ArcelorMittal ROPES

ENGINEERING EXCELLENCE

Mining Ropes

# Technical Information

ArcelorMittal

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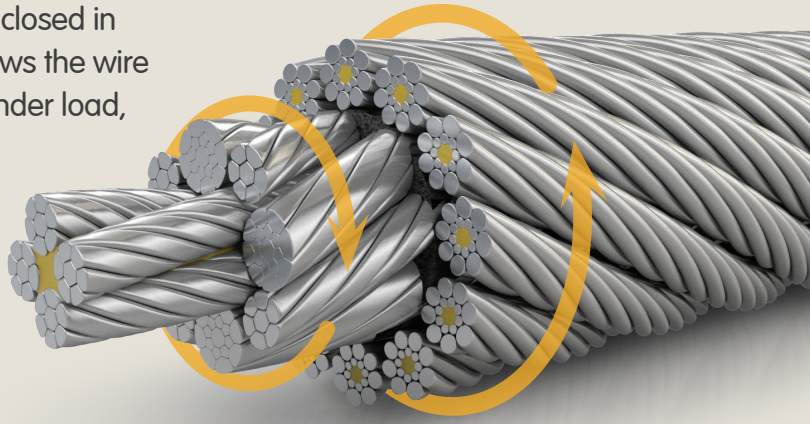
## Non-rotating properties

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

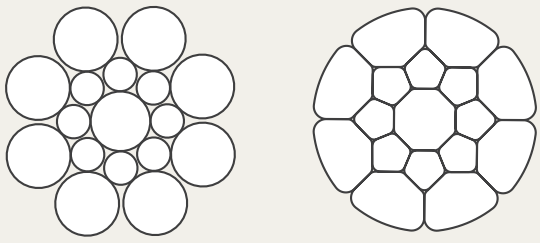
$$ftorque = \frac{C}{F \; x \; d}$$

**With:**

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

## 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

# Technical Information

## Plastic inserts

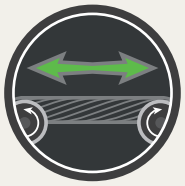
Polyethylene inserts absorb pressure, facilitate rope deformation and extend service life.

## Electromagnetic inspection

An electromagnetic test is performed at the final stage of the production process. The test provides a benchmark for comparison with future electromagnetic tests that will be conducted during operations.

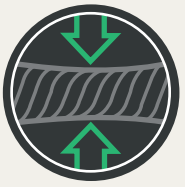
## Stretch resistance

During standard operations it is normal to see some elongation of the rope during the first cycles after installation and before stabilisation. Due to our optimum design and manufacturing process, rope elongation after stabilisation is between 0.1% and 0.3%.



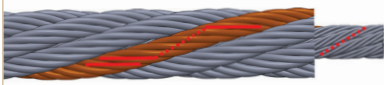
## Crush resistance

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

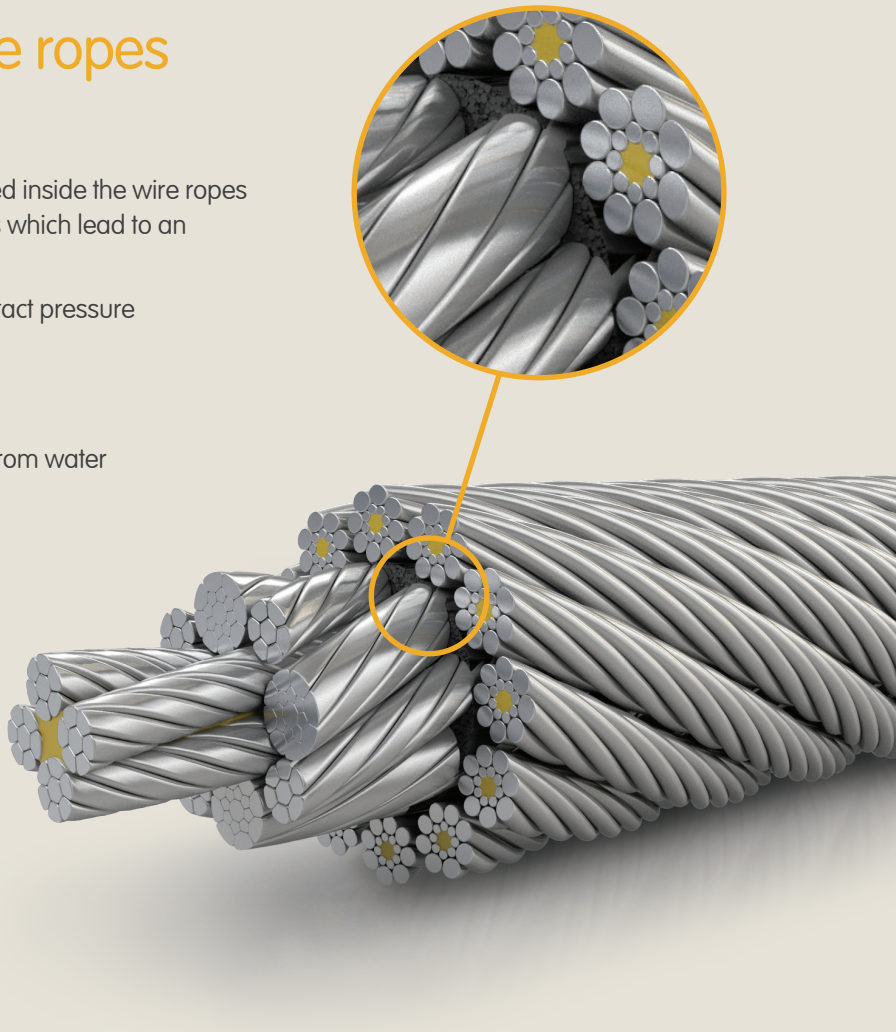
| | Lang Lay | Regular Lay |
|---|---|---|
| |  |  |
| Advantage | Wear resistance<br>Flexibility | Core sensitivity<br>Non-rotation property |
| Disadvantage | Core sensitivity<br>Non-rotation property | Wear resistance |

## Textile strands inside wire ropes

In Klondike® and Notorplast®, textile strands are added inside the wire ropes in the core valleys. These strands bring 2 advantages which lead to an increased lifetime of the rope:

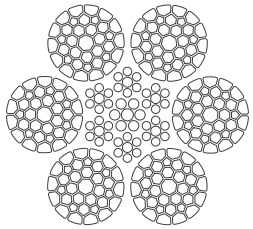
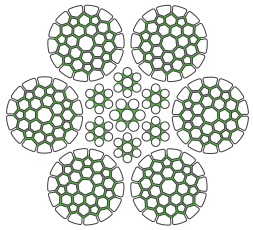
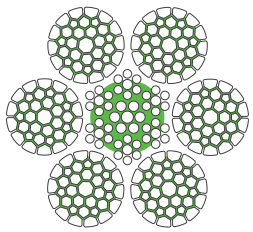
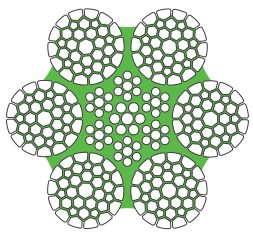
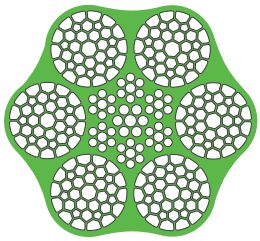
- A densification of the core, that decreases the contact pressure generated by the outer strands.
- A lubricant tank.

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:

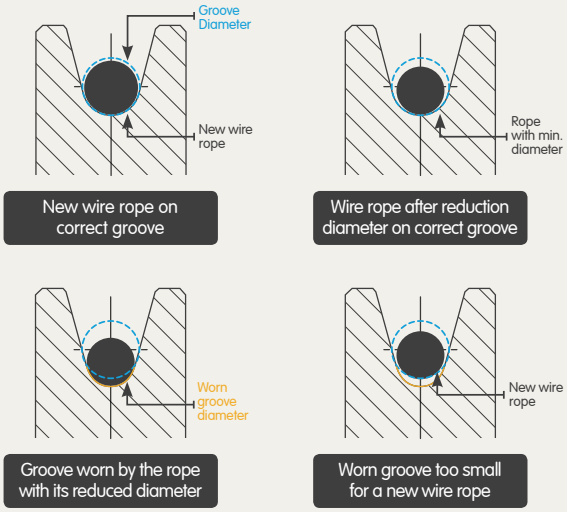
$$1.05d < d_g < 1.1d$$

*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:

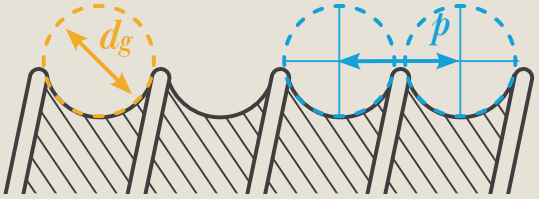
$$d_g = 1.0173d$$

$$1.035dg < p < 1.09dg$$

*Optimal value = 1.06*

**With:**

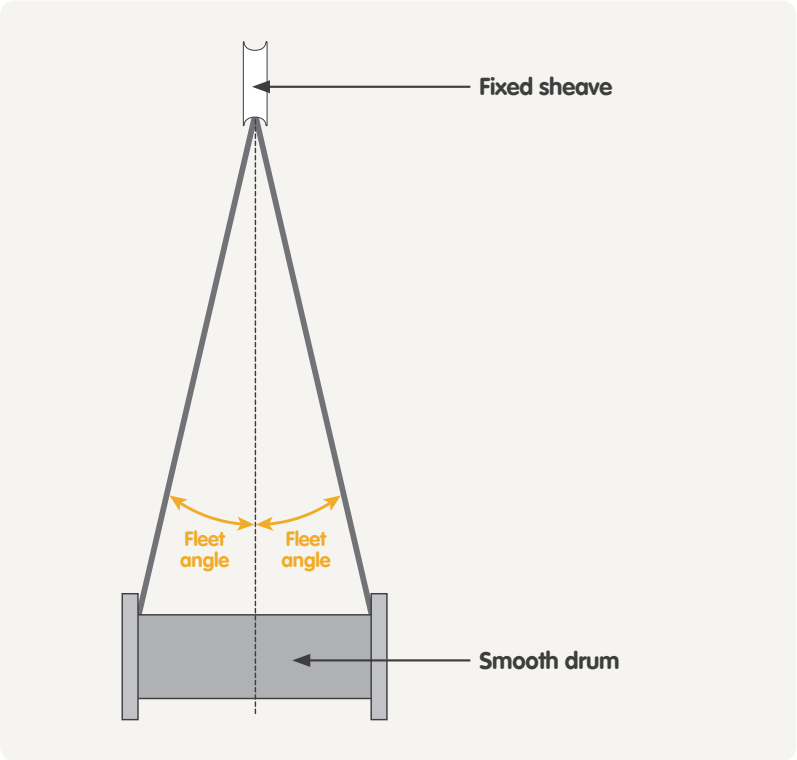
- d = rope diameter under tension of 5%MBL
- $d_g$ = groove diameter
- p = pitch between 2 grooves



## 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 maximum fleet angle is 2.5°.




## Recommendations

### Discard criteria

Discard criteria are defined by current regulations or standards. Generally, the discard criteria is based on steel loss section detected by non-destructive testing. The used limit is quite often 10%.

ArcelorMittal ROPES recommend the follow-up of its ropes by non-destructive testing (steel section loss) together with diameter and elongation checking.

The elongation is representative of rope evolution and directly linked to:

- The nature of the ropes (examples: FLC or multistrand)
- The design of the ropes (examples: compacted strands, gap between the strands)
- The use conditions (examples: tension level, speed)

Regarding the elongation apparition speed, 1/3 appears very quickly (during the first 0.25% of its lifetime), another 1/3 appears during the following 5% of its lifetime and last third will slowly appear between 5% of the lifetime and the discard of the rope.

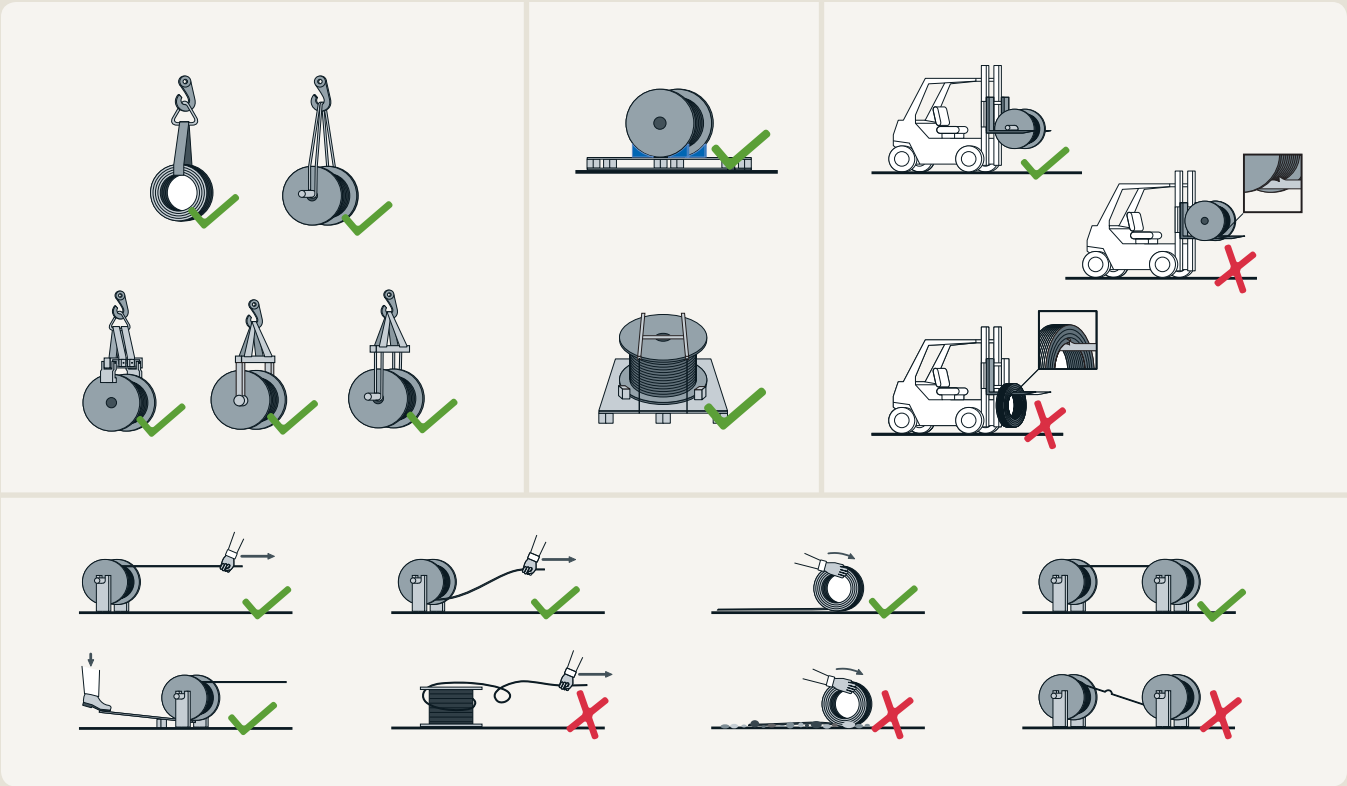
# Recommendations

## 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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# Tensions inequality

A tensions inequality between the ropes may result in slippage on the sheaves during a cycle. This will create structural damages in the ropes. The ropes tensions inequality will generate stress variations with big amplitude. This leads to a decrease of the cyclic loadings resistance.

## Static tension equalisation

Set the conveyance equipped with fine tensioning gear at an appropriate lower level and equalise tension on all ropes. If not so equipped, chair the conveyance, slacken the ropes and adjust accordingly their individual lengths. It is obvious that the first described procedure is more accurate and expedient. Normally this procedure should be performed on a weekly basis. However, after a new rope or ropes have been installed, it should be performed more frequently as required and on a daily basis for the first week.

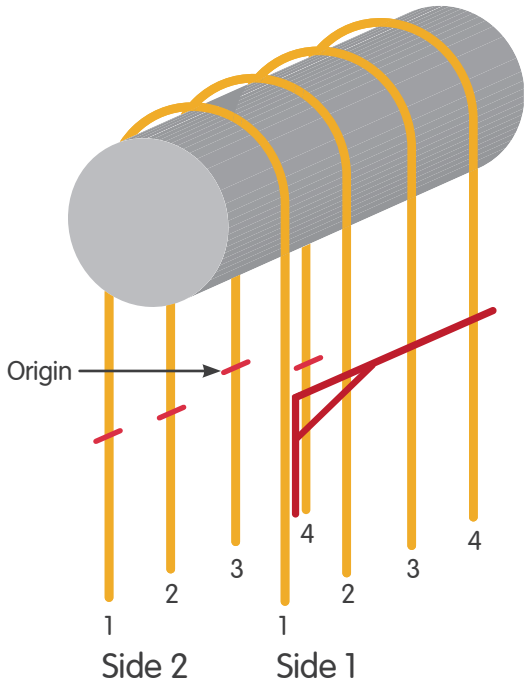
## Equalisation of the lengths developed by sheaves

The developed lengths equalisation will be achieved by appropriate trimming of the friction hoist linings. The most common is the collar to collar check, as described hereinafter.

At this point, it should be kept in mind that dust build-up on the ropes can create differences in the lengths developed by the sheaves. A permanent rope cleaning device might be necessary under extreme conditions.

The equalisation check should be made on a weekly basis.

## Collar to collar (bank to bank) check




1. Lower side 1 conveyance to midshaft (both conveyances empty).
2. Mark all 4 ropes side 1 at collar.
3. Raise side 1 conveyance slowly until the marks are at collar on side 2.
4. Measure variances using the rope that has the mark in the highest position above collar as being the origin, i.e. rope n°3.
5. Correct the tensions inequality by an appropriate method (groove machining).

## Others

Incidents such as objects falling down shaft, unpredicted and numerous emergencies, or unusual rates of acceleration and deceleration ratios may cause structural damage to the ropes. Preventive actions must be taken to avoid these incidences.

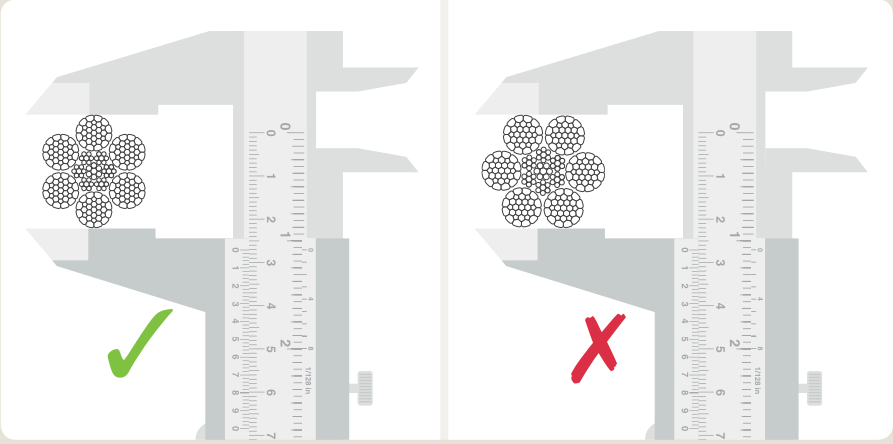
Individual rope stretch curves should be plotted at the time of temporary disconnections. The torque should also be evaluated and recorded for full locked coil hoist ropes. At the time of disconnection for stranded ropes, it will be necessary to retain any torque.

## 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

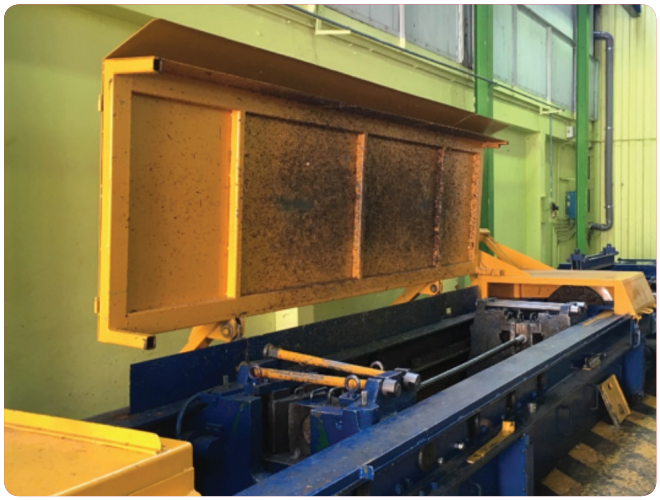
## Wire

Prior to the manufacture of our ropes, samples are taken from each of the wires that we use. Using current international standards, the samples undergo a comprehensive:

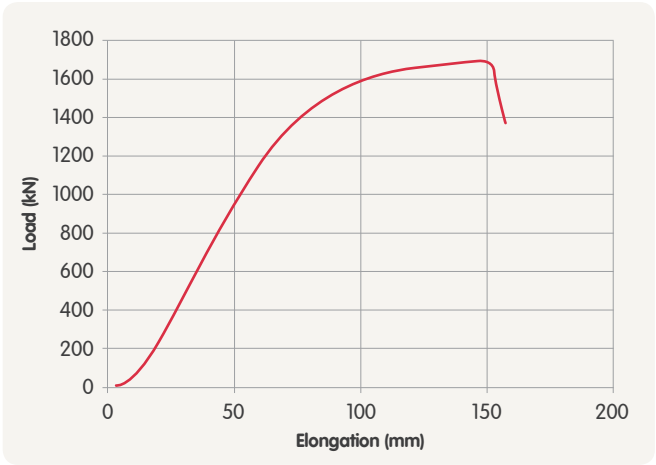
- Tensile test
- Torsion test
- Bending test

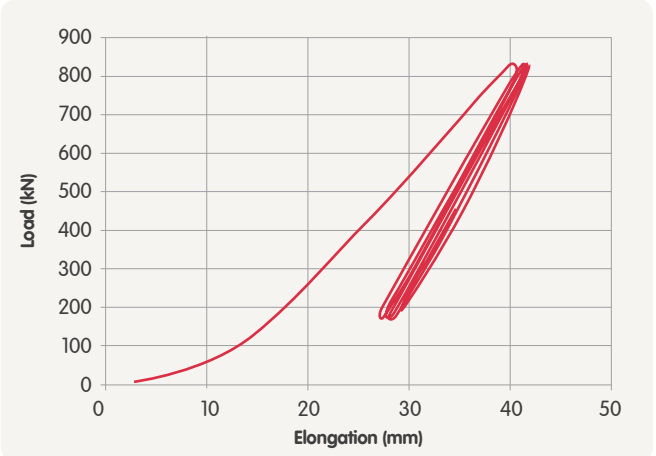
## Wire rope

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.



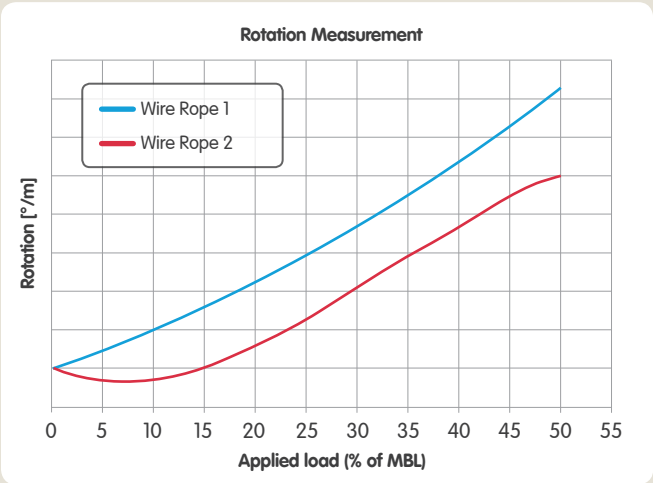
The Bourg-en-Bresse site has 3 test benches:
200 tons, 350 tons and 1500 tons.

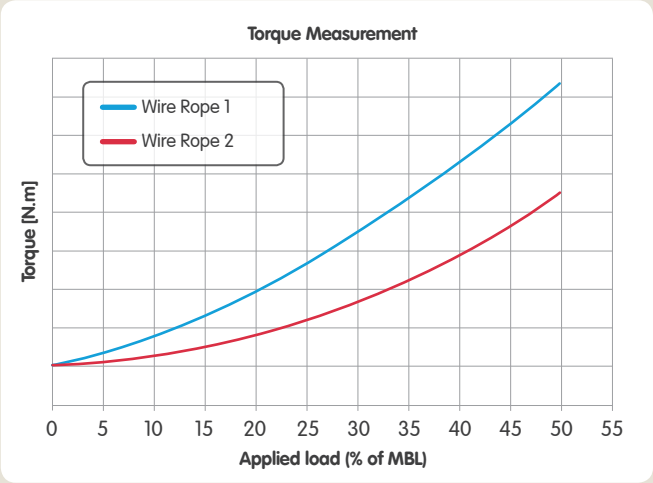


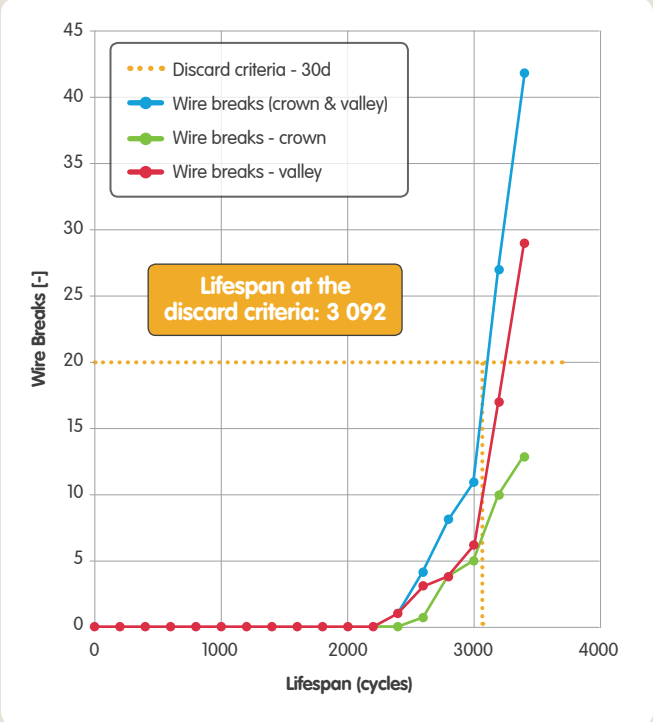



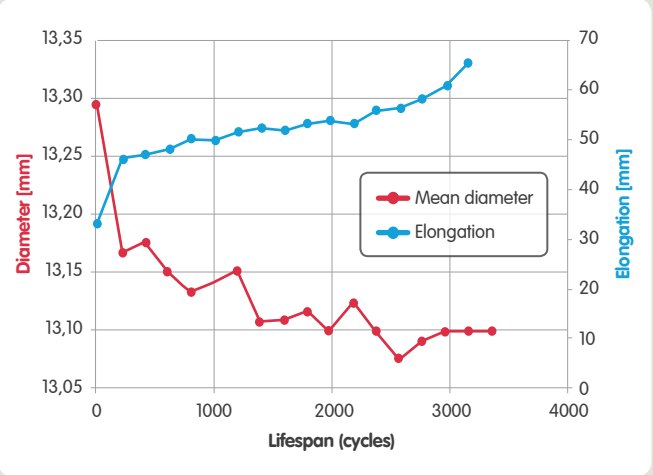
# Test resources - continued

## Wire Rope




On wire ropes, it is also possible to make:

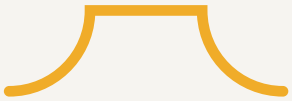
- Rotating test to determine the torque factor and the specific twist
- Bending fatigue test based on the discard criteria given in ISO 4309.

## Bending fatigue properties

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

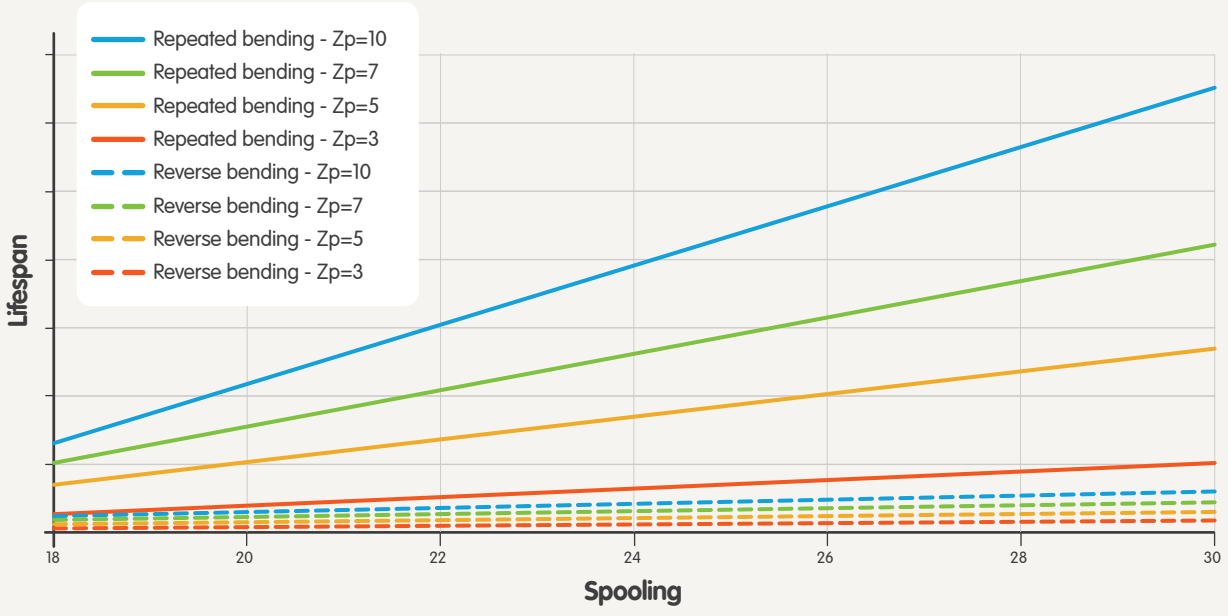
- Spooling ratio D/d
- Type of bending: repeated or reverse
- Load characteristics: safety coefficient (Zp)

Repeated Bending



Reverse Bending

Alternated Bending



# 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