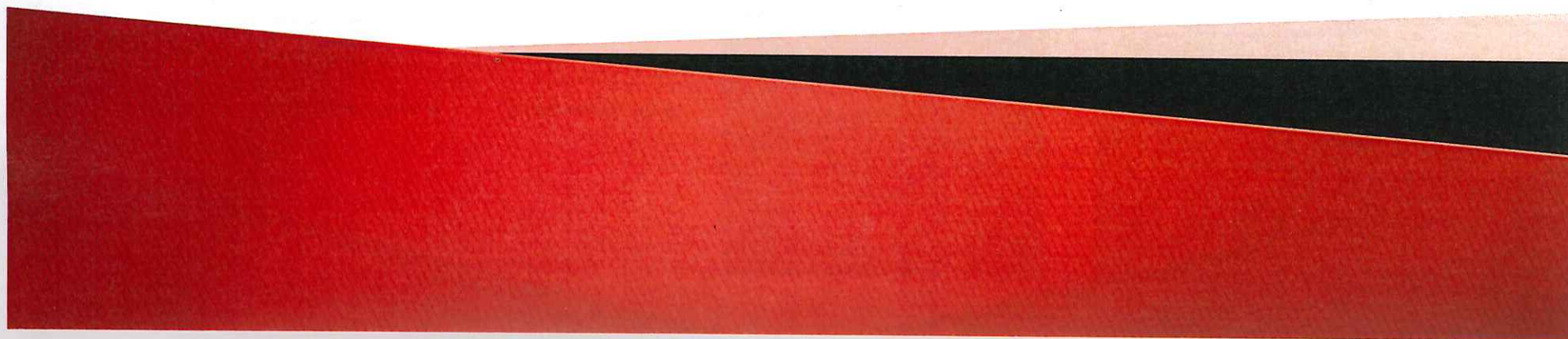


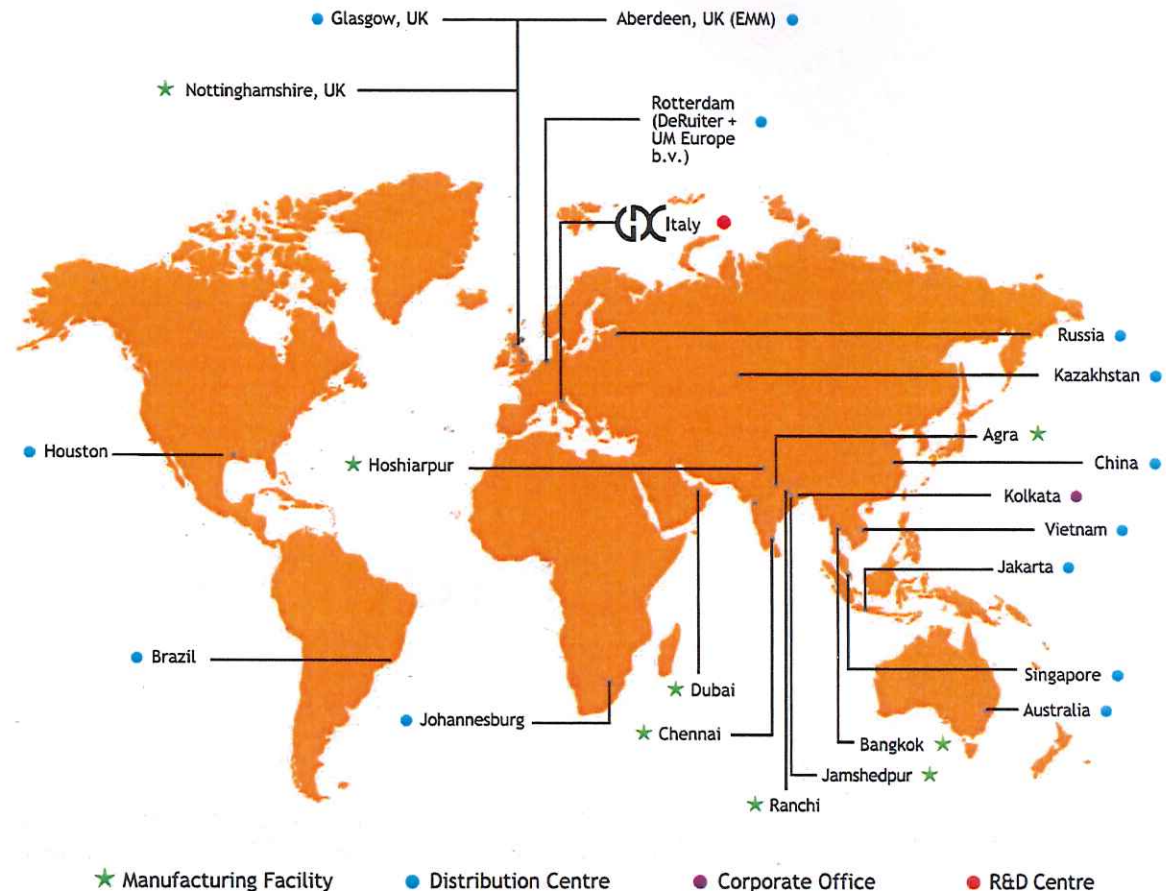
Introduction to wire ropes

Milano, December 2014



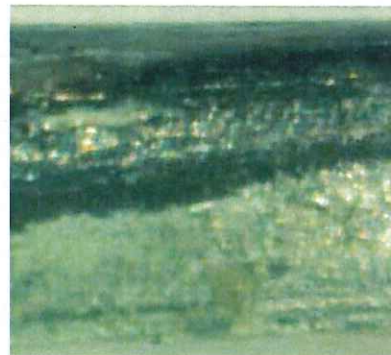
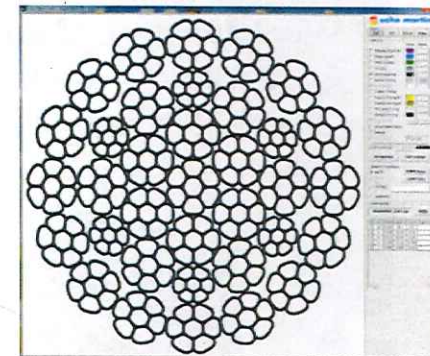
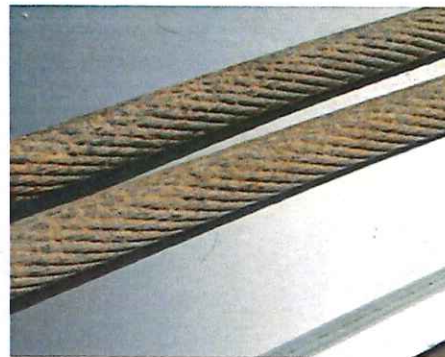
Usha Martin group companies

- ▶ **Manufacturing plants**
 - Ranchi (India)
 - Brunton Shaw (Worksop)
 - Brunton Wolf (Dubai)
 - UM Siam (Bangkok)
- ▶ **Service centers**
 - EMM Corp (Aberdeen)
 - De Ruiter (Rotterdam)
- ▶ **Distribution centers**
 - Singapore
 - Shanghai
 - Australia
 - Houston
 - South Africa
 - Russia
 - Brazil
- ▶ **R&D center (Italy)**



UMItalia – Global Design Centre

- ▶ Corporate technical management and R&D activities
- ▶ Rope design, raw material and manufacturing specification
- ▶ Product testing and characterization
- ▶ Application engineering and technical assistance



Varuna project – OCEANMAX ropes

- ▶ New facility in Worksop (UK) fully operating from August 2014
- ▶ Efficient production line, including
 - SKET closer 8+16 cradles
 - SKIP strander with powerful compacting units
 - 3D measuring system for real time rope inspection
- ▶ 350ton maximum rope weight (upgradable), meaning
 - 35x7 76mm → 12 km
 - 35x7 100mm → 7 km
 - 35x7 135mm → 4 km



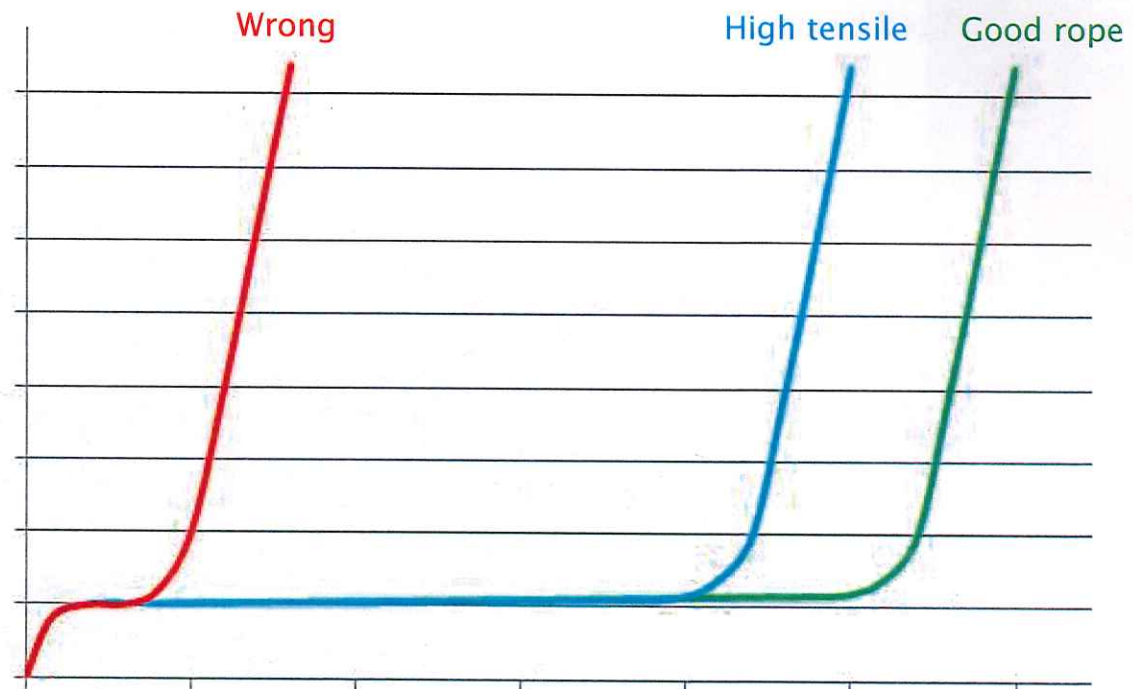
Safety

- ▶ Ropes are safety components, as:
 - Minimum requirements are satisfied for every maker
 - An individual defect or damage (broken wire) does not affect the MBL (rope is redundant)
 - Damage can be noticed by visual inspection, rope break is not a sudden event



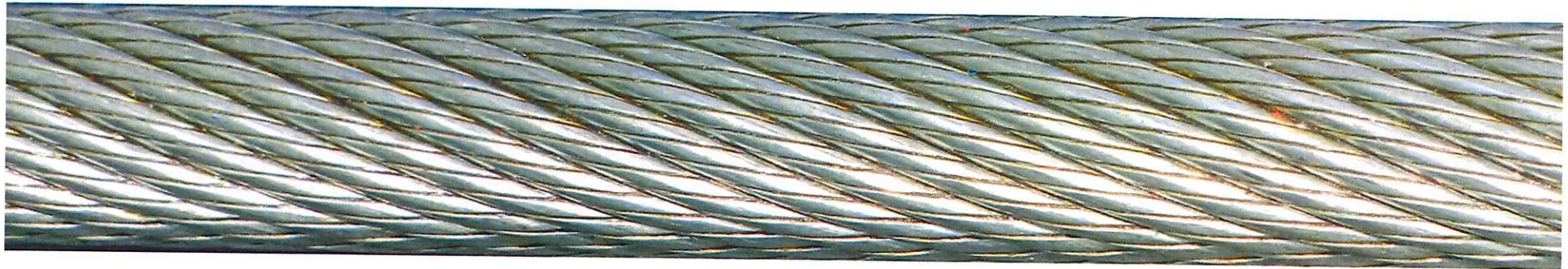
Damage progression

- ▶ Rope fatigue: progressive and localized damage due to cyclic stress, witnessed by several distributed broken wires

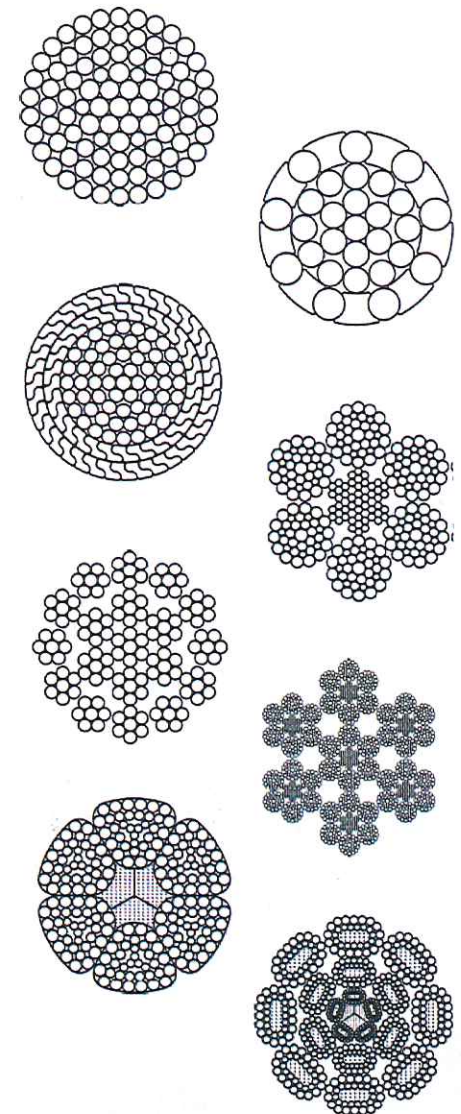
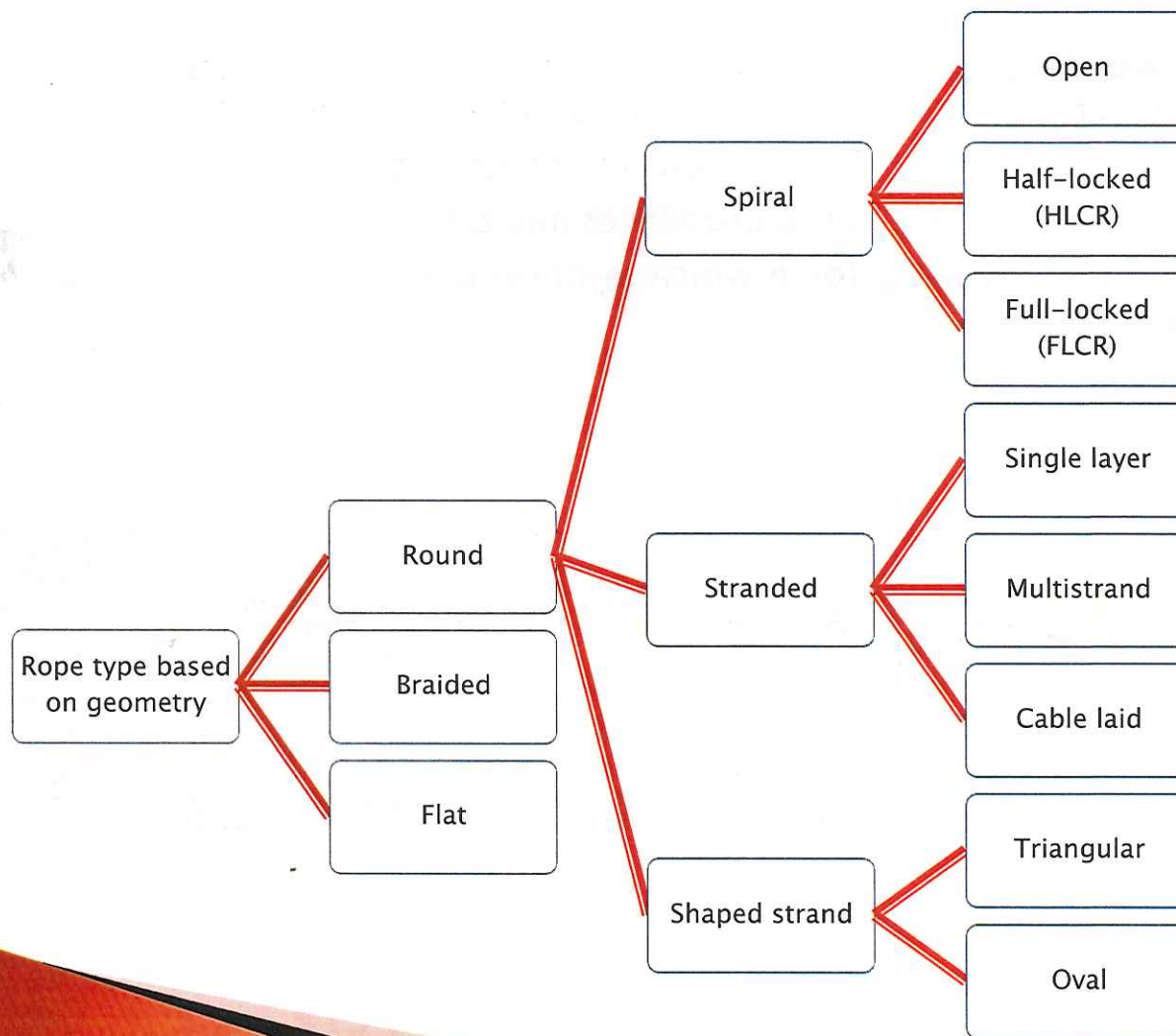


Rope definitions and characteristics

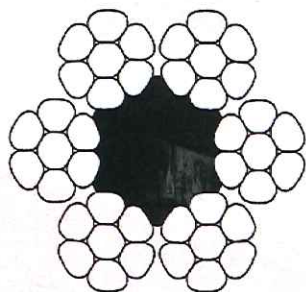
- ▶ Stranded rope: an assembly of several strands laid helically in one or more layers around a core (single-layer rope) or center (rotation-resistant or parallel-closed rope)
- ▶ Construction: the detail and arrangement of the various elements of the rope
- ▶ Class: a grouping of ropes of similar mechanical properties and physical characteristics
- ▶ Grade: a level of requirement of breaking force which is designated by a number (e.g. 1770, 1960)



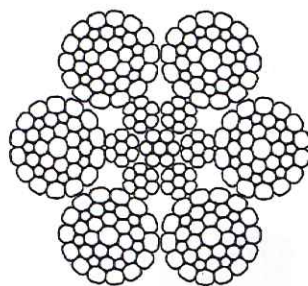
Classification – general layout



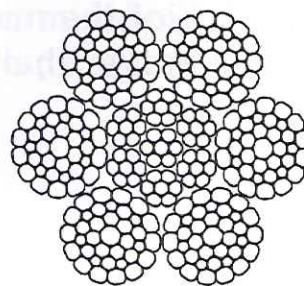
Examples of constructions and designation



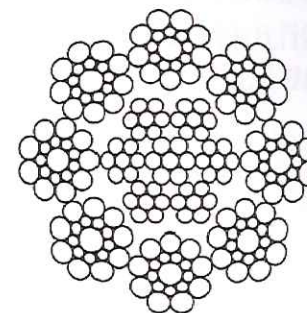
6xK7 - FC



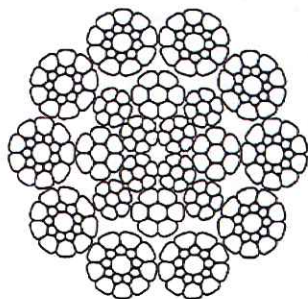
6xK36WS - IWRC



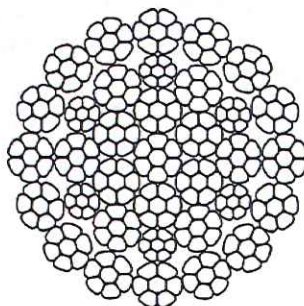
6xK36WS - PWRC



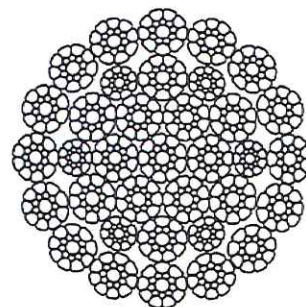
8x19S - IWRC



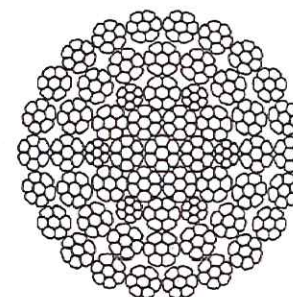
10xK19S - IWRC



35xK7



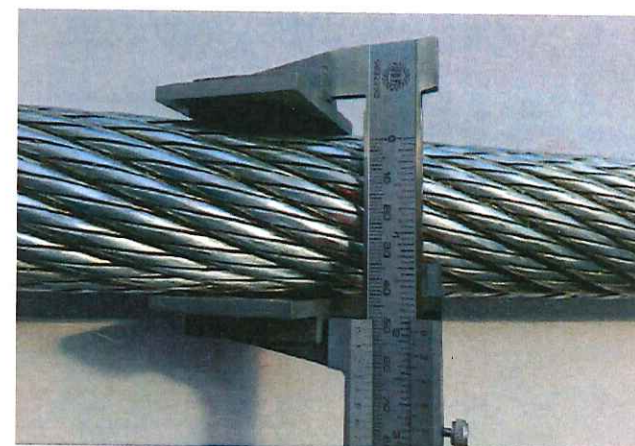
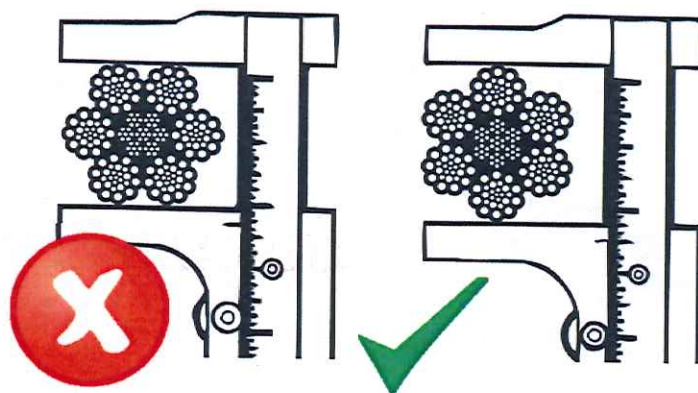
35xK19



57xK7

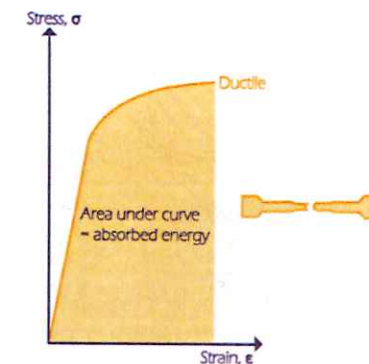
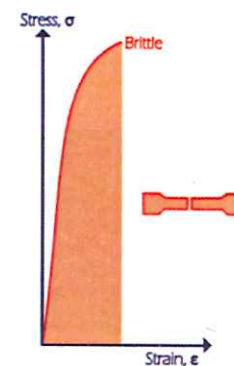
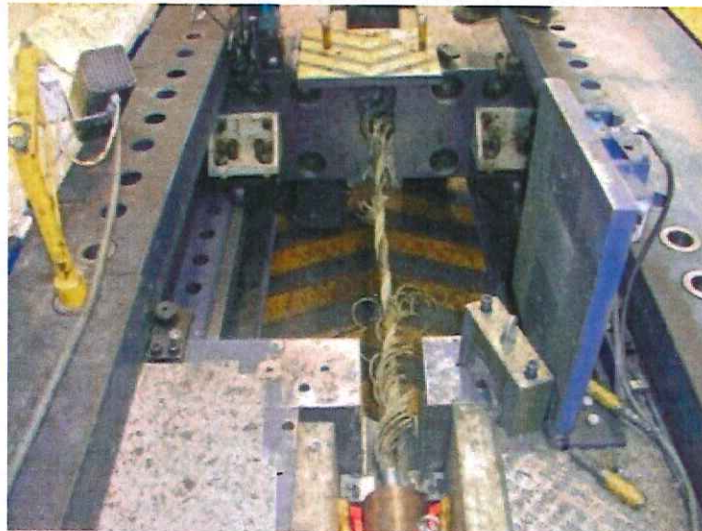
Rope diameter

- ▶ Diameter has to be measured on a straight portion of the rope, either under no tension or a tension not exceeding 5 % of the minimum breaking force, at two positions spaced at least one meter apart. The gauge shall cover at least 2 strands



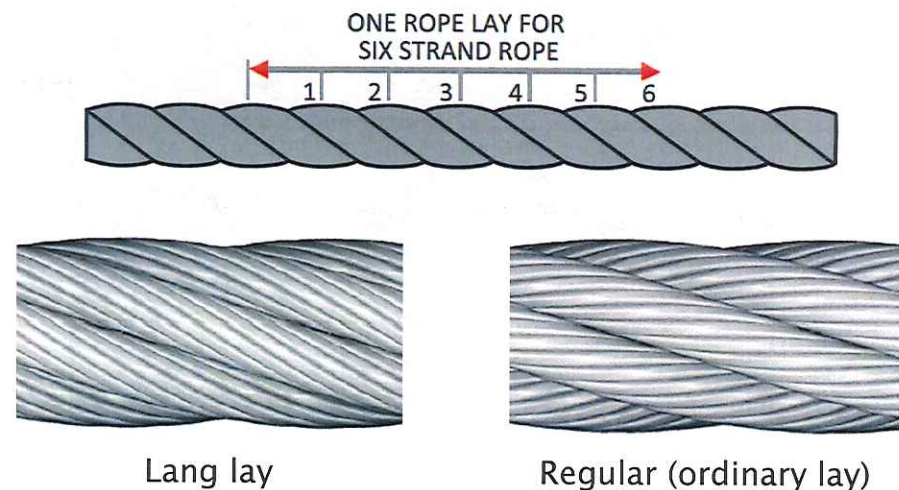
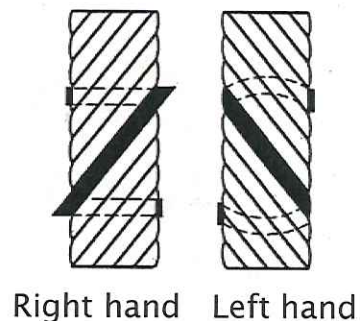
MBF and tensile strength

- ▶ MBF: 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
- ▶ High MBF does not mean safety



Lay direction and type

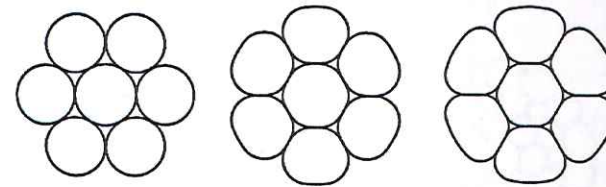
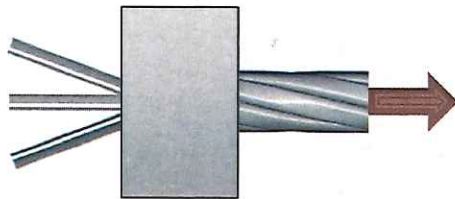
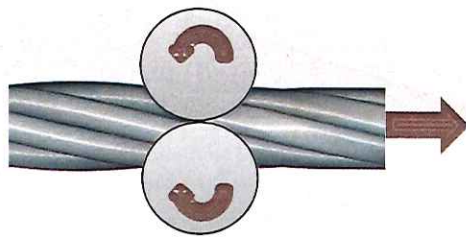
- ▶ Lay length: the distance parallel to the longitudinal strand axis in which an outer wire/strand makes one complete turn (or helix) about the axis of the strand/rope
- ▶ Lay direction: the direction (right or left) corresponding to the direction of lay of the outer wires/strands in relation to the longitudinal axis
- ▶ Ordinary lay: stranded rope in which the direction of lay of the wires in the outer strands is in the opposite direction to the lay of the outer strands in the rope
- ▶ Lang lay: stranded rope in which the lay direction of the wires in the outer strands is in the same lay direction as that of the outer strands in the rope



Compacted strands

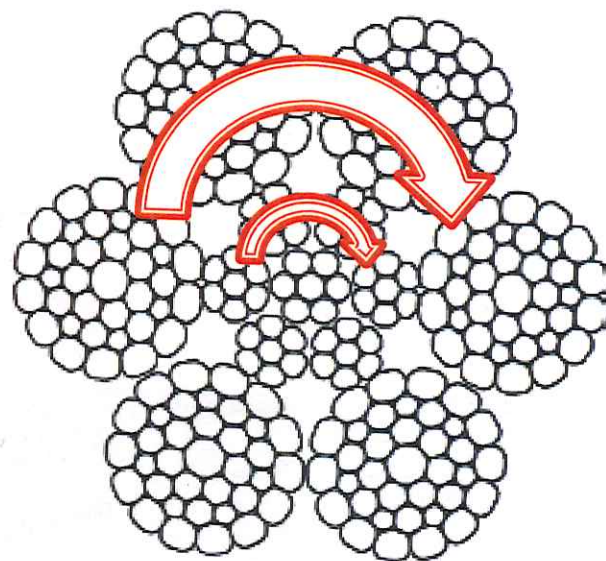
► Benefits:

- Increase of metallic area and higher cooperation level of the individual wires
- Homogeneous and stable strand diameter, smoother contact surface
- Resistance to side pressure, wear and abrasion

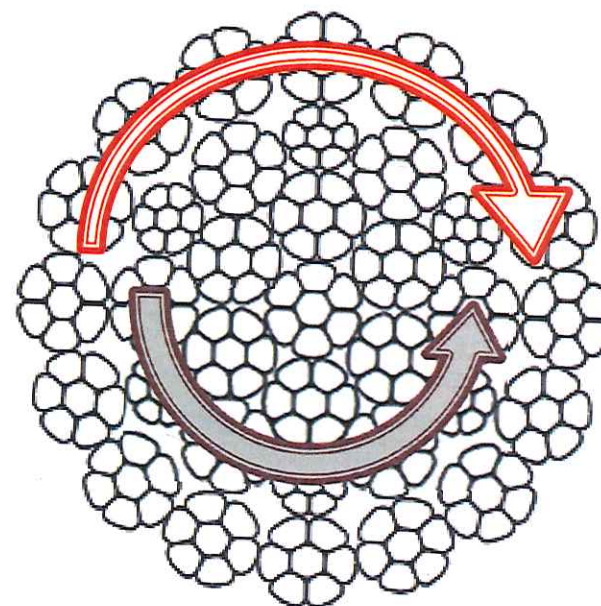


Rotation resistant ropes

- ▶ Stranded ropes designed to generate reduced levels of torque and rotation when loaded



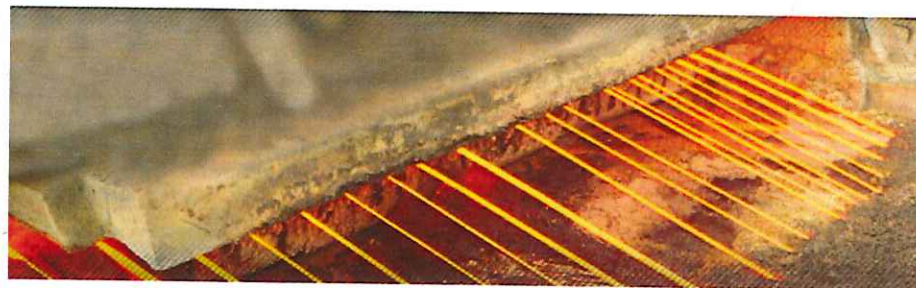
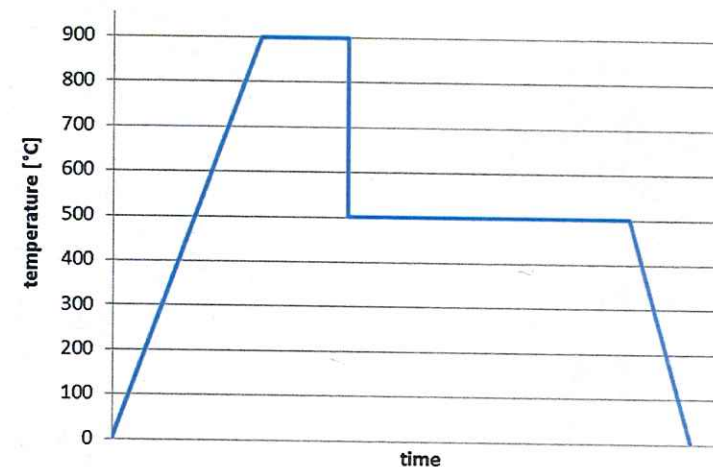
Not rotation resistant



Rotation resistant

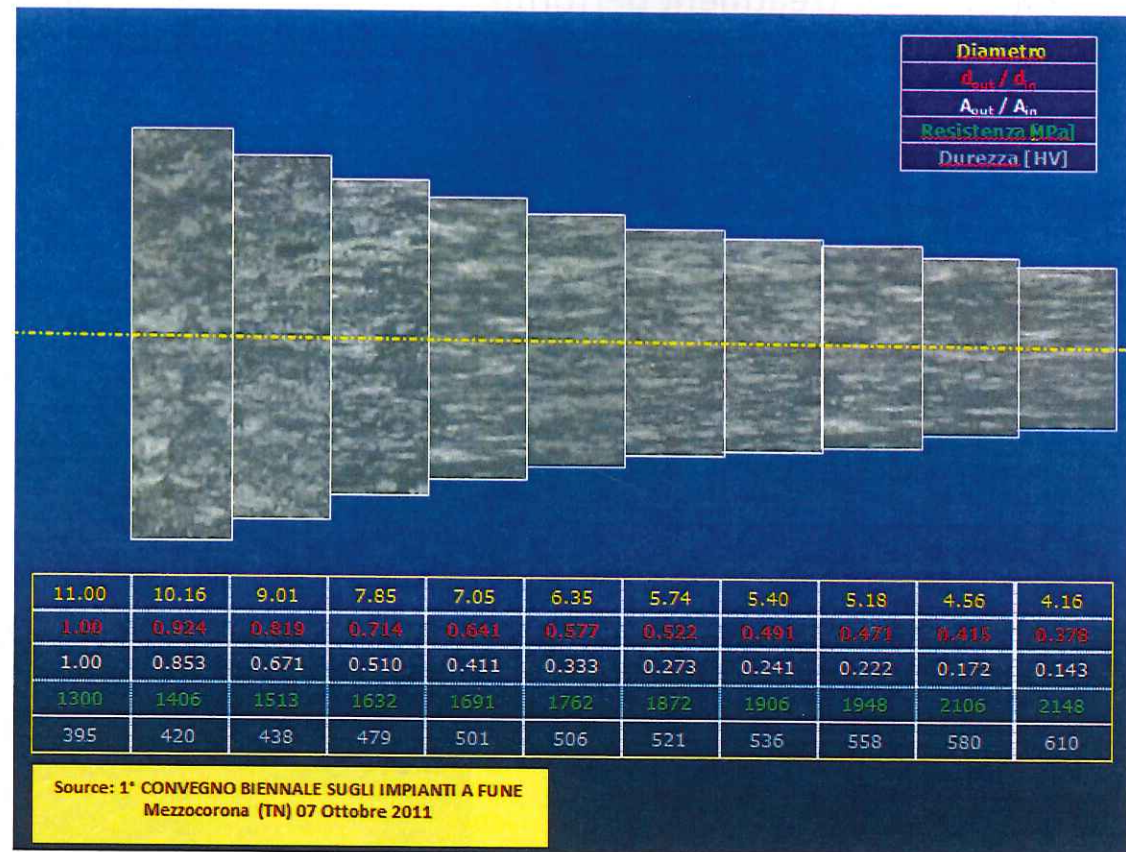
Raw material and patenting process

- ▶ High carbon content patented rod (up to C92), which can be phosphated, hot dip galvanized or ZnAl alloy treated
- ▶ Patenting: heat treatment performed by the passage at controlled speed in 850 – 940 °C furnaces and by consequent cooling in lead or salt bath at 490 – 550 °C



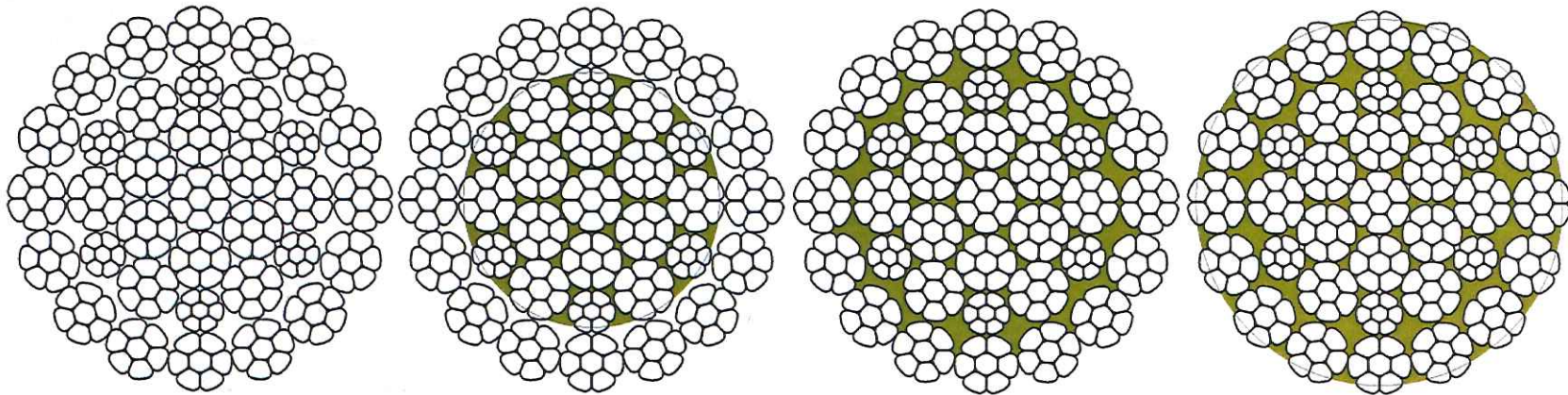
Wire drawing

- ▶ Rod wire passage through a series of dies or rollers which gradually reduce the cross section and modify steel structure, resulting in a strength increase



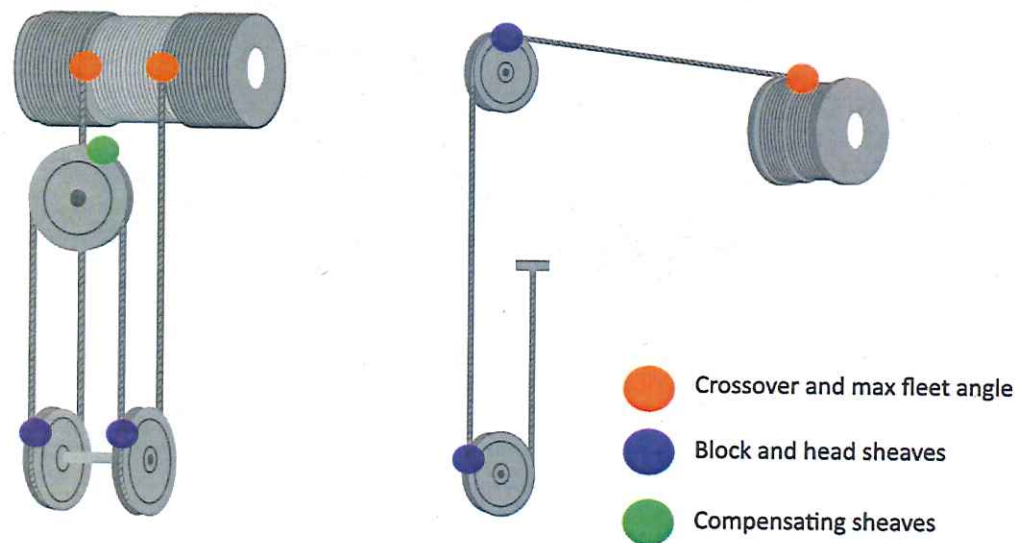
Lubrication

- ▶ Required characteristics:
 - Good compatibility with other lubricants
 - Safety drop point
 - Custom lubricant level






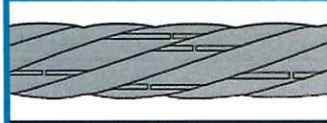




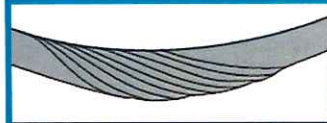
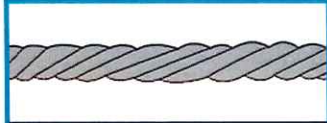
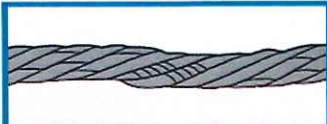

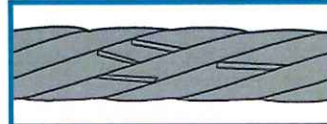


Rope inspection

- ▶ Ropes shall be inspected by competent persons according to regulations, crane type, environment, results of previous examinations, load spectrum and experience related to similar ropes and systems
- ▶ Main modes of deterioration: broken wires or stands, decrease in rope diameter, corrosion, deformation, mechanical or heat damage and change in elastic behaviour of rope under load



Typical damages

- ▶ Reference Standard: ISO4309 Cranes – Wire ropes – Care and maintenance, inspection and discard

 <p>Wire protrusion Cause Improper rope handling Ref. ISO4309 - 6.6.5 Action Discard (can be removed for limited extension)</p>	 <p>Core protrusion Cause Fleet angle, shock loading Ref. ISO4309 - 6.6.4 Action Immediate discard</p>	 <p>Protrusion of inner rope Cause Fleet angle, shock loading Ref. ISO4309 - E.4 c) Action Immediate discard</p>	 <p>Crown wire breaks Cause Fatigue Ref. ISO4309 - 6.2 Action Discard (can be removed for limited extension)</p>	 <p>Flattened portion Cause Rope derailing over the sheave Ref. ISO4309 - 6.6.7 Action Immediate discard</p>
 <p>Strand protrusion or distortion Cause Forced twist Ref. ISO4309 - 6.6.4 Action Immediate discard</p>	 <p>Local increase in rope diameter Cause Fleet angle Ref. ISO4309 - 6.6.6 Action Remove the cause and monitor the evolution</p>	 <p>Local reduction in diameter Cause Core break Ref. ISO4309 - 6.3 Action Immediate discard</p>	 <p>Basket deformation (birdcage) Cause Improper installation, narrow grooves Ref. ISO4309 - 6.6.3 Action Immediate discard</p>	 <p>Waviness Cause Reverse bending, rope rotation Ref. ISO4309 - 6.6.2 Action Keep monitored</p>
 <p>Kink (positive) Cause Fleet angle, forced rotation Ref. ISO4309 - 6.6.8 Action Immediate discard</p>	 <p>Kink (negative) Cause Fleet angle, forced rotation Ref. ISO4309 - 6.6.8 " Action Immediate discard</p>	 <p>Valley wire breaks Cause Fatigue and Improper rope design Ref. ISO4309 - 6.2 Action Discard (can be removed for limited extension)</p>	 <p>External wear Cause Normal use Ref. ISO4309 - 5.3.1, E2 Action Keep monitored</p>	 <p>External corrosion Cause Environment conditions Ref. ISO4309 - 6.5 Action Keep monitored</p>

Thank you

For further details, please contact

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