drums

The groove diameter d_g and the pitch diameter p must comply with the following criteria:

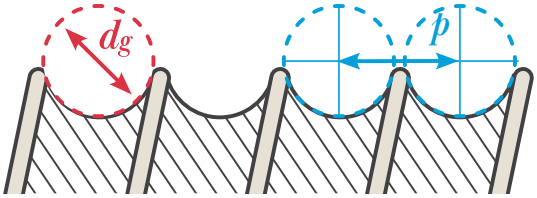
$$d_g = 1.0173d$$

$$1.035dg < p < 1.09dg$$

Optimal value = 1.06

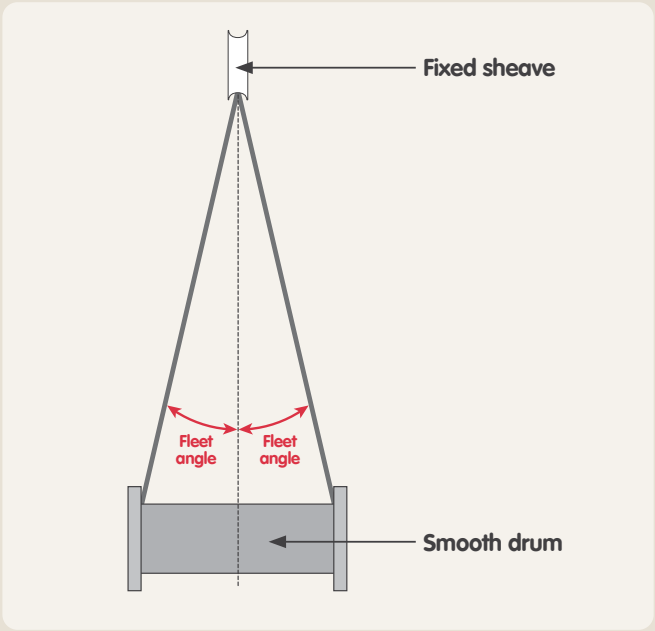
With:

- d = rope diameter under tension of 5%MBL
- d_g = groove diameter
- p = pitch between 2 grooves

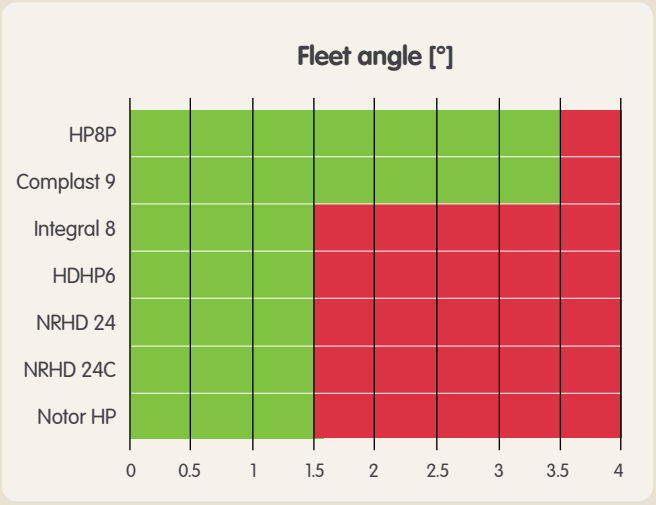


Fleet angles

When the wire rope comes from a drum to pass over a sheave, there is an angle between the rope and the centre line of the sheave.



It is recommended that the fleet angle stays in the optimal range in green.



Please note that these values are only indicative. Actual conditions of the installation's use may slightly impact the admissible maximum fleet angle.

Recommendations

Discard criteria

A steel wire rope is a sensitive flexible safety element. It has to be followed up and regularly inspected by a competent person. Our ropes must be inspected and discarded using the ISO 4309 standard: **Cranes – Wire ropes – Care and maintenance, Inspection and discard.**

Particular attention should be paid to:

- Broken wires
- Decreasing rope diameter (local/general)
- Fracture of strands
- Corrosion
- Wire rope deformations (e.g. waviness, baskets, core or strand protrusion or distortion, wire protrusion, flattened portions of rope, kinks).

ISO 4309 is a document which cannot be dissociated. It shall be carefully studied and applied.

Visual inspection is necessary to help determine the overall condition of the rope.

- Local reduction is the result of a core break – **discard immediately**
- Visual signs: local damage, basket or bird cage, deformations of one or several strands, wire protrusion, kinks, looped wires – **discard immediately**
- Severe corrosion – **discard immediately**.

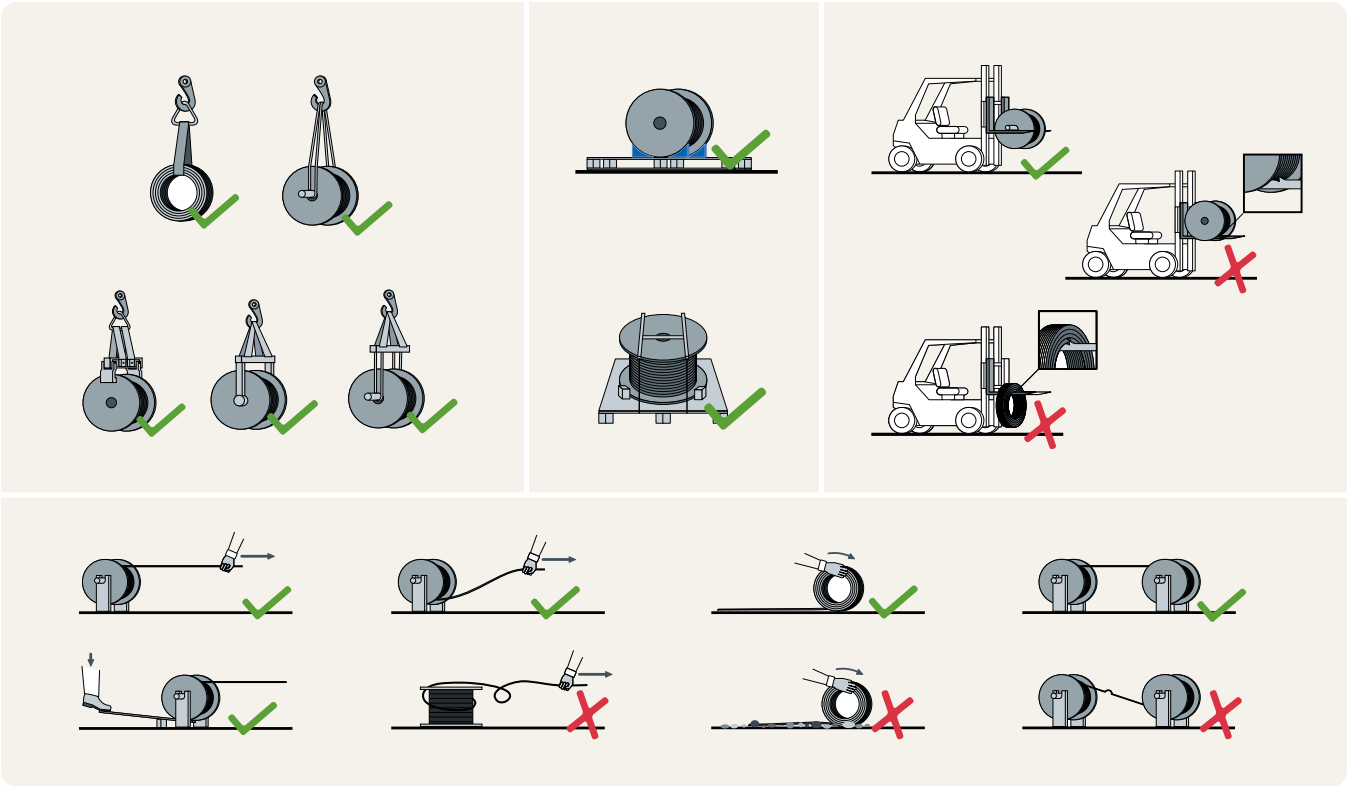
Recommendations

Storage and maintenance

The rope must be adequately maintained and regularly lubricated, as often as it is necessary, but at least when the rope works in extreme conditions and before/after prolonged inactivity. The lubricant must be compatible with the original grease. Before re-lubrication, the wire rope must be dry and cleaned by scraping. Cleaning by cloth, cryogenic spray, high pressure cleaner and solvents are forbidden.

When stored, the rope should be kept in a dry and ventilated environment with no direct contact with the floor and an air flow under the reel. Visual inspection is necessary before the use of a stored wire rope. In case of doubt of the quality of the wire rope, we can help you to find and make additional inspection analysis.

EWRIS handling recommendations



At all times, contact of the rope with any metallic pieces should be avoided to prevent early damage.

EWRIS
European Federation of Steel Wire Rope Industries

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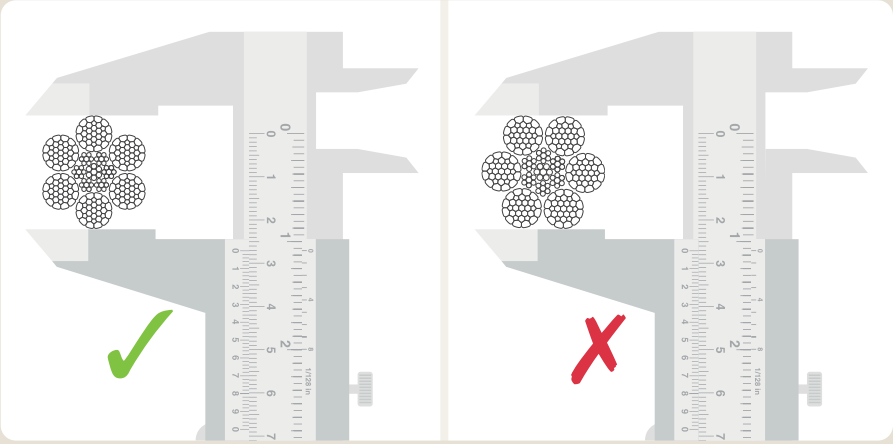
Dimensional control

Diameter (NF EN 12385-1)

The diameter must be measured with an appropriate measuring instrument covering at least 2 strands.

Measurements must be made at two positions spaced at least one metre apart and for each position, 2 measurements must be taken at right angles.



Lay Length

The lay length must be ideally measured on 5 lay lengths minimum.

Stick a paper strip on the rope, draw a straight line on it and pass a chalk stick to reveal the track. Then make the measurement directly on the paper strip.

Test resources

Wire

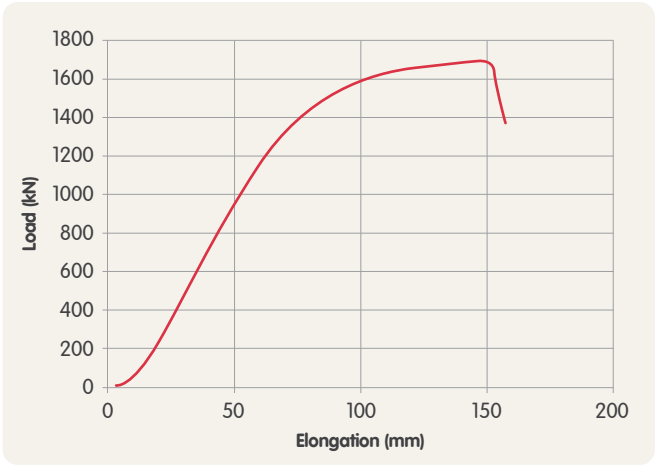
Prior to the manufacture of our ropes, a sample is taken from each wire spool and tested according to the international standards:

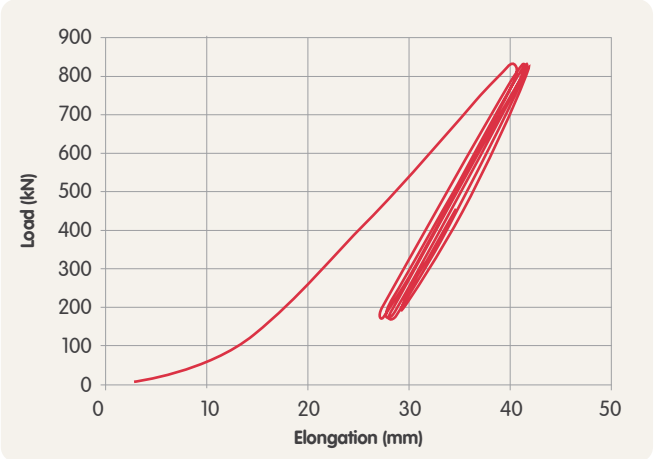
- Tensile test
- Torsion test
- Bending test

Wire rope

For each manufactured wire rope, the breaking load is checked with a test. During this test, the stress/strain curve is recorded and a modulus measurement can be made on request.

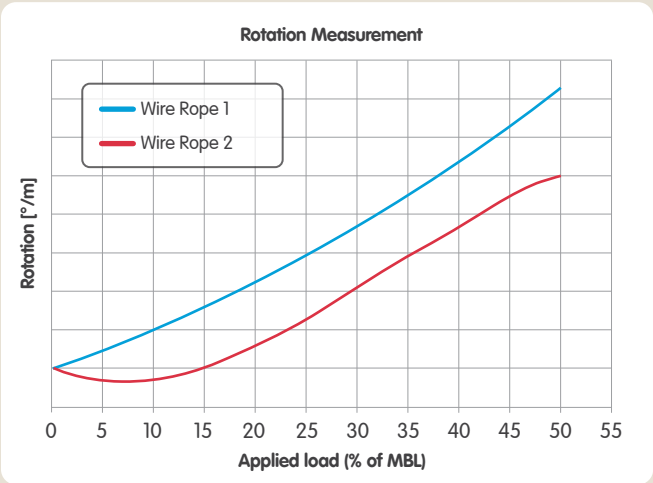
The Bourg-en-Bresse site has 3 test benches: 200 tons, 350 tons and 1500 tons.

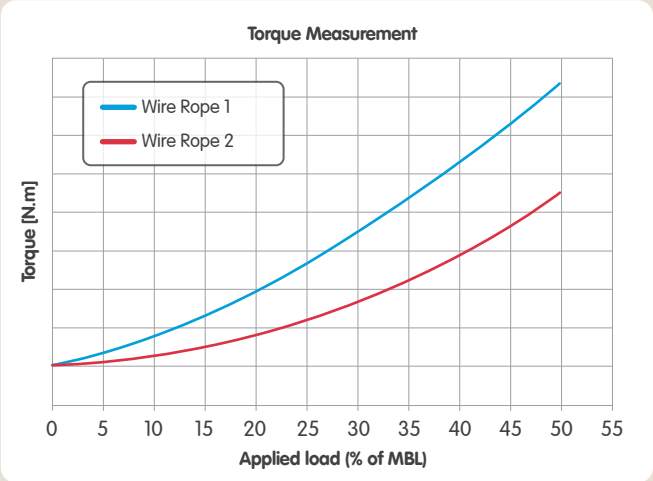


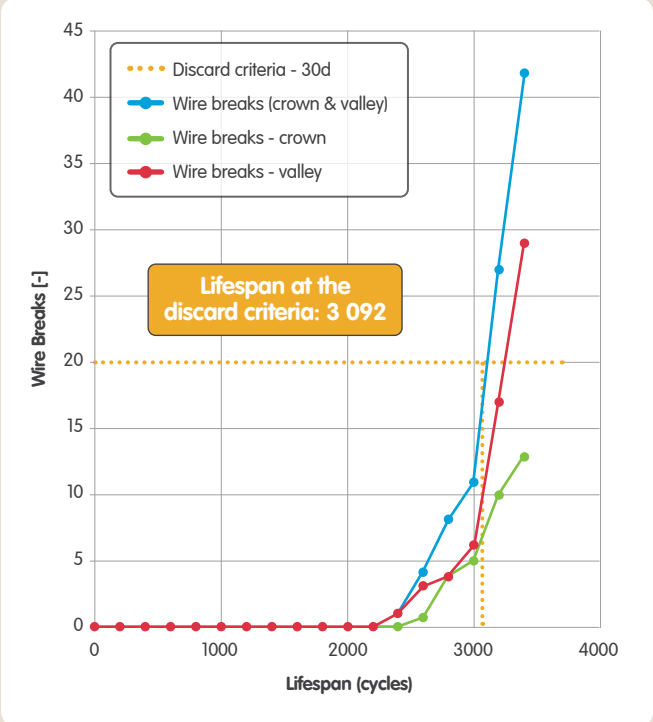


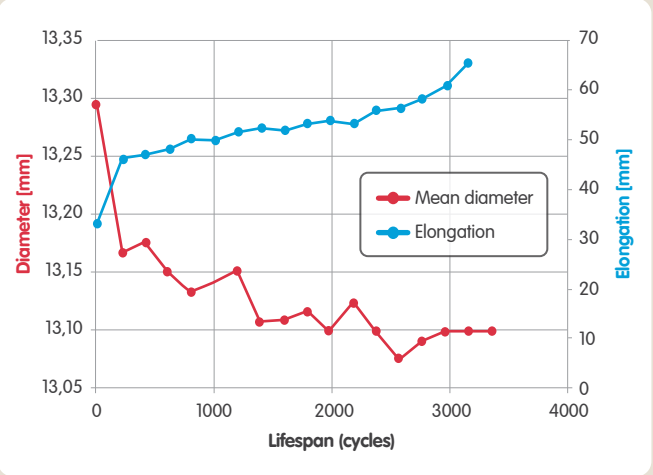
Test resources - continued

Wire Rope









On wire ropes, it is also possible to make:

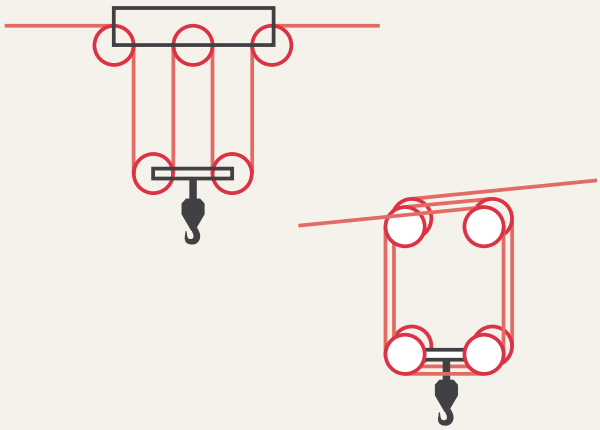
- Rotating test to determine the torque factor and the specific twist
- Bending fatigue test based on the discard criteria given in ISO 4309.

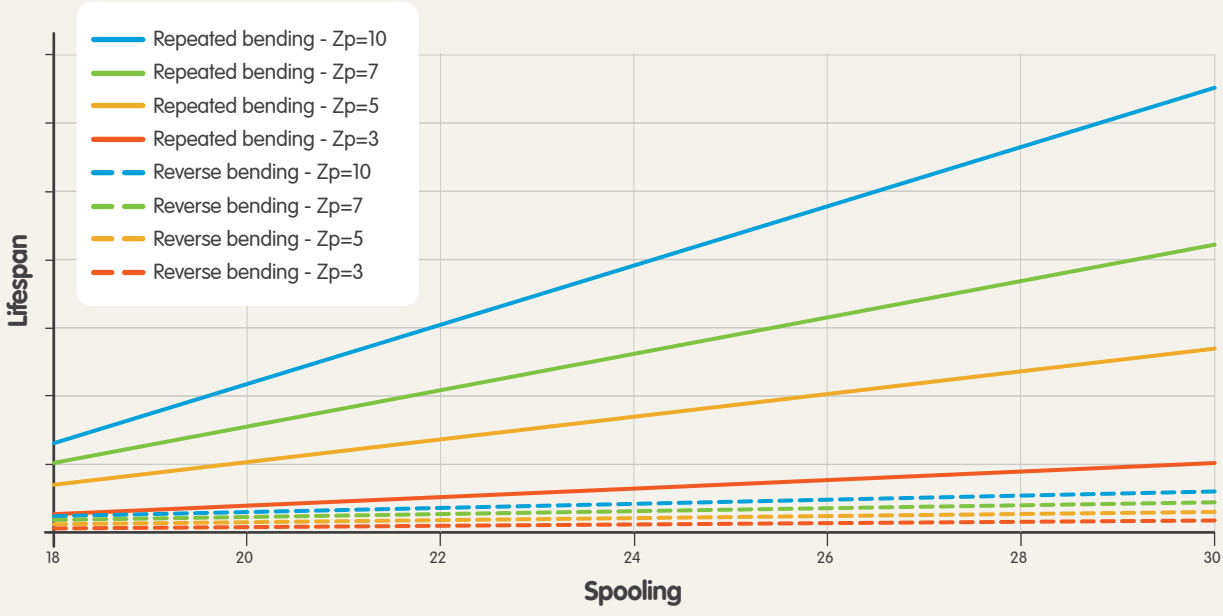
Bending fatigue properties

Fatigue resistant ropes are capable of bending repeatedly under stress. Increased fatigue resistance is achieved in a rope using a combination of several parameters in the rope construction.

The wire rope lifespan depends on many parameters. The most important parameters being:

- Spooling ratio D/d
- Type of bending: repeated or reverse
- Load characteristics: safety coefficient (Zp)





Pseudo-static properties

Elasticity modulus

	Orders of magnitude (±10 000 MPa)
Wires	210 000 MPa
Strands	170 000 MPa
Wire ropes	110 000 MPa

Elongation