Crane rope selection, maintenance and inspection

Dr. Oliver Fries, VP Global R&D, Innovation and technology, May 2014
Safety and best practise

- Who are we?
- What rope to select?
- What about maintenance and inspection?
Who are we?  
Significant dates in our history

|------|------|------|------|------|------|------|------|------|

**Union®**
- Global oil & gas wire ropes
- Specialty crane ropes
- Mining ropes
- Engineered assemblies for OEMs

**CASAR**
- High performance wire ropes for crane and mining markets

**Drumet**
- Steel wires
- Wire ropes
- Low cost manufacturing

**WireCo® Structures**
- Structural projects

**WRCA**
- Wire Rope Corporation of America
- TESTED, TOUGH & TRUE

**camesa**
- Steel wires
- Steel wire ropes
- Electro mechanical cables

**PHILLYSTRAN**
- Leading manufacturer of synthetic ropes

**OLIVEIRA**
- High performance wire rope for crane and fishing market
- Synthetic rope manufacturer

**WireCo® WorldGroup**
- Synthetic rope manufacturer
- Engineered products
- Manufacturer of nets

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One WireCo

Executing for Growth
What rope to select? (1)

Product attributes, restrictions and specifications

- Crane type -> *what type of ropes are needed*
- Standards -> *safety factors, discard criteria, inspection*
- Environment -> *lubrication, surface treatment, material*
- Crane load capacity -> *breaking load, diameter, wire grade*
- Target costs - > *cost of ownership, you get what you pay for*
- 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*
- 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 - take no safety risk: Talk to the experts!
What happens if you use the wrong rope?

Standard 6-strand rope does not provide any rotation resistance.
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
- 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**
  - 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
Why inspection of wire ropes?

- Loss of breaking force – limited lifetime
  - Progressive loss of metallic cross section
    -> Abrasion, Steady increase of wire breaks, structure changes
Inspection of the wire ropes

- Daily visual inspection
  - General wearout
  - Mechanical damage
  - Check if the rope is sitting correctly on the drum and over sheaves
  - Check the whole reeving system of the crane
- Inspection following period out of operation
- Inspection after an incident
- Periodic inspection → Discard before failure
  - Interval depends on application, standards, manual and experience
  - Done by a competent person
  - Inspection of the working length plus at least 5 drum wraps
  - All attachment points
Particular care at critical areas!

- Anchoring points on drum or fixed end
- Drum sections with greatest interference (e.g. max. fleet angle between 1/2 or 5/4)
- Section that enters head sheave (4) or block sheave (2) when load is lifted
- When using a compensating sheave (3), the entry points that just do micro movements are critical
- Drum cross over zones and pressure between layers on multi layer drums (5)
Rope failures
Service life time depending of the reeving

1 BC per hoisting cycle: service life 24 months
3 BC per hoisting cycle: service life 8 months
5 BC per hoisting cycle: service life 5 months
7 to 21 BC per hoisting cycle: service life 2 months
Discard criteria according to ISO 4309

- Number of visible broken wires
- Reduction in rope diameter
- Fracture of strands
- Corrosion
- Deformation
- Mechanical damage
- Heat damage
Number of visible broken wires

Example: Casar catalog – Starlift Pro

Visible broken wires on 6xd and 30xd

Ask the supplier for support!
Rise of broken wires!

BENDING FATIGUE 7: Number of visible broken wires depending on the number of cycles in a bending fatigue test. The number of wire ropes breaks increases steadily according to a powerfunction.
Measurement of the diameter

- Local increase in diameter
  - If the rope diameter increases more than 5% the reason shall be investigated and consideration given to discarding the rope.

Correct

Wrong
Decrease in rope diameter

- Uniform decrease in diameter
  - single layer rope with steel core: discard max. -7.5%
  - rotation resistant rope: discard at max. -5%

\[
\left(\frac{d_{\text{ref}} - d_m}{d}\right) \times 100
\]

\(d_{\text{ref}}\) = reference diameter
\(d_m\) = measured diameter
\(d\) = nominal diameter

- Local decrease
  - caused by failure of the core or rope center, the rope shall be discarded
Fracture of strands

- If a complete strand fracture occurs, the rope shall be immediately discarded.
Corrosion

- **External corrosion**

  Discard:
  Wire surface heavily pitted and slack wires!

- **Internal corrosion**

  Discard:
  Obvious visible signs – corrosion debris exuding from valleys of the outer strand


Waviness

- Straight rope without contact to sheaves or drum: $g_{\text{max}} = 1/3 \times d$
- Rope which runs through a sheave or spools on a drum: $g_{\text{max}} = 1/10 \times d$
Deformation

- Basket deformation (also called bird cage)
  - Caused by rope twisting
  - Sheave too narrow
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

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\begin{align*}
\phi_{min} &= 0.525 \times d_{nom} \times 2 = +5\% \\
\phi_{opt} &= 0.5375 \times d_{nom} \times 2 = +7.5\% \\
\phi_{max} &= 0.55 \times d_{nom} \times 2 = +10\%
\end{align*}
\]
Rope failures
ISO 4309: Valley breaks

Arc pressure between the outer strands
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

service life (rope and elements)
Deformation

• Core or strand protrusion or distortion

• Protruding wires in loops
Deformation

- Flattened portion
- Kink
Rope failures
Electric shock – accidentally contact

Significant cross section loss and structural change caused rope to break