



Choosing the best ropes for your tower cranes

*Dr. Oliver Fries, VP Global R&D, Innovation
and technology, November 2013*





Agenda

- Who are we
- Tower crane ropes
- Rope Selection





Who are we ?

Global Brands – Superior Solution



CASAR

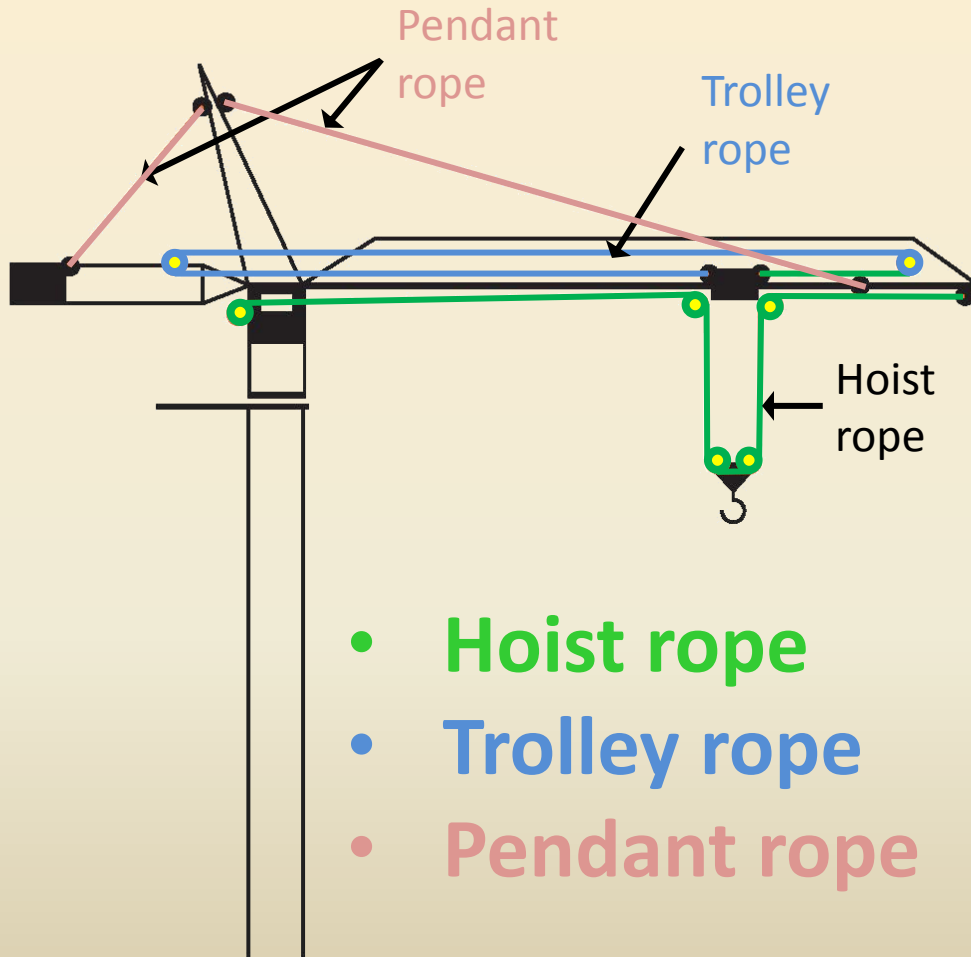
 **OLIVEIRA**



4,600 employees, 25 manufacturing facilities, 22 distribution centers, 18 sales offices and 175 sales personnel servicing customers in 122 different countries

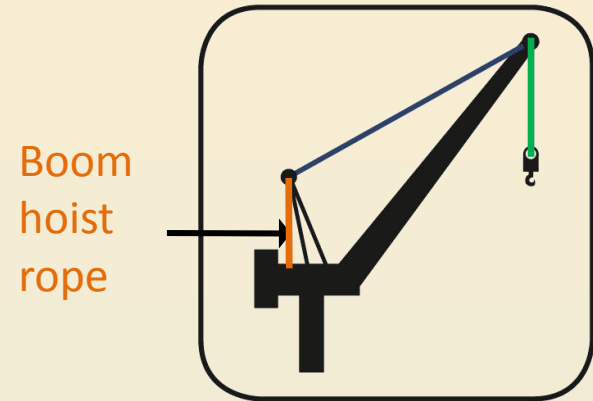


Tower Crane Rope types

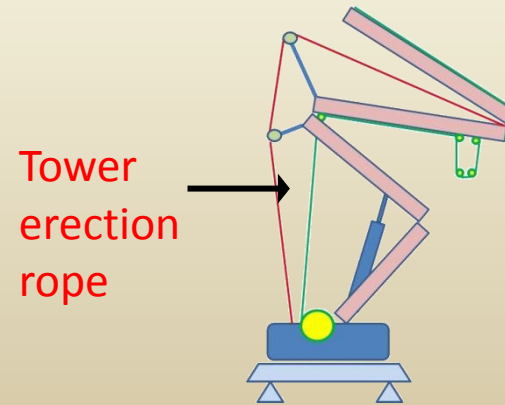


- Hoist rope
- Trolley rope
- Pendant rope

- Boom hoist rope



- Tower erection rope





What rope to select? (1)

Product attributes, restrictions and specifications

- Tower crane type -> *what type of ropes are needed*
- Standards -> *safety factors, discard criteria, inspection*
- Environment -> *lubrication, surface treatment*
- Crane load capacity -> *breaking load, diameter*
- Target costs - > *cost of ownership*
- Operation -> *safety, reliability, quality, service life time*
- Supply chain -> *manufacturing, distribution, spare parts, technical service*
- Repetitive part usage -> *modular design*





What rope to select? (2)

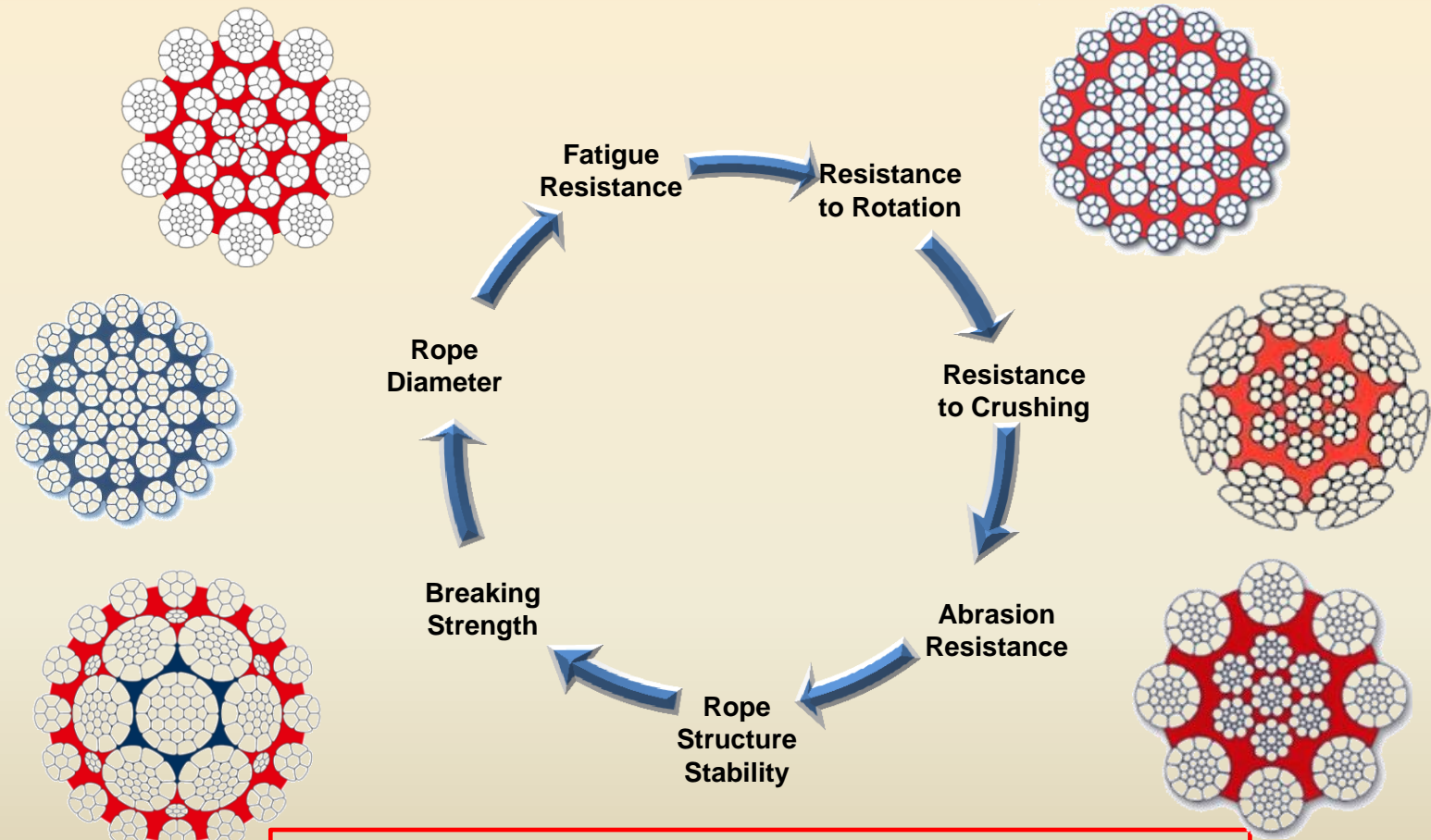
Product attributes, restrictions and specifications

- Hoisting rope → *rotation resistance, use of a swivel*
- Trolley rope → *low elongation, bending cycles, breaking load*
- Boom hoist → *flexibility, breaking load, rough spooling*
- Pendant rope → *length tolerance, weight, breaking load*
- Tower erection rope → *resistance against twist*
- Systems lengths → *rope lengths, weight*
- Reeving system → *number of falls, bending cycles, reverse bending, flexibility, hoisting speed*
- Geometry details → *sheaves, drum, fleet angles*
- Multi layer spooling → *roundness, exact diameter tolerance, rope stiffness, change of shape under load and pressure, special design features*
- End connections → *material, breaking load*





Technical rope properties



No single rope design fits to all requirements





Crane Rope Safety Standards (Crane manufacturer, crane user)

- USA – ASME B30 Series Standards
 - *Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings*
 - *Inspection and discard criteria*
 - *B30.3 Tower Cranes; B30.29 : Self erecting tower cranes*
- Europe – EN 13001
 - *Lifting Appliances; Principles Relating to Rope Drives*
- ISO 16625
 - *Cranes and hoists - selection of wire ropes drums and sheaves*
- ISO 4309
 - *Cranes - Wire ropes – Care, maintenance, installation, examination and discard*
- ISO 21669
 - *General guidance on swivel use*



Wire rope standards (Wire and wire rope manufacturer)

- USA
 - *ASTM A 1023 – Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes*
 - *RR-W-410 – Federal Specification, Wire Rope and Strand*
- Europe
 - *DIN EN 10264-1 – Steel wire and wire products - Steel wire for ropes-Part1: general requirements*
 - *DIN EN 12385-4 – Steel wire rope-safety, Stranded ropes for general lifting applications*
- China
 - *GB/T 20118 – Steel wire ropes for general purpose*
 - *GB 8918 – Steel wire ropes for important purposes*
- Japan
 - *JIS G 3525 – Wire ropes*



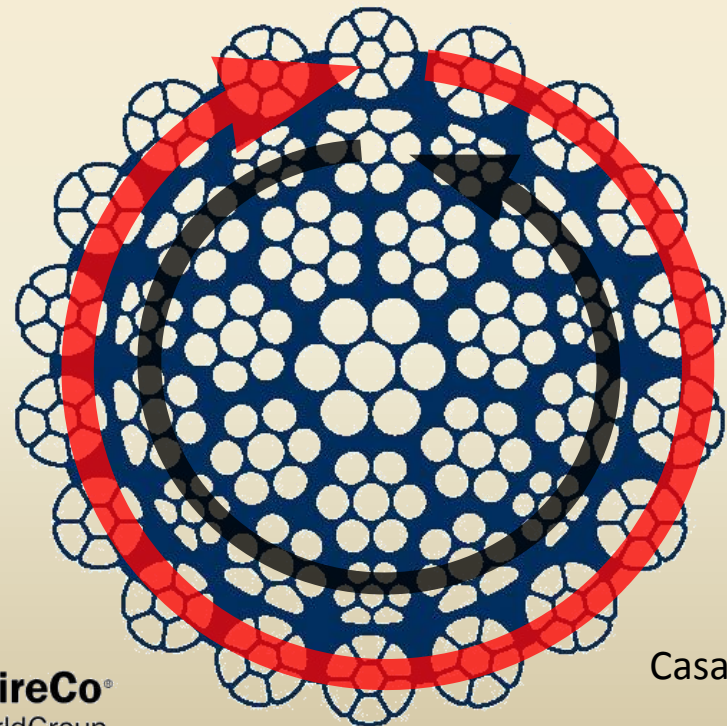
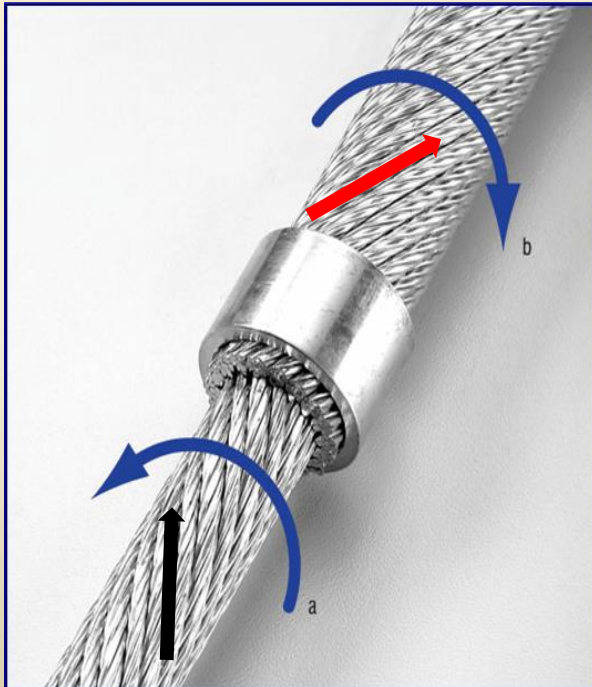


Resistance to rotation: Rotation resistant

Rotation resistant ropes are required for lifting an unguided load on a single fall or on several falls at a big lifting height. Rope can be used with or without swivel

Consists of an independent core closed in the opposite direction to the overlaying outer strands.

Under load, the moments of the core and the outer strands try to twist in opposite directions and will practically compensate each other.



Casar Eurolift



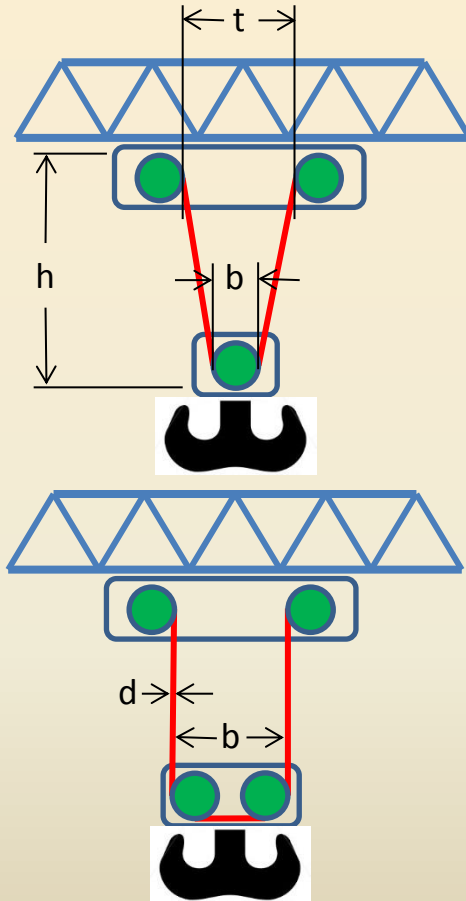
What happens if you use the wrong rope ?



Standard 6-strand rope does not provide any rotation resistance.



How do you avoid spinning of the hook block ?



- $k \leq \frac{b \times t}{4,8 \times d \times h}$

- *k* - the torque factor of the wire rope
- b - the spacing of the ropes at the block
- t - the spacing of the ropes at the top
- d - the nominal rope diameter
- h - the lifting height

Example:

- *k* – factor: Starlift Pro: 0,005
- *K* – factor: Turboplast: 0,092

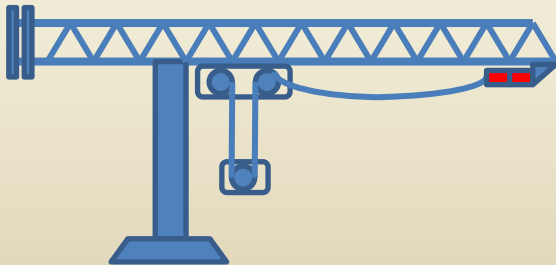
The torque factor of the rope should be below the calculated value



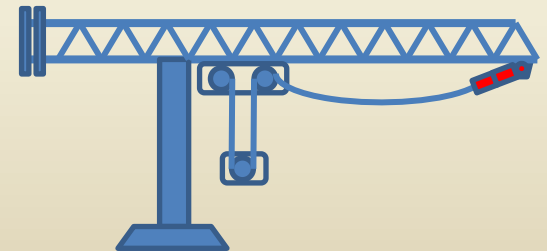
Avoid twist

- Influence of the sheave material (plastic or steel) and sheave angle on external twist
- High fleet angle ($< 1,5^\circ$ for rotation resistant ropes; $< 4^\circ$ for non rotation resistant ropes)
- Proper maintenance of moving sheave for hoist rope
- Running rope over small diameter rollers or sharp edges
- Improper rope installation from drum to drum and handling
- Possible negative impact: wind on the load and slewing of the Tower crane

When a rope is twisted by external forces, a swivel maybe useful



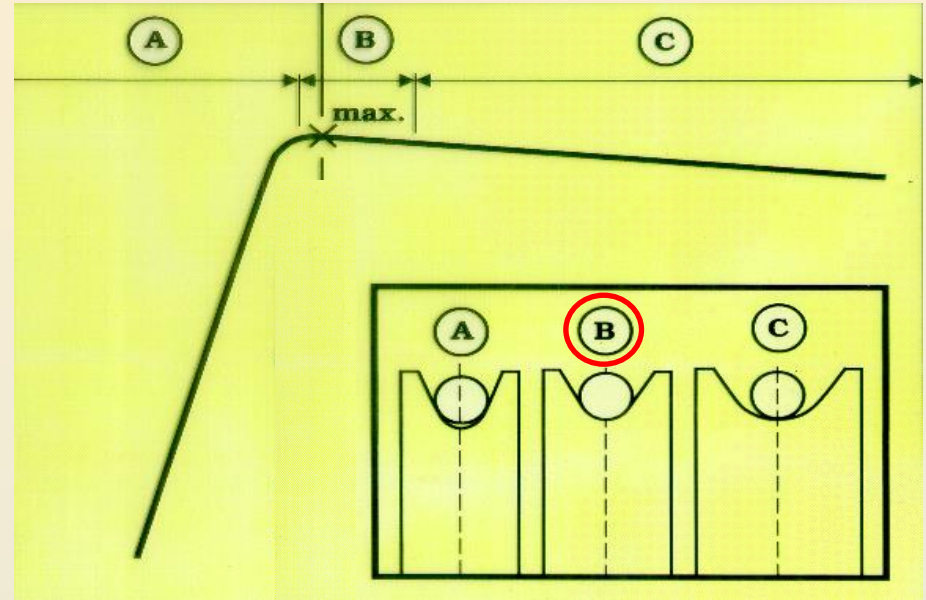
Swivel should be hinge mounted to stay in line with the rope





Influence of the groove diameter on the rope life time

- **A**
 - the groove diameter is too small
 - service life of the rope decreases rapidly
- **B**
 - the optimal size of the groove diameter
 - best service life
- **C**
 - Larger groove diameter
 - Service life decreases steadily

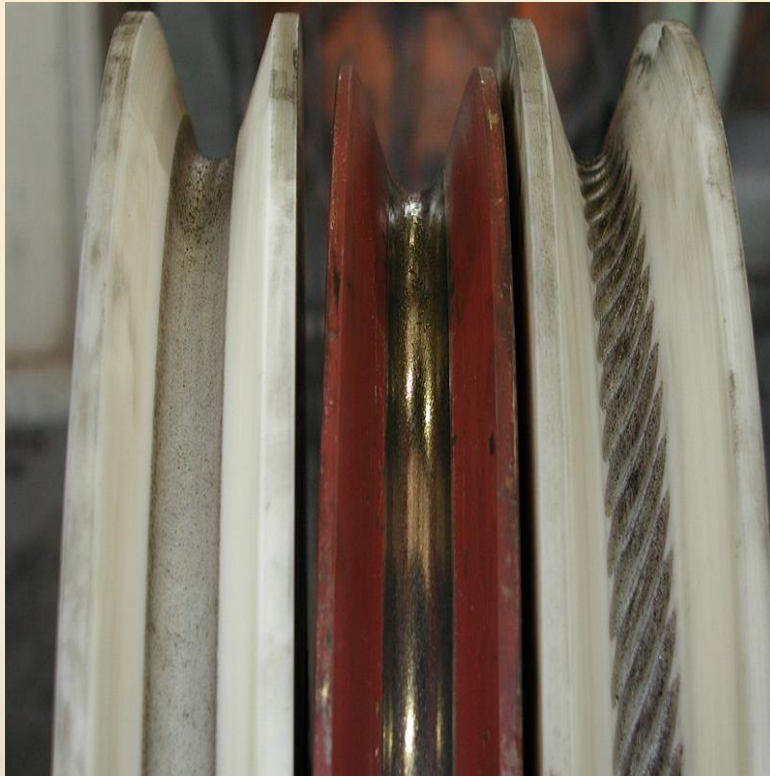


Groove measuring tool

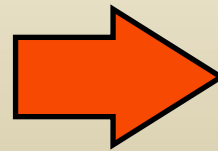
$$\begin{aligned}\varnothing_{min} &= 0,525 \times d_{nom} \times 2 = +5\% \\ \varnothing_{opt} &= 0,5375 \times d_{nom} \times 2 = +7,5\% \\ \varnothing_{max} &= 0,55 \times d_{nom} \times 2 = +10\%\end{aligned}$$



Hardness of rope and sheave



tensile strength	HRB Ball	HRC Cone
1770 N/mm ²	450	45
1960 N/mm ²	500	50
2160 N/mm ²	530	53



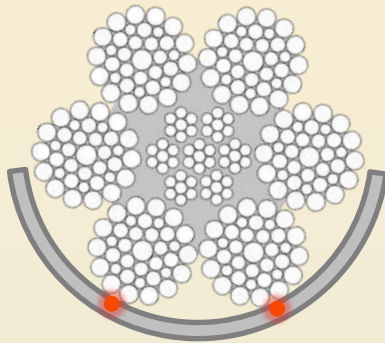
recommendation for the hardness of the sheave: >350 HRB / >35 HRC





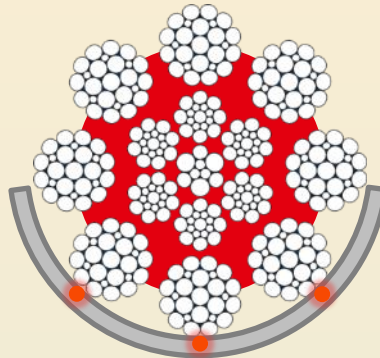
Bearing Surface

6 strand



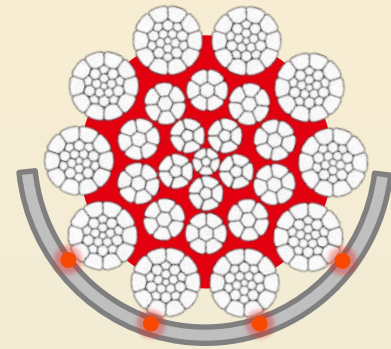
load spreading 50 %
on each strand

8 strand



load spreading 33,3 %
on each strand

10 strand



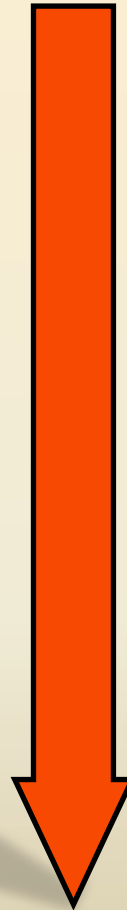
load spreading 25 %
on each strand



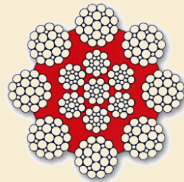


Compacted and swaged ropes

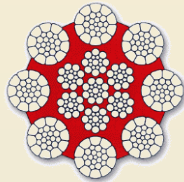
- extremely round cross section
- smooth surface
- better bending fatigue behaviour
- special ropes for multi layer spooling
- better contact area with sheaves and drums
- lower bearing pressure
- less wear
- very high breaking strength
- very good crushing resistance



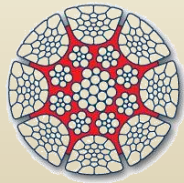
- uncompact rope



- compacted rope

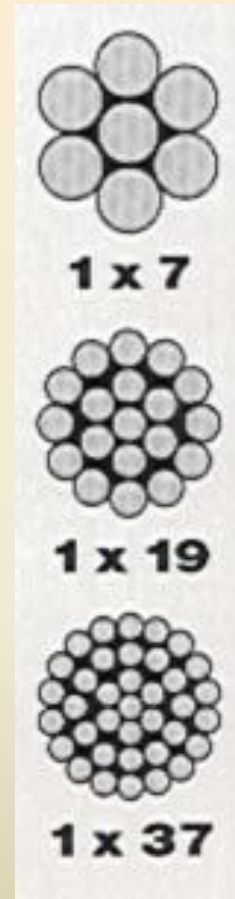
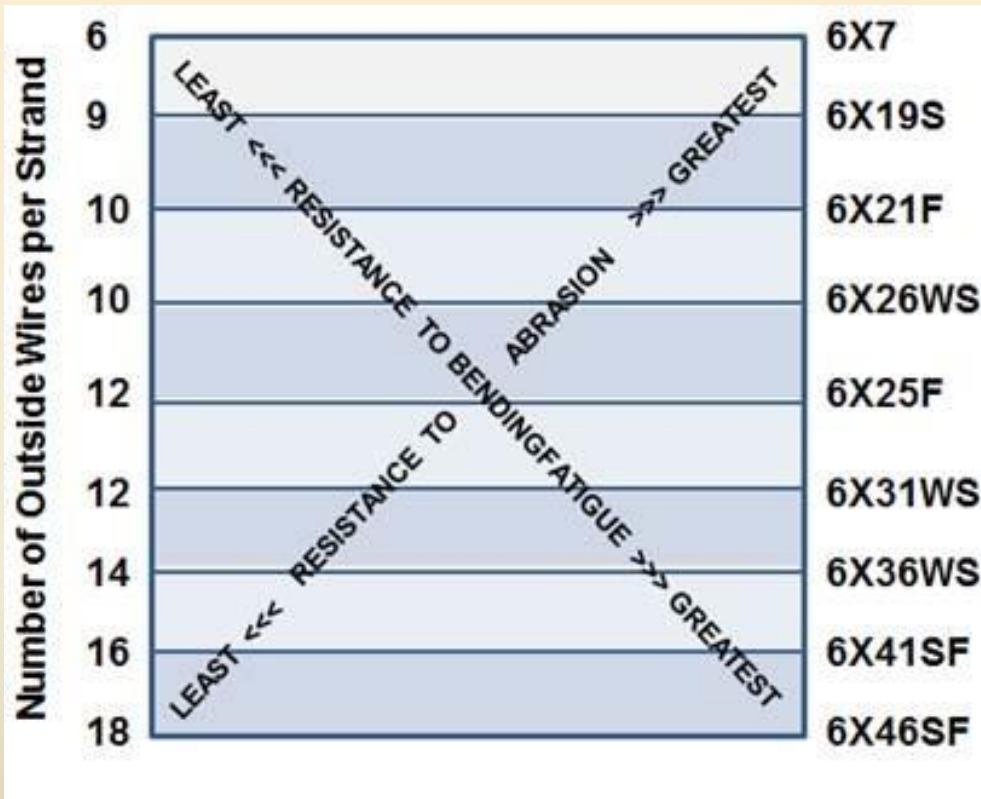


- swaged rope

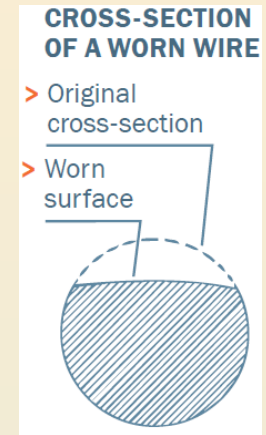




Abrasion & Fatigue resistance



Abrasion

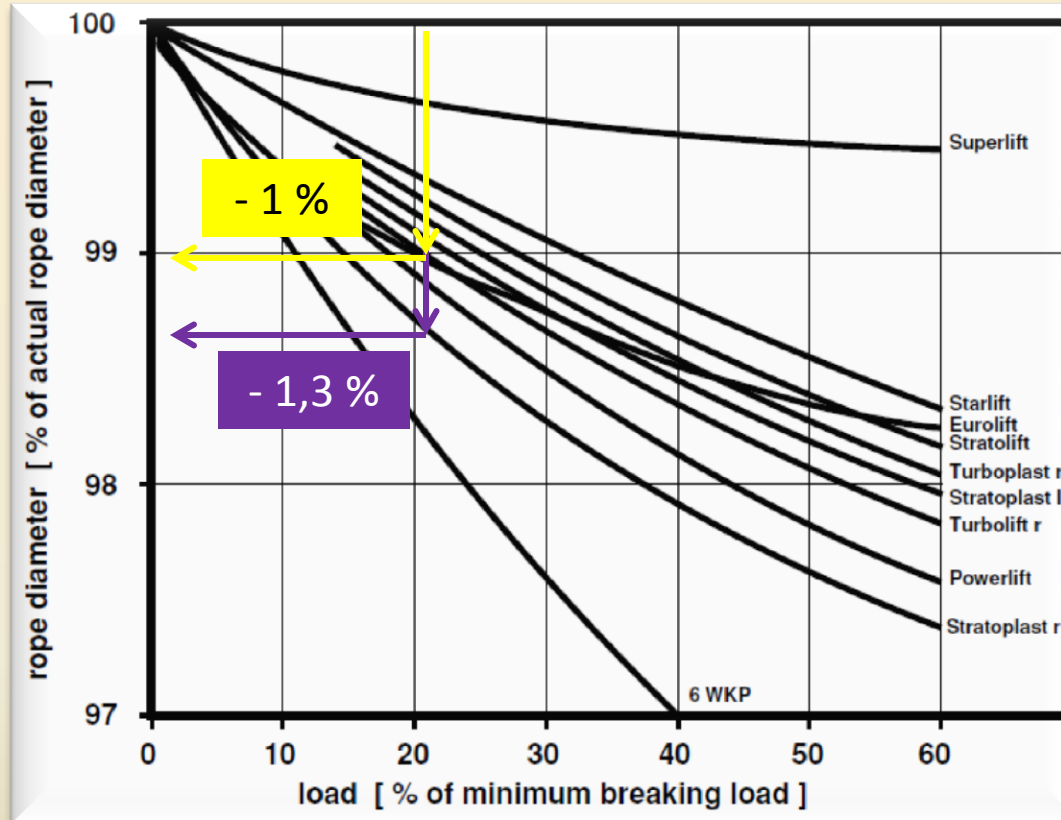


Fatigue





Diameter reduction under tension



Diameter reduction should be less than 1% under maximum rope load for rotation resistant and less than 1.5% for non rotation resistant ropes

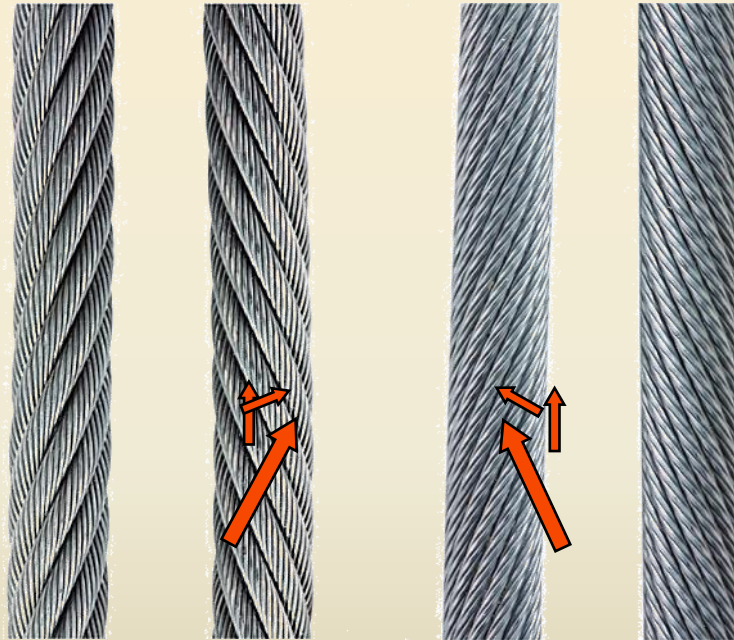




Ordinary lay – Lang's lay

Regular (ordinary) lay

The wires in the outer strands are laying almost in line with the rope's axis



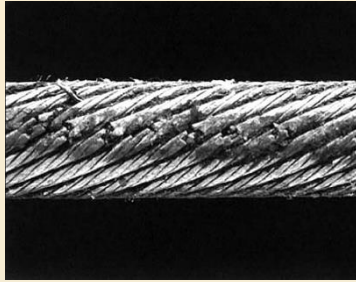
Lang's lay

The wires in the outer strands have a distinct angle to the rope's axis.

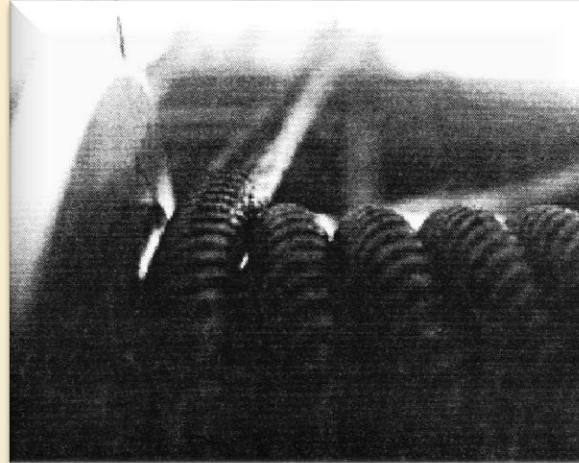




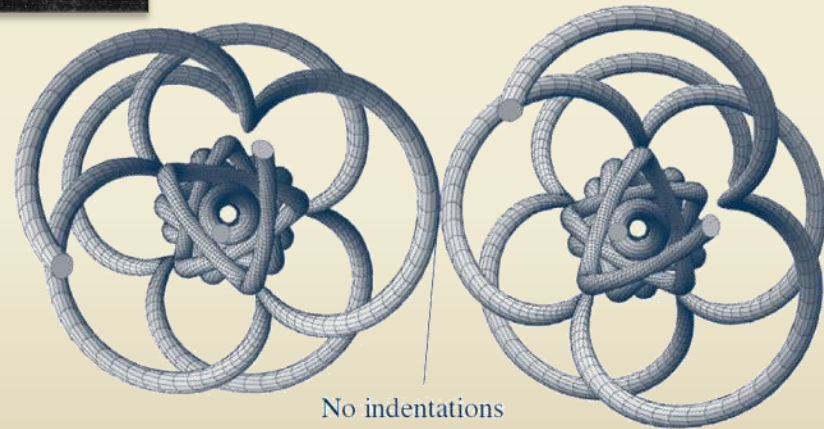
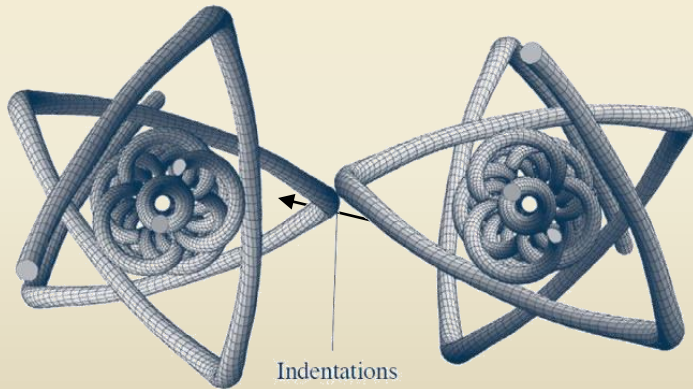
Indentation on multiple layer drums



Regular lay



Lang's lay

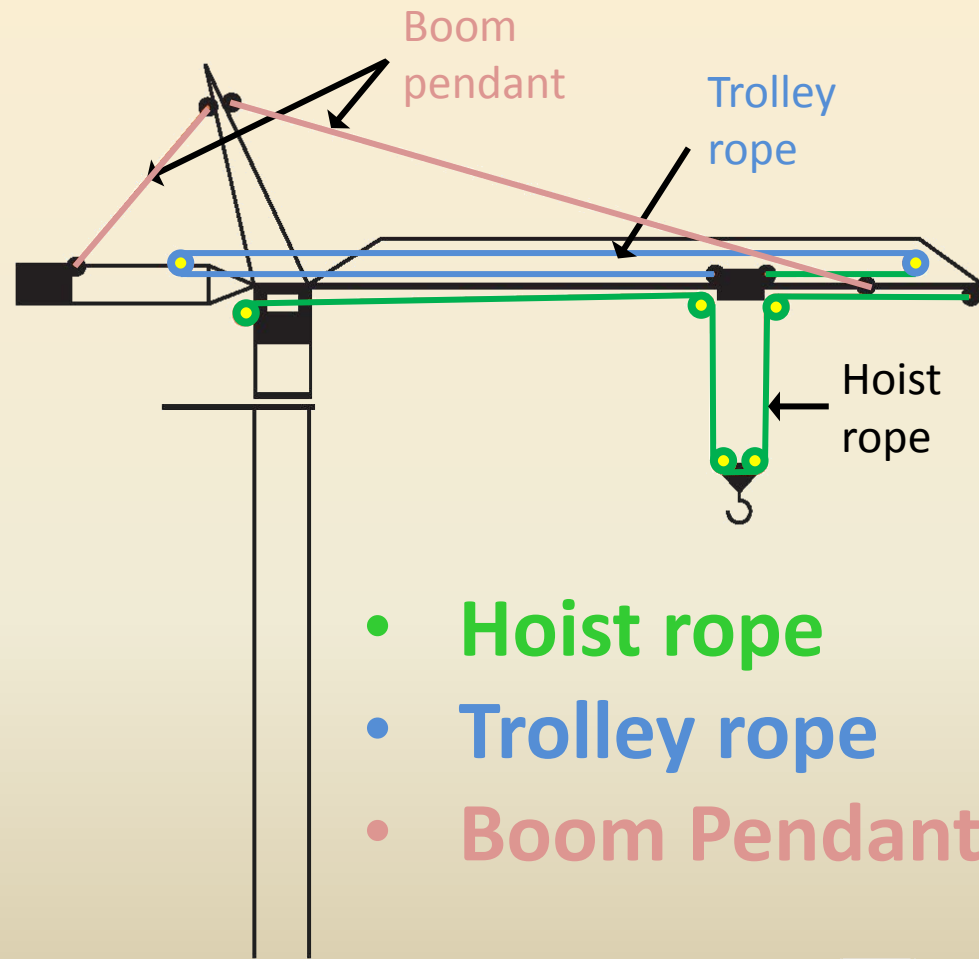


Compared to regular lay, in Lang's Lay, indentations between outer wires do not occur.



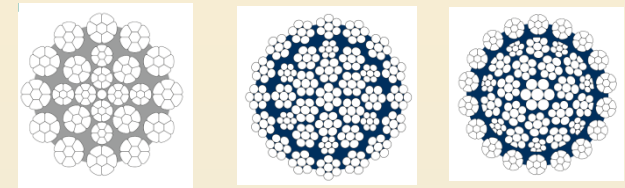


Rope selection examples

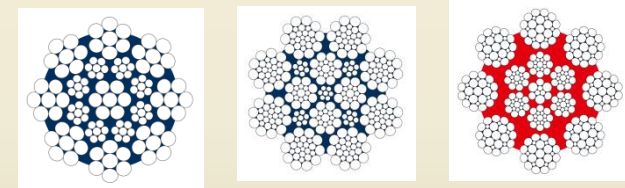


- **Hoist rope**
- **Trolley rope**
- **Boom Pendant**

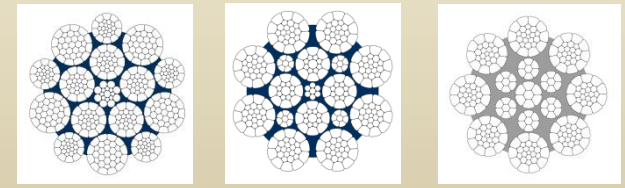
- **Hoist rope**
12 to 18 strand rotation resistant



- **Trolley rope**
Non rotation resistant



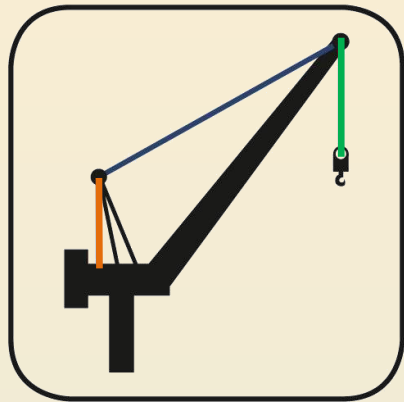
- **Boom Pendant**
Non rotation resistant



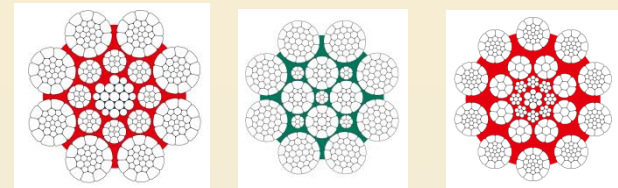


Rope selection examples

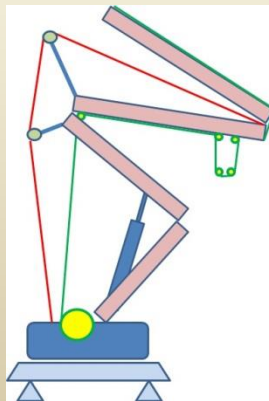
- **Boom hoist rope**



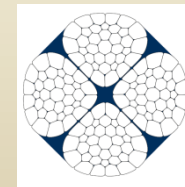
- **Boom hoist rope**
non rotation resistant



- **Tower erection rope**



- **Tower erection rope**
Semi rotation resistant





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