IMCA High-Value Wire Ropes in the New Offshore Environment – Report 2024

Lifting & Rigging Seminar

12 September 2024

The International Marine Contractors Association (IMCA) is the international trade association representing offshore marine contractors, service companies, and the industry's supply chain.

IMCA's mission is to improve performance in the marine contracting industry. Our value proposition is to influence our industry in key technical, contractual, policy and regulatory matters that are in the collective best interest of the marine contracting industry.

For over 25 years, IMCA has maintained an important body of knowledge to assist our industry in the form of published guidance documents promoting good practice across a wide range of technical and professional disciplines. Documents have a self-explanatory title and are catalogued using a code containing letters and numbers. The letters indicate the discipline, and the number is simply sequential within that discipline. Members are expected to adopt the contents of the IMCA technical library as a minimum standard in accordance with our document designation and grading system, see www.imca-int.com/publications

Feedback – If you have any comments on this document, please email us: feedback@imca-int.com

Lifting & Rigging Seminar – **Version History**

Date	Reason	Revision
October 2024	First issue	

IMCA High-Value Wire Ropes in the New Offshore Environment – Report 2024

Background and Setting the Scene **5**

Introduction & Welcome – David Cannell (Chair) 5

Warm-up Workshop 6

Setting the Scene to Planning a Lift – IMCA LR 001 – Wire Rope Integrity Management 7

Session 1 – Operators' Experiences – Offshore Wire Ropes **10**

1.1 Subsea Construction – Collective Team Effort, Lifecycle? – Russell Craig, TechnipFMC 10

1.2 Life of a Wire Rope – From Specification to Discard – Yoeri Brouwers, Heerema 12

1.3 Crane Utilisation – Traditional and Current Utilisation of HLV Crane (Offshore Wind Industry) – Jack Spaan, Boskalis 14

1.4 Wire Rope Integrity Management Policy – The Importance of Having It – Marco Pedroso, SBM 16

1.5 Workshop 1 17

Session 2 – Rope Interaction with Equipment **20**

2.1 Comparison of Permanent Magnetic Testing with Automatic Evaluation to Individual Magnetic Tests with Manual Evaluation – Ralph Eisinger, Stuttgart University 20

2.2 What You Have to Know About Wire Rope Lubrication – Laura Lombardi, Usha Martin Italia 24

2.3 Workshop 2 26

Session 3 – NDE of Wire Ropes **30**

3.1 Rope Lifetime Prediction and Considerations for Offshore Renewable Installations – Christoph Ruffing, Bridon Bekaert Group 30

3.2 Crane Utilisation and Inspection and Maintenance, How Can They Dance Together – Martijn Reissenweber and Robin van Nieukerk, Huisman 32

3.3 Fatigue Broken Wires as a Major Threat for the safety of Crane Wire ropes – Prioritisation of MRT Inspections – Maciej Martyna, LRM-NDE 35

3.4 Continuous Rope Monitoring Systems – Bruno Vusini, AMC Instruments 38

3.5 NDT Panel Session – Suppliers Q&A 40

Session 4 – Advancing Rope Technology **44**

4.1 Prolonging Rope Service Life: Evaluating Plastic Coated Ropes in Multi-Layer Spooling Applications – Max Stök, Clausthal University 44

Session 5 – Review of the Day **46**

5.1 Review of the Day and Final Comments/Questions – David Cannell, Chair 46

5.2 Closing words by IMCA CEO 48

Foreword

IMCA's Lifting & Rigging Seminar is put together by a workgroup, comprising people involved in IMCA's Lifting and Rigging Committee work. They are IMCA members and have vast experience and in-depth knowledge of offshore lifting activities within our industry.

These events are primarily a discussion forum for members and non-members alike covering key technical and operational topics. Bringing a mix of presentations and workshops allows attendees to focus on the specific topics during the day, identifying the actual state of the industry and its future requirements.

Output from this seminar, the fourteenth in the annual series, helps guide the IMCA Lifting and Rigging Management Committee in defining its future work scope on codes and guidance. The output from past seminars has influenced and shaped key areas of our industry and this one is set to perform just as useful a task.

This year's theme focused on high-value wire ropes, along with presentations and discussions on the wire rope inspection, case studies and technology in the new offshore environment.

Thank you to our sponsors.

Background and Setting the Scene

Introduction & Welcome – David Cannell (Chair)

The Chair of the event, David Cannell of Technip FMC, introduced himself and welcomed everyone to the event. David is also Chair of the Lifting and Rigging Seminar working group.

David said that this year, we are focusing on High-value wire ropes in the New Offshore Environment. A reminder that it is "not just a line on a drawing" but a complex machine that needs care in design, maintenance in operation and replacement at the right time.

Figure 1 – David Cannell

This seminar is a return to our roots for the IMCA LR conference, which was initially created to help improve our understanding and approach to wire ropes used offshore. Their maintenance, inspection, the impact of the winches/sheaves/operations and ultimately, the definition of safe economic replacement

The forums have proven to be an excellent platform for subsea contractors to discuss their issues and concerns with the various equipment suppliers, for the suppliers to share their developments, and to ensure academia is involved in preparing solutions for the future. Over the years, we have had great discussions and seen significant changes in the approach taken to the care and maintenance of high-value ropes within the industry. This included preparing for high-performance fibre rope operations.

In 2018, we took the decision to "Widen the discussion to include Offshore Cranes and Lifting". Looking wider at the full lifting systems offshore. However, the offshore energy sector has changed significantly since we last looked at ropes. As the sub-title for the event says, 'they are not just a line on a drawing', but integral to safe operations offshore, and they are very expensive if they need urgent replacement or even worse when things go wrong.

David presented the programme for the event and emphasised that engagement at the event was necessary to ensure that any concerns and solutions were captured.

David thanked the event's sponsors and introduced the first Slido warm-up session.

Warm-up Workshop

The first question was for the audience to say 'hello' in their language, followed by a word cloud on where delegates were from.

Figure 2 – Delegate locations

The next question to the audience was, 'What is your interest in offshore lifting?'

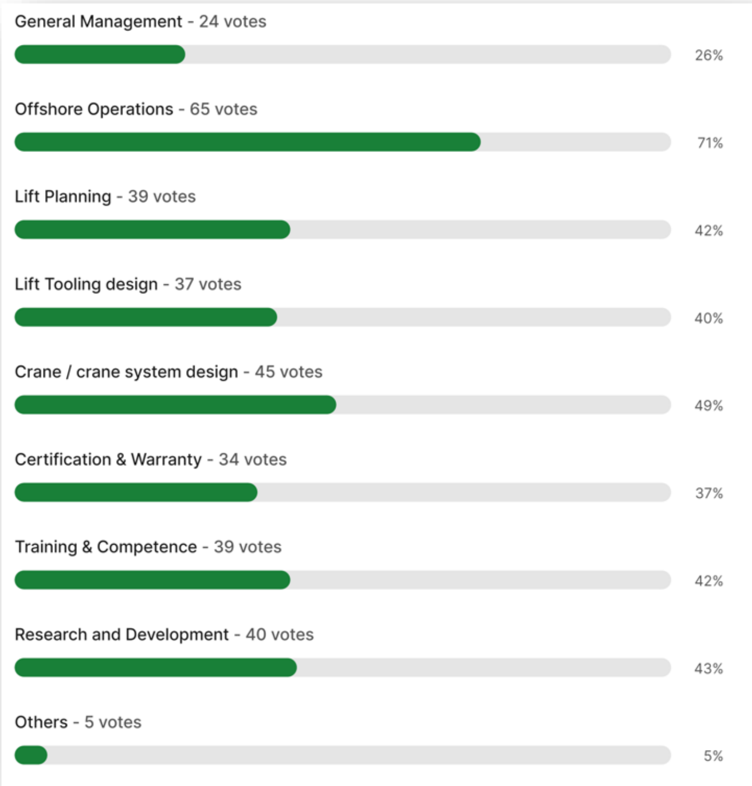


Figure 3 – Interest in Offshore Lifting

The next question put to the audience was, 'How many relevant years of experience do you have?'

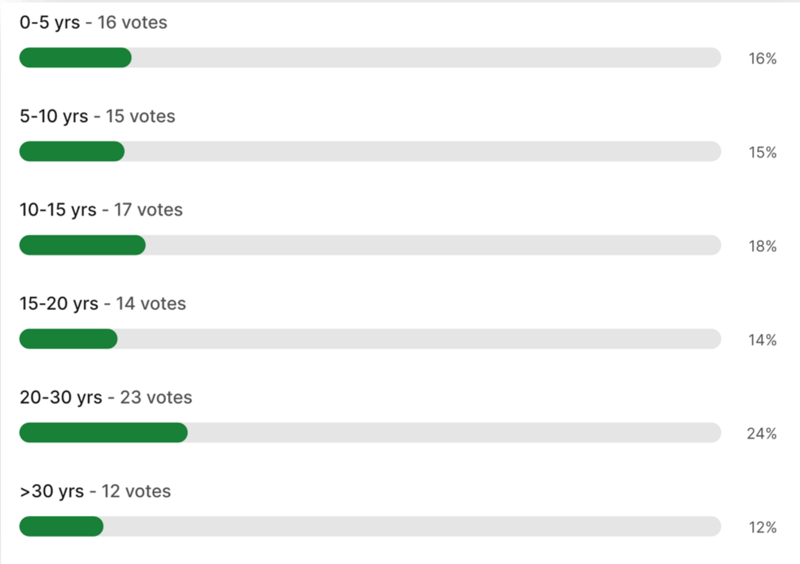


Figure 4 – 50% had over 15 years of experience, but overall, a good spread

David thanked everyone for participating in the Slido questions and introduced the next speaker, Mark Ford, Marine and Quality Manager of IMCA.

Setting the Scene to Planning a Lift – IMCA LR 001 – Wire Rope Integrity Management

After the introduction, Mark discussed IMCA's Wire Rope document LR001 – Wire Rope Integrity Management. He further explained that the document had been developed by the Lifting and Rigging Management Committee (LRMC) and highlighted that wire rope for offshore heavy lifting is a valuable asset and something that needs care and maintenance.

The definition of Wire Rope Integrity Management (WRIM) was stated as follows:

A systematic approach encompassing the entire lifecycle of wire rope to ensure safety and reliability.

It was mentioned that the document provides guidance to help identify risks and implement preventative measures to reduce the likelihood of rope failure.

Mark then presented to the audience an overview of what the document sections contained and focused on the six tools that can be utilised to provide wire rope integrity assurance as follows:

Figure 5 – Mark Ford

(*A minimum of two integrity tools should be used for each rope.*)

1. Thorough examination and inspection
2. Automatic discard (replacement) after a set period – e.g. twelve months

3. Non-destructive examination – e.g. magnetic rope testing, visual inspection
4. Destructive examination – e.g. breaking force test, rope dismantle, ductility evaluation
5. Fatigue evaluation – i.e. evaluation of usage /duty cycle fatigue impact through real-time monitoring and/or empirical and mathematical methods
6. A range of post-retirement activities which will provide feedback into the integrity management system.

Wire rope selection was presented, and it was emphasised that those involved with selecting a wire rope for any application, such as the engineers and project managers, need to assess wire rope requirements early to ensure the wire rope's compatibility with its associated system for its intended use.

The storage and preservation were presented, and the details of location, period, preservation (e.g. drum rotation, etc.) and storage conditions should be recorded on the wire rope's documentation. They should be maintained until the wire rope has been retired from service.

Each wire rope needs to have its unique identification and a method of linking the wire rope to its documentation, for example, by an identifying sleeve or tag.

Wire rope lubrication was another subject presented, and it was said that a wire rope is like a machine – it has moving steel parts that slide across one another, so lubrication is essential to minimise wear.

With all the different methods of re-lubrication of steel wire ropes, it is important that they are carried out regularly right from the beginning of the rope's service life, including storage, and not only after the first damage has been found.

The inspection of wire rope was emphasised as steel wire rope can be an expensive asset with a limited lifespan. Many properties will change during its service period. For instance, the breaking strength will slightly increase at the beginning of its service life but may rapidly decrease after reaching this maximum. The initial increase of the breaking strength is a consequence of settling-in effects (within the rope), which lead to a more homogeneous load distribution amongst the wires in the rope. The subsequent decrease in breaking strength can be explained by the increased loss of metallic cross-sectional area caused by abrasion and corrosion, the occurrence of wire breaks, and structural changes to the rope. With a chain, which represents a series connection of load-bearing elements, the failure of a single element results in the total failure of the whole lifting device. In contrast, the load-bearing elements of a wire rope are in a parallel arrangement. Therefore, even after many wire breaks, a steel wire rope can still be operated safely.

The terminology of wire rope construction was shown, and it was said that the terminology of wire rope is often incorrect. Ensure that the terminology for identifying the components of a wire rope is correct.

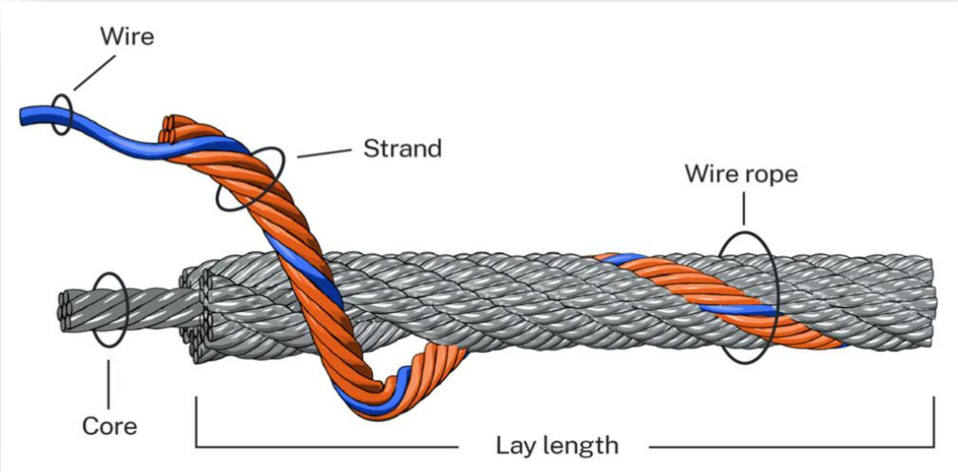
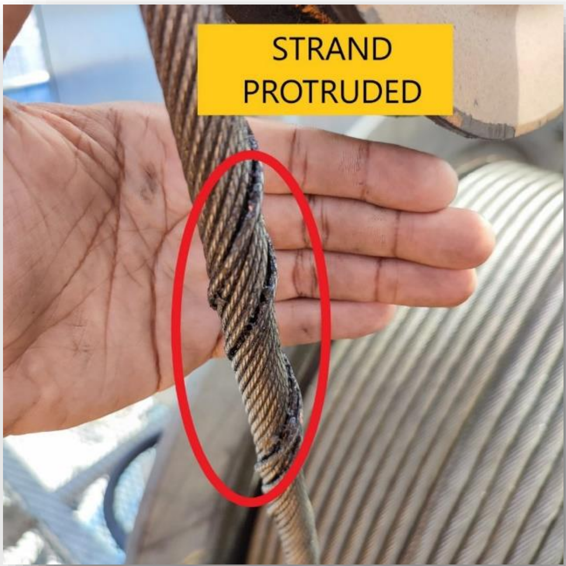


Figure 6 – Wire Rope Construction Terminology

To close the presentation, a few photographs of wire rope in different failure modes were shown as follows:



Figures 7 – Example Wire Rope Failure Modes

Session 1 – Operators' Experiences – Offshore Wire Ropes

1.1 Subsea Construction – Collective Team Effort, Lifecycle? – Russell Craig, TechnipFMC

Russell Craig was introduced by David Cannell, who started by saying that despite using ropes for many years, there is always something to learn – we cannot become complacent. Knowledge and lessons learnt need to be shared.

Figure 8 – Russell Craig

Russell pointed out that in many engineering drawings, a wire rope is shown just as a simple line. However, he stressed that it was far from that, as a wire rope is a complex machine that requires knowledgeable people with differing expertise levels.

Russell described a selection of the team involved with wire rope as follows:

Who	What
Rope Superintendent	Safe use document owner, process owner, first point of contact when issues
Installation Engineer	Ensures rules are followed when using ropes on site
Riggers	Pre-Post use checks
Operators	Daily checks
Ops Engineers	Pre-use planning and engineering
R&D Personnel	Improving operations, reducing costs
3rd Party Experts	NDT, lubrication, rope design, inspection
Academia	Transfer of knowledge from studies to operations

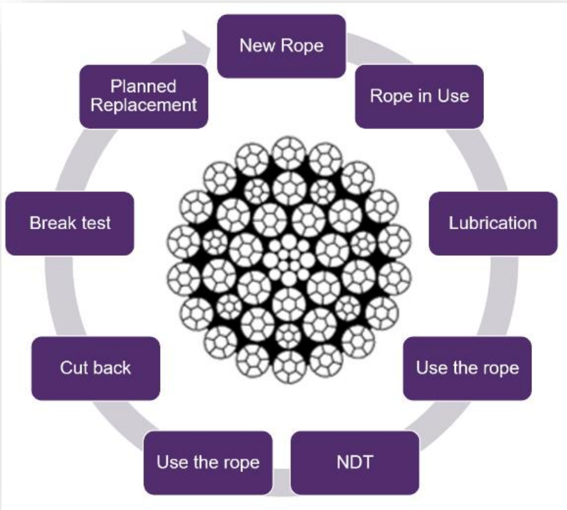


Figure 10 – Rope Lifecycle

Russell explained the rope lifecycle using the above *Figure 10 – Rope Lifecycle*.

The presentation then turned to the challenges regarding the maintenance of wire rope as follows:

Replacement	Lubrication	Cutbacks	NDE
Schedule	Schedule	Always the working end	Schedule
High-value ropes – high cost	Slips from excess grease	Shipping costs	Interpretation of data
Shipping Costs	Environmental impact	Is it an accurate inspection?	Placement of equipment – water ingress
Installation equipment	Compatibility	Delay in results	Are results comparable?
High risk of damage	Contamination		
Handling risks	False sense of security		
Installation risks			
Planning change out			

The challenges of a wire rope during its use were also presented as follows:

D/d	Winch Interaction	Load Cycles
Sheaves	Lebus grooves	Active heave compensation
Snatch blocks	Tolerances in rope diameter	Repetitive operations
Winch drums	High loads with traction winches	Heat and humidity
Crane hook radii	Packing or ropes on winches	Interaction with sheaves
Shackle bows and pins	Knifing	
Static Vs Dynamic		

Russell moved on to rope interaction. Is it clear?

He mentioned the questions posed by engineers as 'Can we do this?'. 9 times out of 10, the answer would be 'Yes'. But how long do you want the wire rope to last?

Every time we use the rope, we degrade it in some way. Whether it is related to the D/d ratio and the Donandt Force[1]. Regarding the Donandt Force, what do we need to consider? What is the rope construction; Snatch blocks may have a different usage depending on the rope type. Regarding the rope diameter, does it fit in the groove of the snatch block correctly? What is the D/d ratio? Using a small D/d will work, but your rope life will seriously be reduced.

Lubrication was key – too much leads to difficulties inspecting the rope – and also leads to slip hazards. Too little, and we start to have abrasion and corrosion.

What is the right amount of lubrication? Russell said that every rope is different and there is no one-size-fits-all approach.

Russell then covered what couldn't be seen with a wire rope. Ageing is a phenomenon commonly observed in carbon steels, where the strength of a metal increases while the tension elongation capacity is reduced. The ageing process can't be prevented as it is an intrinsic phenomenon mainly influenced by temperature change over time. Reduced ductility with time leads to potential brittle fractures of wires and, thus, premature withdrawal of the wire rope from service. High steel grade is more subjected to the ageing process when subjected to long-term storage within elevated ambient temperatures and, thus, more subjected to reduced ductility within the wire material. Russell referred to IMCA SF 08/24 – Strain ageing – DSV Main Bell Wire Retired Early.

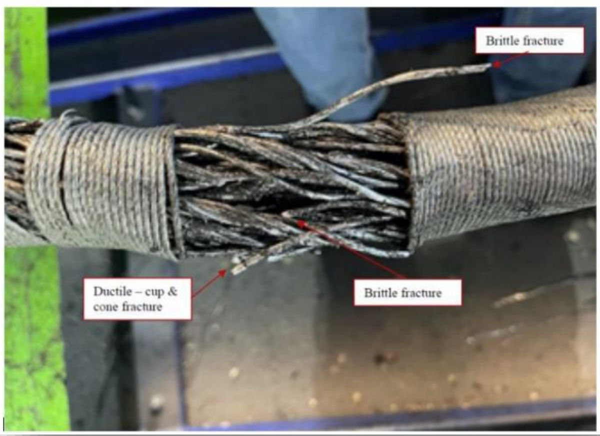


Figure 9 – Strain aged bell wire rope

[1] The yielding tensile force for a given bending diameter ratio D/d – strict limit. The nominal rope tensile force S must be smaller than the Donandt force SD1

Russell summarised as follows:

- Safe use of wire rope is a collective team effort.
- Wire ropes are complex machines – not just simple lines.
- A satisfactory wire rope policy is required, which is applied across a variety of rope types and use.
- Safe use requires regular inspection by those operating.
- Regular maintenance is essential both for the ropes in use and those in storage.

1.2 Life of a Wire Rope – From Specification to Discard – Yoeri Brouwers, Heerema

David Cannell introduced Yoeri Brouwers of Heerema, who commenced his presentation by highlighting the importance of a rope specification for a new wire rope. He said that for a new build, it is very important to be involved, as the vessel operator will have a different interest to that of the rope manufacturer.

It was notable that Heerema specified an Actual Breaking Load (ABL) clause in their wire rope specification to ensure that the ABL does not fall below the Minimum Breaking Force (MBF). Test pieces made directly at manufacturing were stored with the manufacturer, and testing was performed 1 and 2 years after production. The ABL was to remain above the MBF. An example was shown in the following tests at production and after two years on the test pieces. It can be seen that, in this case, the ABL had reduced to below the MBF. The cause was attributed to the strain ageing of the rope.

Figure 10 – Yoeri Brouwers

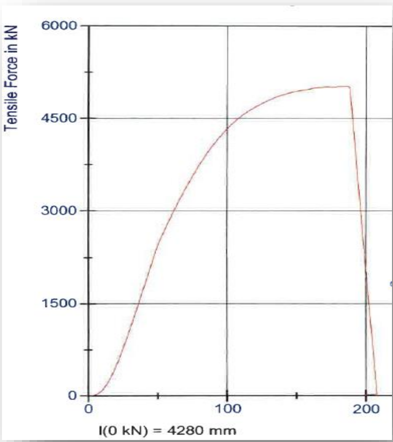


Figure 11 – At production: ABL = 5021 kN, elongation 4.6%

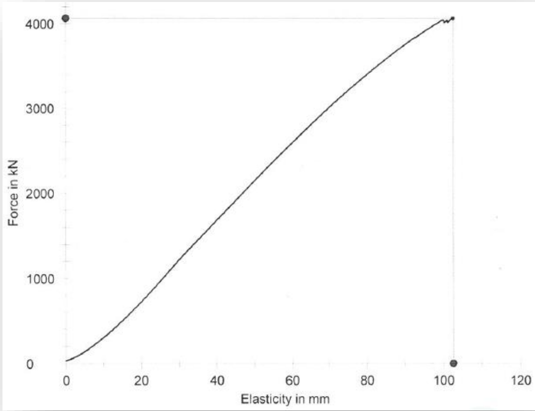


Figure 12 – 2 years after production: ABL = 4066 kN (80% MBF), elongation 1.9%

The requirement for tension on the reel was also included in the specifications.

Yoeri stressed that installing a new rope with back tension was important. It improved the spooling, reduced crushing damage and reduced the risk of knifing or cutting in. He said that there were obvious risks and challenges associated with back tension installation, such as reel strength, and that it required a large line pull force to install. The use of a proper pullhead was mentioned. It was noted that a pulling head process and guidance on safely fixing the pullhead was a potential subject for IMCA to address.

Figure 13 – Pullhead

Wire rope training was said to be important post-installation. It was mentioned that for the boom hoist, tension was achieved by spooling rope from one drum to another, which was repeated three times over the full stroke.

For the hoist wire rope, it was said to reeve the wire with a back tension of approximately 10% of the SWL. Then lower three times at full stroke with an empty hook, followed by three times full stroke at 25-40% load. It was noted that the bigger the crane, the bigger the challenge.

Yoeri said that Heerema does not perform Magnetic Rope Testing (MRT) but does a bi-monthly visual inspection following ISO 4309 and LR001 – Wire Rope Integrity Management. It was mentioned that a trial is currently being carried out using automated inspection by camera. It was noted that breaking load tests were performed annually with a post-discard thorough strip-down inspection on the most used sections.

1.3 Crane Utilisation – Traditional and Current Utilisation of HLV Crane (Offshore Wind Industry) – Jack Spaan, Boskalis

David Cannell introduced Jack Spaan of Boskalis, who commenced his presentation on 'Traditional and Current Utilisation of HLV Crane (Offshore Wind Industry)'.

Figure 14 – Jack Spaan

Jack presented real-life case studies on the effect of high crane utilisation on wire rope damage from the Bokalift 1. It was estimated that the vessels would be operating with high crane utilisation due to wind turbine work, which is approximately five times the number of cycles experienced in oil and gas projects.

The first case study concerning the Bokalift 1 was for the 1,200t auxiliary hoist. The wire rope was commissioned in November 2017 and was discarded due to damage in October 2018. There was evidence of mechanical damage on the outside of the rope, which was not linked to the cross-over area when spooling. The damage was evident in the 6th and 7th layers of an 8-layer drum. It was said that the damage was potentially caused by layer-to-layer crushing and possibly enhanced by the dynamics experienced during installation.


Figure 15 – Damage of the auxiliary hoist rope

The type of work being undertaken was noted to be pin pile installation, template handling and jacket installation.

Jack said there was no clear conclusion on the cause of the damage. No cut in the drum layers was reported. The remedy was to change the wire rope for a new one and carry out wire rope training post-installation.

The second case study from the Bokalift 1 followed on from the above. The wire rope was commissioned in November 2017 and was again discarded due to damage in the Summer of 2023.

There was visible outside damage and multiple broken strands. The cause was attributed to wire rope cut-in on the drum.

The type of work being undertaken was noted to be repeated jacket installation. It was noted that the boom length had been increased, and there was a high line tension on the full drum.

The remedy to prevent the cut-in on the drum was to increase the pre-tension in the lower layers. The wire was also changed to non-rotating and was of a slightly larger diameter than specified by the manufacturer. The rope was then trained post-installation.

Figure 16 – Damage to the auxiliary hoist rope

Jack summarised as follows:

- The effect of intensified wire rope use appears limited, but the rope does not last more than five years.
- The testing of the residual strength of the wire rope after damages proves there is a rapid decline in MBF. Adherence to the discard criteria, again, proves essential.
- Low-spin/ compacted wire performs significantly better when 'cut-in' on the drum is the issue.
- Traditional 6x36 wire rope is better for 'generic use'.
  - Bokalift 1 MH changed back to regular wire for the 2024 season.

1.4 Wire Rope Integrity Management Policy – The Importance of Having It – Marco Pedroso, SBM

David Cannell introduced Marco Pedroso of SBM, who commenced his presentation on 'Wire Rope Integrity Management Policy – The Importance of Having It'.

Figure 17 – Marco Pedroso

Marco started by defining a Wire Rope Integrity Management System and refreshed the audience with the six tools for WRIM assurance.

He said that in SBM, the two tools that are used are:

1. thorough examination and inspection every six months
2. automatic discard (replacement) after a set period, every thirty months.

Marco then commenced a case study involving a 5-tonne WLL crane. The lifting operation involved a cargo Carrying Unit (CCU) backload. The CCU weight was 5.8 tonnes, equating to a 116% overload. The crane suffered damage to the wire rope, sheave collapse and wire rope failure. The load dropped into the sea. The age of the rope was 26 months. The rope had been inspected and, although it had broken wires, was within the limits defined in ISO 4309.

Marco then moved on to another case study involving a 3,993-tonne WLL crane lifting a module of 3,600 tonnes. The main hoist wire rope failed during the lift, and the module dropped to the seabed. Upon investigation, it was found that the wire rope suffered unknown internal corrosion, which led to the failure.

Figure 18 – Crane and rope failure

Marco stressed that using a robust wire integrity management system would have more than likely prevented the failure of the wire rope.

Marco concluded with a sobering message that between 1999 and 2013, more than 60 persons had died due to wire rope incidents, and more than 65 had been injured. Source – Steel Wire Rope Failures Who Is Accountable? – HSE – Maintworld

1.5 Workshop 1

David Cannell introduced the next audience interactive workshop, which used Slido. There were four questions based on areas of concern and interest.

Figure 19 – Workshop 2

1.5.1 Do you have a defined in-house maintenance policy for your high-value wire ropes?

The audience provided feedback on their thoughts as follows:

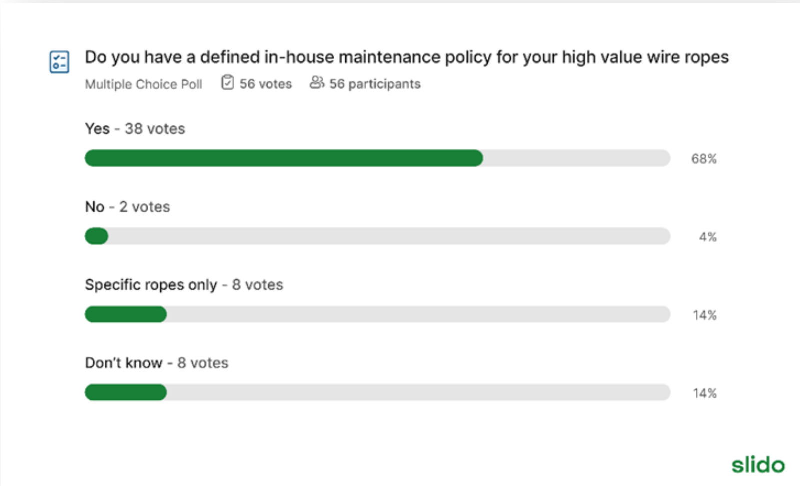


Figure 20 – Feedback on a defined maintenance policy

1.5.2 Do you have a defined in-house discard criteria for your high-value wire ropes?

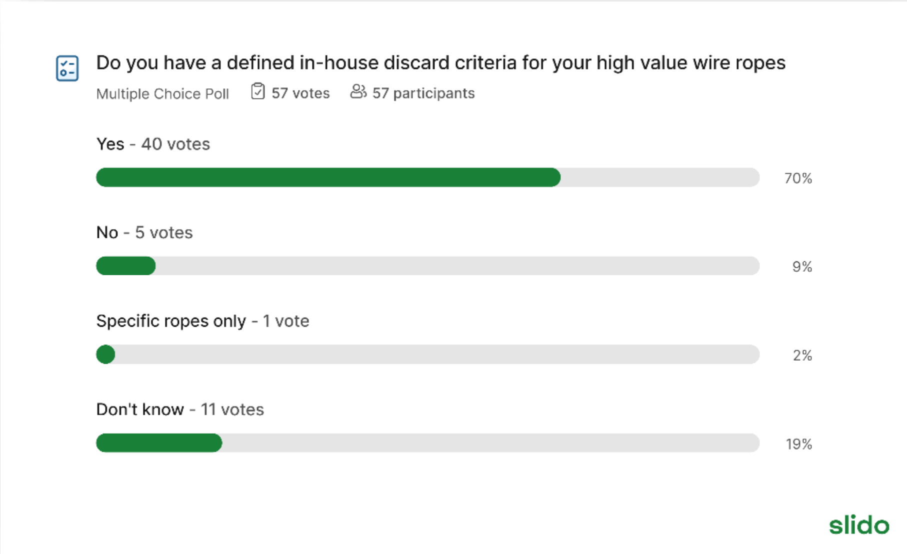


Figure 21 – Feedback on defined discard criteria

1.5.3 List the top 6 ranked items from the following list.

The top six results were ranked in their order of preference.

The following was displayed:

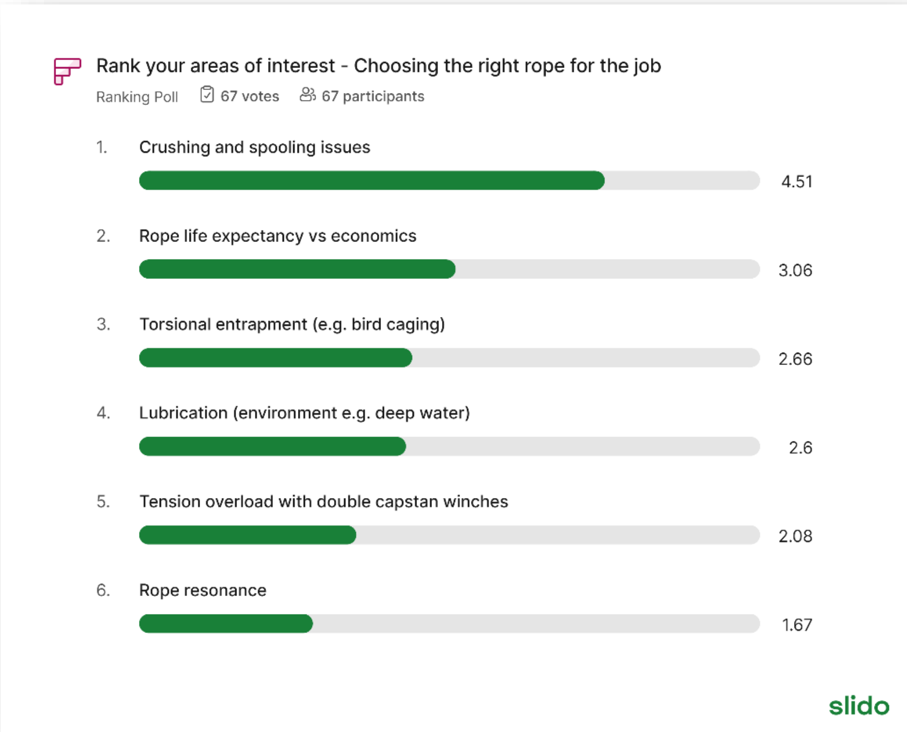


Figure 22 – Top 6 priorities in order of preference

1.5.4 List the top 5 ranked items from the following list.

It was clear that crushing and spooling issues were a main concern along with rope life expectancy.

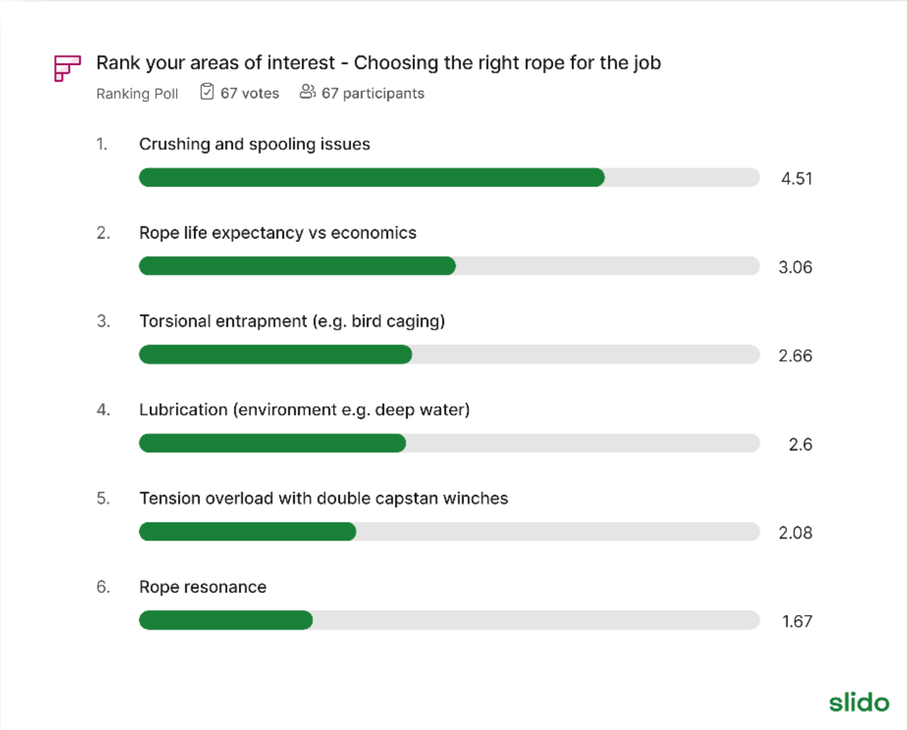


Figure 23 – Are current lift plans fit for purpose?

Session 2 – Rope Interaction with Equipment

David Cannell introduced session 2, which was focused on wire rope interaction with equipment, and introduced the first presenter, Ralph Eisinger of Stuttgart University.

2.1 Comparison of Permanent Magnetic Testing with Automatic Evaluation to Individual Magnetic Tests with Manual Evaluation – Ralph Eisinger, Stuttgart University

Ralph presented the view of Stuttgart University concerning the comparison of permanent magnetic testing with automatic evaluation to individual magnetic tests with manual evaluation.

Ralph commenced by proving how the condition of a steel wire rope can be assessed using the following parameters:

- broken wires
- abrasion profile of the outer wires
- diameter profile
- lay length profile
- distortions
- corrosion
- effects of lightning strikes.

Figure 24 – Ralph Eisinger

He then turned to damage to wires within the rope caused by bending cycles. He said that cable cars/ropeways have an even distribution of wire breaks. However, in stacker cranes/storage and retrieval systems, cranes with differing lifting heights, offshore cranes with active heave compensation and elevators, there is a strong varying distribution of wire breaks in sections.

Ralph then commences presenting magnetic testing methods. He said that the Loss of the Metallic Cross-section Area (LMA) was mainly caused by corrosion and abrasion and that Local defects (LDs) were mainly caused by bending cycles.

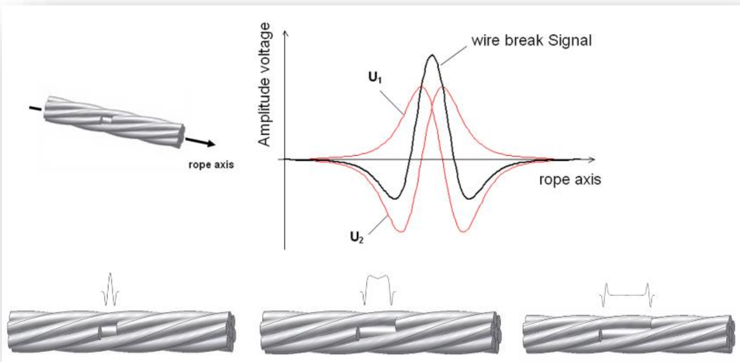


Figure 25 – Form of wire break signals (theoretically)

The actual wire break signal was then presented, and it was clear that the signal depended on the cross-sectional area ratio and the length of the wire break.

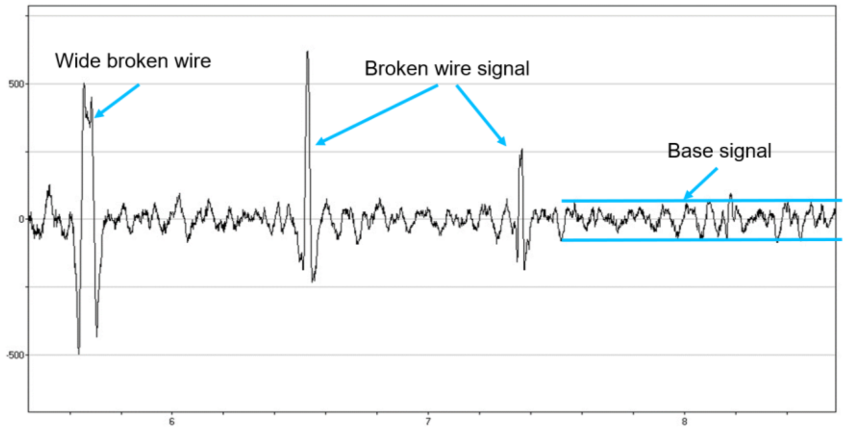


Figure 26 – Form of wire break signals (real)

The procedure for a typical MRT inspection was presented as follows:

- Recording of measurement data
- Quick on-site inspection and, if necessary, visual inspection of individual spots
- Analysis of the data (wire breaks, etc.)
- Comparison and allocation to existing measurements
- Estimation of the 'remaining service life' based on the current damage pattern
- Development of wire breaks over all previous measurements
- Determination of the next test interval.

It was mentioned that the above works well if the wire breaks occur exclusively due to bending cycles and if the rope utilisation in the past and future is similar.

It was said that the motivation for permanent MRT was that the utilisation of the rope sections varies greatly in terms of frequency and load. Due to the fluctuating utilisation over time, it was said to be difficult to estimate the next MRT testing time.

An example of a discarded rope from a storage retrieval system was shown as follows:

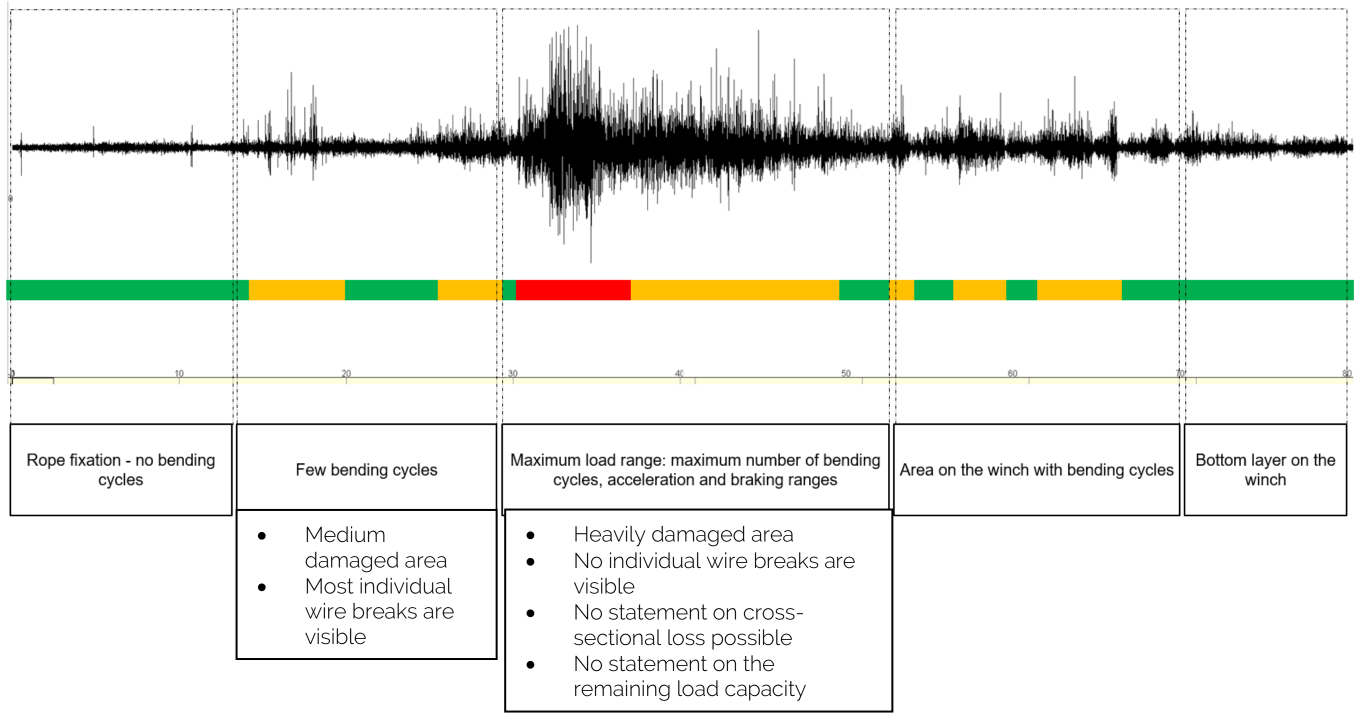


Figure 27 – Example of a discarded rope from a storage retrieval system

The objectives and requirements for a permanent MRT system were presented as follows:

- Measuring system
    - Non-contact (and therefore wear-free)
    - Permanently active measurement recording (during rope movement)
- Recording of bending cycles for each rope section

The goals and requirements for the evaluation were said to be:

- Reference measurement (basic measurement) of the rope
- The position of a measured rope section must be identified in the reference measurement
- Comparison of the measurement with the reference measurement
- Wire breaks are counted per position if
    - Clearly identifiable by measurement signal (rope relatively new)
    - 'Larger' local change in the measurement signal compared to the reference (rope already more damaged)
- Rope elongation must be taken into account
- Reference must be adjusted for every new wire break

The problems and challenges of a permanent MRT system were presented as follows:

- Exact rope position
    - Non-contact length and direction measurement
    - Rope elongation
- Bending fatigue load per rope section due to the system geometry
- Classification of partial measurements in the overall measurement
    - Recognition of the signal
    - Changes between reference and measurement
- Rope sections are not measured regularly
- Amount of data
    - Need for a very compact data format
- Fast evaluation algorithms

The conclusion of Ralf's presentation was:

- Comparison of classic MRT with permanent MRT
- Permanent MRT has clear advantages over conventional MRT for various installations
- Test measurements successfully completed on several test benches at IFT
- First algorithms for simplified and semi-automated evaluation implemented; test results were promising

2.2 What You Have to Know About Wire Rope Lubrication – Laura Lombardi, Usha Martin Italia

David Cannell introduced Laura Lombardi of Usha Martin Italia, who is also the Chair of the IMCA Lifting and Rigging Management Committee. Laura commenced her presentation on what you need to know about wire rope lubrication.

Figure 28 – Laura Lombardi

Laura commenced by presenting the current needs and challenges of wire rope lubricant in a marine environment.

She said that the application requirements were as follows:

- **A&R and heavy lifting:** corrosion protection, grease wash out
- **Renewables:** repetitive jobs, high usage intensity and rate
- **Environmental awareness:** minimisation of pollution.

The question was asked: Which lubricant, how much, and how often?

The worst case was shown, which was no grease (and no maintenance). Of course, it was eco-friendly, but there was severe corrosion.

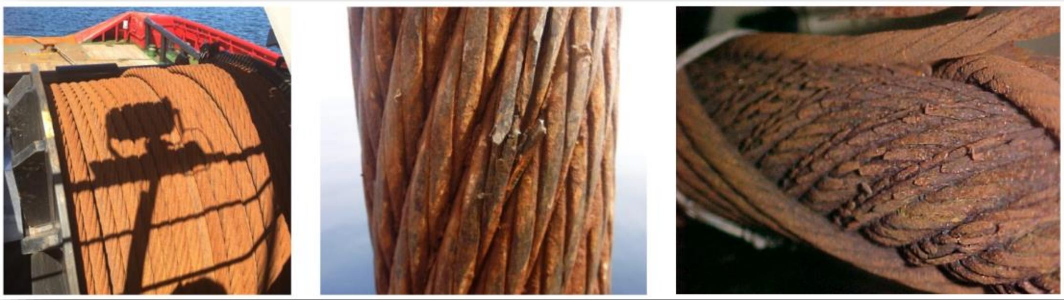


Figure 29 – No grease

The following slide showed an example of early-stage bio-grease and the wrong lubrication technique. This was followed by an image showing excess grease with obvious safety, operational and environmental issues.

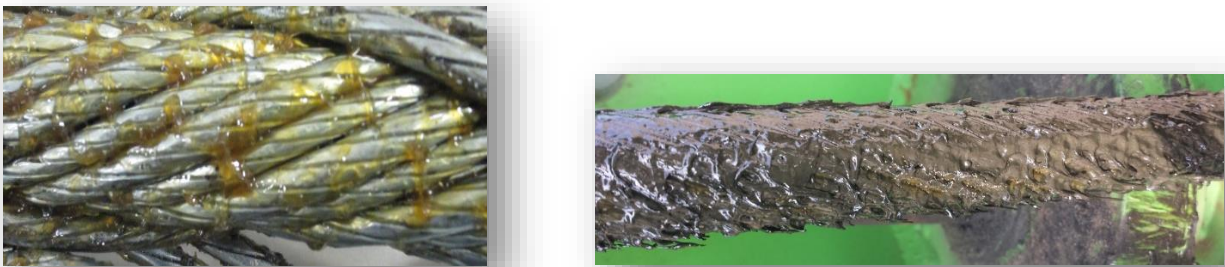


Figure 30 – Bio-grease / wrong lubrication & excess lubrication

Laura then presented the various lubrication phases during wire rope manufacture, which are:

- wire drawing
- stranding
- core closing
- rope closing.

It was noted that prior to first rope use, lubrication was generally not necessary. Additionally, periodic lubrication was said to be useful if it was properly planned and executed.

Laura then presented various tests that had been carried out on lubricated and degreased ropes. It was evident that a thoroughly degreased rope showed a 17% reduction in the number of bending cycles before discard compared to a new one. Additionally, if the rope was re-lubricated after the first wire break had been identified, then there was a 13% reduction in the number of bending cycles before discarding it compared to when it was new.

The results are summarised as follows:

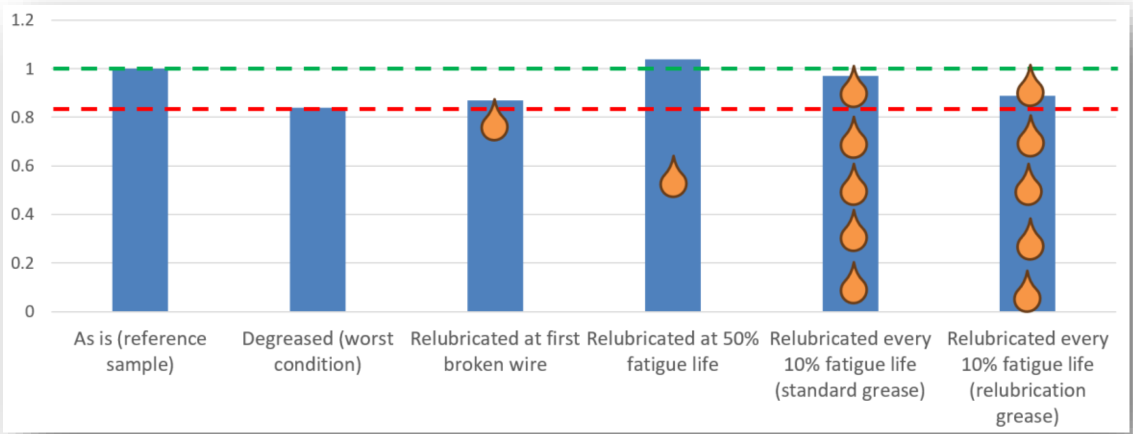


Figure 31 – Summary of the results.

It was stated that preserving the native rope lubrication was essential for better service life.

This is shown in the image below, where there is a thin and semipermeable layer between the core and the outer strands. It was said to protect the native lubricant against water contamination and showed a reduction of 'wash out' phenomenon by keeping the lubricant inside the core.

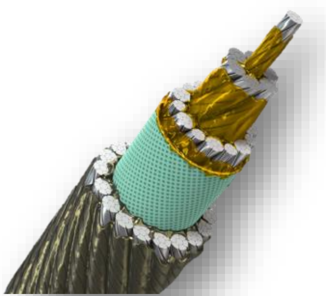


Figure 32 – Rope with semipermeable membrane

Laura presented a rotary fatigue test that had taken place without and with the retention system. It was clear that without the retention system, the rope suffered a heavy lubricant-squeezing effect compared to minimal lubricant squeezing with the retention system.

The presentation moved on to a post-retirement analysis of a rope that had been used subsea. It was clear that the retention system had maintained the wire rope lubrication internally.

Laura summarised as follows:

- Many effective greases are available in the field
- Environmentally friendly media have been greatly developed (practical constraints still exist)
- Prompt relubrication increases the rope service life, massive greasing is not beneficial
- Native rope lubrication is relevant for service life
- Protecting the native grease of the core maintains the inherent service life

2.3 Workshop 2

David Cannell introduced the next workshop session, which was 'What we don't know' and 'Drivers in discard criteria'. The session comprised six groups, all using the flip charts to capture the feedback.

The following questions were asked:

2.3.1 Spooling Issues:

a. Where can we damage ropes? (e.g. equipment interfaces, operational interactions)

b. Do you have experience of rope damage in operation?

c. Do we understand rope – equipment interaction?

2.3.2 Internal Condition?

a. What inspection methods do you use?

b. What works / what do you trust?

c. What are we missing? Can inspection methods be improved? How?

2.3.3 Discard Criteria?

a. What, in your opinion, are the most frequent causes for high-value rope discard?

  - Schedule driven
  - Duty cycle driven
  - Number of wire breakages
  - Damage – e.g. crush/torsion
  - Corrosion
  - Others?

Each group took it in turn to discuss one of the above three points.

Group 1

Spooling – It was recommended to use Langs Lay, but you need to pay more attention to cutting in. The tolerances must be correct, not only after fabrication but also under tension.

Figure 33 – Group 1

Inspection – Both companies did not use internal inspections by way of MRT. Visual inspections along with dismantling and rope analysis post discard.

Discard criteria – It is important to monitor the MBL reduction along with visual wire breaks that mainly occur at the cross-over points on multilayer winches. When using a cross-lay rope or regular lay, you also see that at the cross-over points, there is rubbing, which causes chipping of the rope, which is a focus for the discard criteria.

Group 2

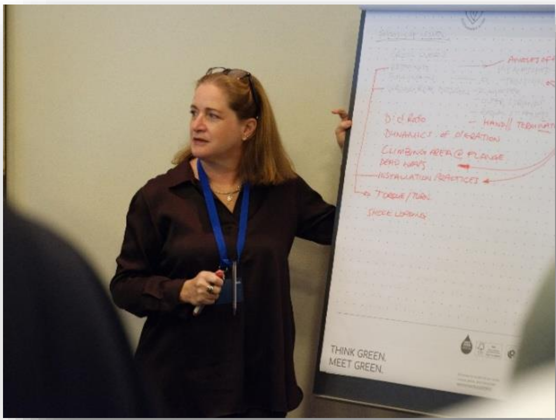


Figure 34 – Group 2

Discard criteria – The most frequent cause of discard was an accumulation of the different factors contributing to rope damage, fatigue or corrosion. It was said that this was one of the drawbacks of ISO 4309, which looks at each factor individually. So, this is something that needs looking at. It was also stated that it may be better to discard on a lifetime basis depending on operational reasons and constraints. It was mentioned that this may lead to discarding a rope when it still has a good lifetime ahead or that rope could be used when it is past its discard criteria, leading to potentially unsafe conditions. The potential benefits of having permanent monitoring equipment fitted, especially with the technology improvements with MRT over the last ten years, were then discussed amongst the group. We look forward to the next step, where we can address the challenges of the generated data and have improved confidence in permanently installed systems. For example, make sure the unit is waterproof and that it is easy to handle the data.

Group 3

Internal condition – There was some discussion in this group on MRT. Some companies were using it, and some were not. It was said that there is an increasing trend of using MRT with the benefits of the total cost of ownership and avoiding downtime. To improve, it was suggested that more data was needed so we could use machine learning with a potential shift towards continuous monitoring depending on the critical locations and dead ends being measured.

Figure 35 – Group 3

Group 4

Spooling – Issues occur due to the following points: At the crossover zones at the layer transitions, damage occurs if the rope is large in diameter or too small in diameter. When the tension is different between the upper layers and the lower layers, there is an increase in wear. This depends on the spooling pattern, Lebus, helical or plain drum.

Figure 36 – Group 4

Group 5

Augmented reality was thought to be a helpful tool to support lift plans using videos during toolbox talks.

Lift plans should be able to be understood by a changing/new crew.

There needs to be a focus on quickly adapting the lifting plan to the real-life situation.

The relevant information needs to be included for any lifting accessories/tools in the rigging plan, an example being the use of shock absorbers.

Associated standards need to be user-friendly.

Figure 37 – Group 5

Group 6

Spooling – An example of replacing a wire on a crane after ten months in use, the wire rope needed to be replaced due to a birdcage defect. The defect occurred due to the excessive fleet angles between sheaves and the rotation imparted in the rope due to this.

Inspection – It was said that some personnel opened the wire rope using a screwdriver to inspect the internal condition and inspect the core. It was mentioned that a screwdriver was an acceptable tool for this. Another method was visual inspection followed by a cutback and breaking test.

Figure 38 – Group 6

Discard criteria – For the high-value wire ropes, some companies changed the rope on a set schedule relating to the rope's duty cycle to avoid any potential damage.

Session 3 – NDE of Wire Ropes

David Cannell introduced session 4, the supplier session, and introduced the first presenter, Christoph Ruffing of Bridon Bekaert Group.

3.1 Rope Lifetime Prediction and Considerations for Offshore Renewable Installations – Christoph Ruffing, Bridon Bekaert Group

Christoph commenced his presentation by showing how either of the following determines the lifetime of a wire rope:

- Cyclic Bending Over Sheave (CBOS) – Lifetime is determined by bending cycles of the rope when it is bent over sheaves -> Flexible ropes, smaller wires, low bending stresses.

- Multi-Layer Spooling Fatigue (MLS) – The amount of spooling cycles determines the lifetime of the rope on a multilayer spooling drum -> Robust ropes, a smooth outer surface, larger wires, and high lateral stiffness.

Figure 39 – Christoph Ruffing

The presentation then turned to wire rope fatigue modelling using the Bekaert-Leipzig model CBOS.

It was said that the advantage of using this model is that the stresses could be calculated for every single rope design change. The data for different designs can be combined to have "big data". Over recent decades, the fatigue test database has been available and used to compile a model for fatigue prediction.

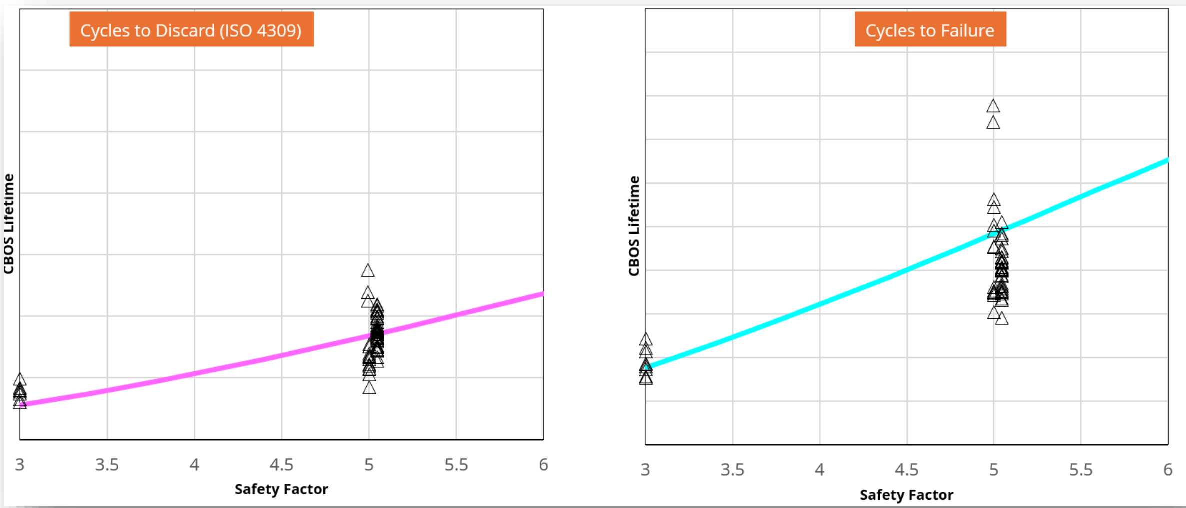


Figure 40 – Lifetime calculation model – Dyform 6x36 CBOS

The case for an offshore renewable installation crane was shown with the installation of foundations, transition pieces, towers, nacelles, and blades. It was said that cranes that perform all lifting operations need long and strong booms and a high lifting capacity.

Two types of wire ropes were considered – the main hoist rope for lifting the mass and the boom hoist rope for lifting the mass and the boom.

Christoph said that, with an empty hook, the force for a boom hoist rope was not constant and had to be considered. The number of bending cycles was shown from the boom in the cradle to max height and then back to the cradle.

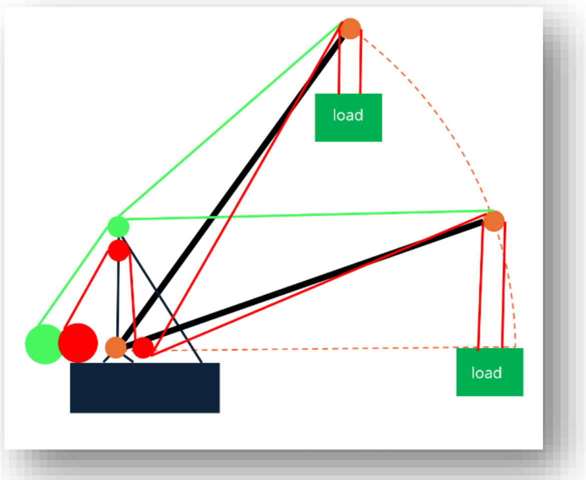


Figure 41 – Two wire ropes considered

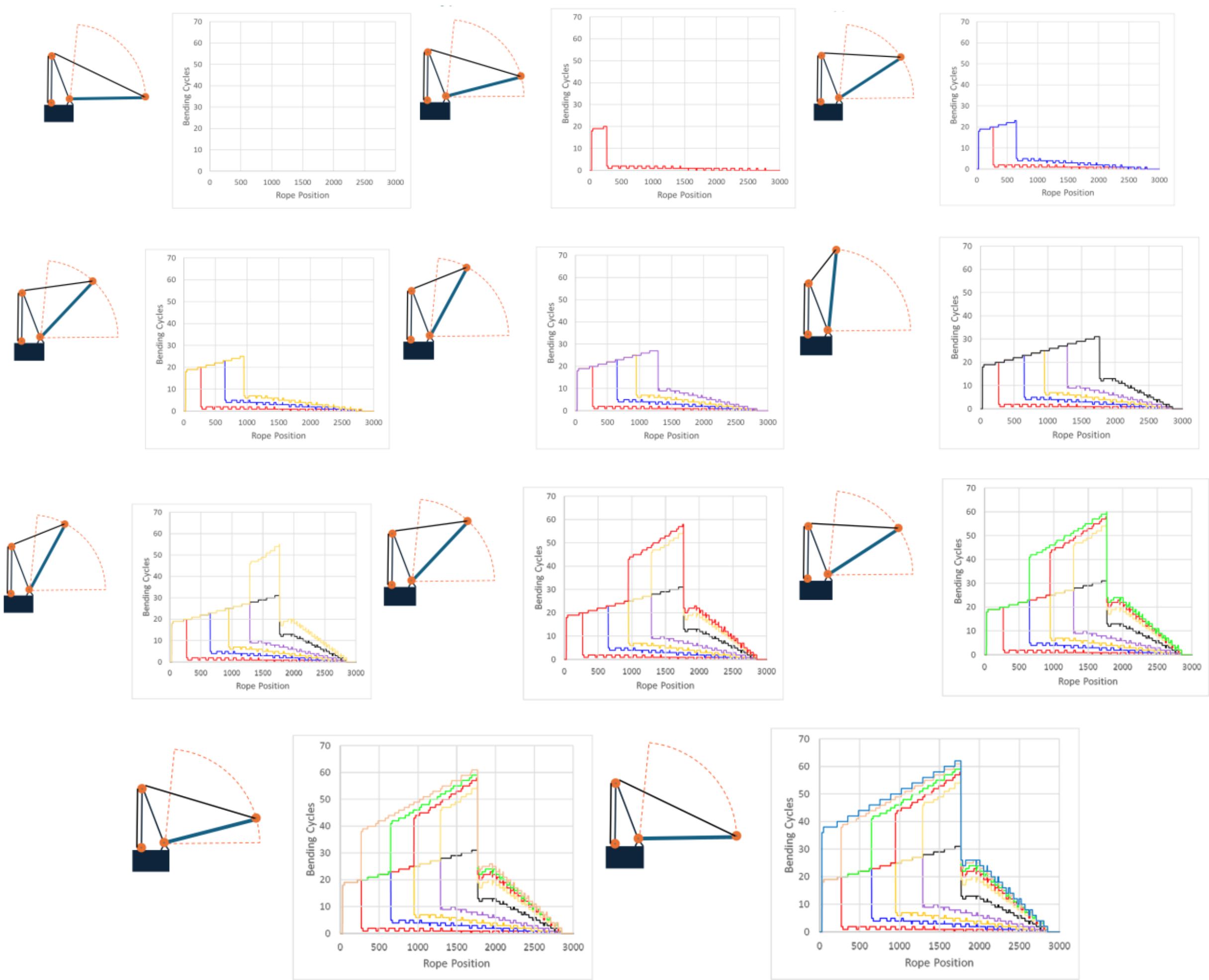


Figure 42 – Rope bending cycles

It was noted that bending cycles and accumulated damage were important for rope lifetime considerations. The number of bends and the force during bending are considered. The bending cycle distribution needs to be calculated for finite crane movements. Damage accumulates for small finite (limit->0) movements considering load level during movement.

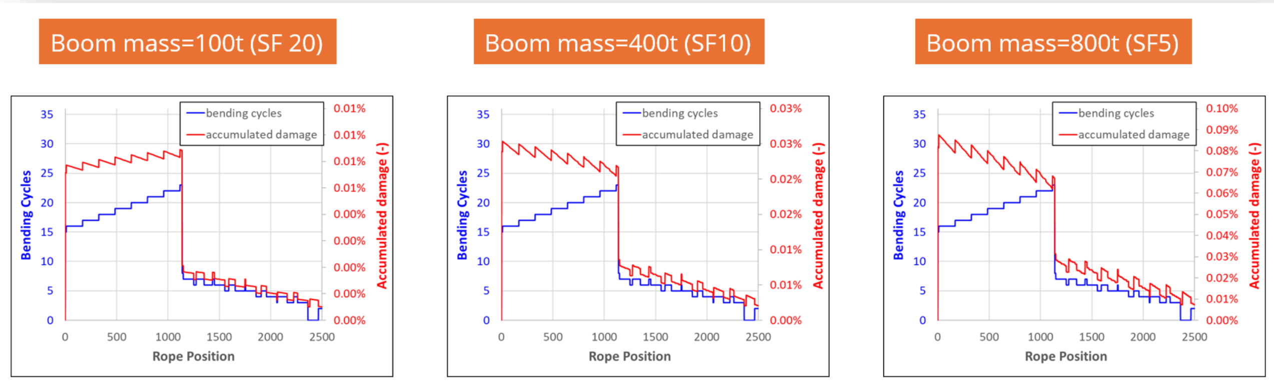


Figure 43 – Most stressed rope zones move with different boom weights

Christoph said that the best rope solution was double compacted wire rope as it benefited from high bending fatigue performance, excellent spooling performance and multilayer spooling over its lifetime.

The presentation concluded with a summary as follows:

- Zones with the highest wear and fatigue can be estimated by an analysis of the reeving system and rope lifetime calculations.
- Example calculations help to understand rope wear and lifetime issues.
- Double compacted ropes reduce wear on MLS, even with lower CBOS lifetime.
- Load spectrum and lift history have to be known to decide on the ideal rope construction.
- Flexibility in rope production might support shifting the wear point to preferable positions in the future.

3.2 Crane Utilisation and Inspection and Maintenance, How Can They Dance Together – Martijn Reissenweber and Robin van Nieukerk, Huisman

David Cannell introduced Martijn Reissenweber and Robin van Nieukerk of Huisman, who commenced their presentation on Crane Utilisation and Inspection and Maintenance, How Can They Dance Together.

Figure 44 – Martijn Reissenweber and Robin van Nieukerk

It was mentioned that the heavy lifting performed in the oil and gas industry was the odd occasional lift up to the maximum of the crane's Maximum Rated Capacity (MRC). However, in the offshore wind industry, maximum rated capacity lifts were more frequent, up to the maximum crane lifting height.

This was clearly shown in Figure 45 and Figure 46 by two crane usage graphs, one of which showed the number of lifts performed by a crane working in the oil and gas industry and the other by a crane working on offshore wind installation.

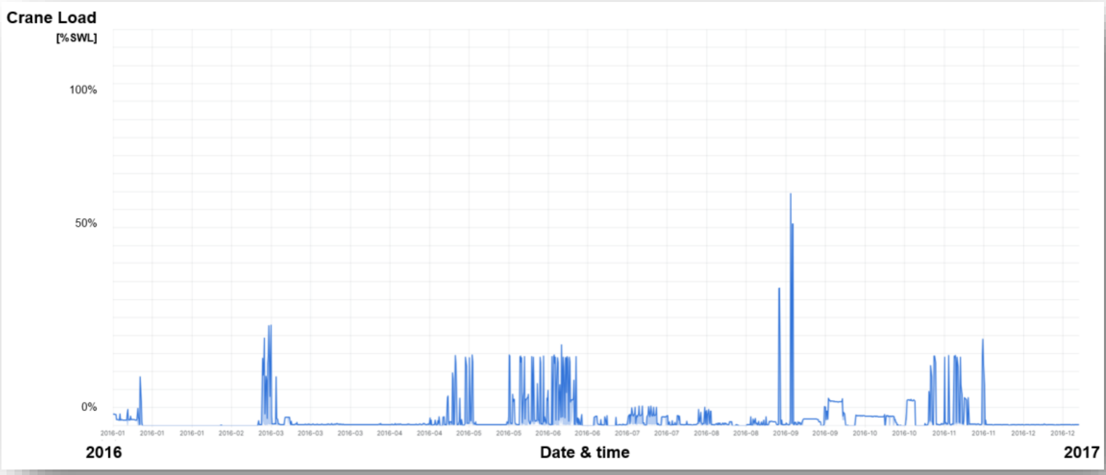


Figure 45 – Crane working in oil and gas

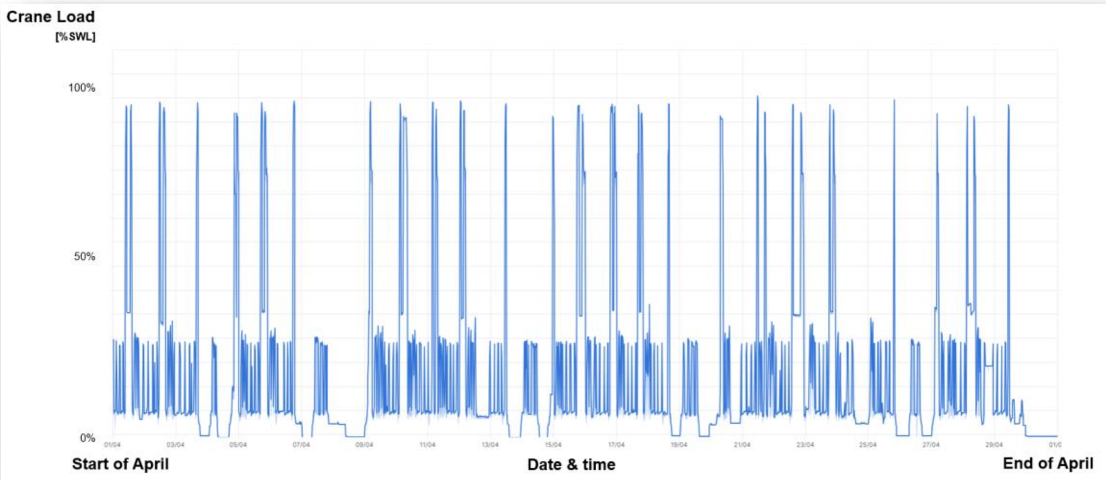


Figure 46 – Crane working in the wind industry

Analysis of the cranes working in the offshore wind industry was continuous and repetitive lifts with over 270 lifts in one month, 27 of which were at 90% of MRC and 244 lifts at 30% capacity, averaging out at approximately nine lifts per day. There was an associated increase in wire rope replacements caused by the following five reasons:

1. Drums crushing fatigue – wear due to high usage at high loads
2. Faulty use – overload, lack of re-lubrication.
3. Installation of wire rope – avoid torsion introductions during installation, wrong runners, wrong connections, large fleet angles, and touchpoints. Often not immediately visible, but can result over time in torsion issues (birdcage, waviness, twisting block, accelerated wear, etc.). Pre-tensioning of lower layers is essential.
4. Quality and specification of wire rope – wrong tolerance specified, wrong torque-turn-tension or wrong direction ordered.
5. Bending fatigue – CBOS.

It was said that ISO 4309 and IMCA LR 001 should be used for rope inspections. There are several modes of deterioration; some have clear criteria, but most depend on a competent person.

In practice, one mode is seen or monitored, leading to discard. It was also mentioned that there is low-quality reporting, no risk assessment and no operational advice.

The desired rope inspection regime is shown in Figure 47 below.

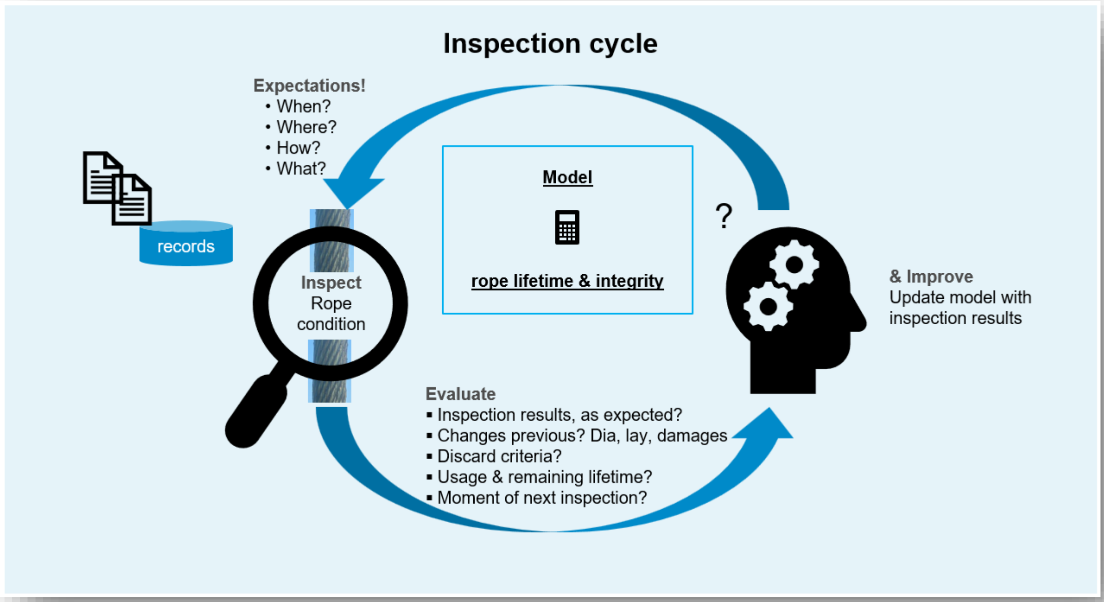


Figure 47 – Desired rope inspection regime

It was stated that large improvements (safety, lifetime and planning) can be achieved when the above inspection cycle is applied.

The presentation then turned to how Huisman performs rope inspection using their rope vision system and rope usage monitoring. The aim was to digitalise the information to monitor changes in condition and link them to usage. A demonstration report was shown, which comprised images of indications every 100 m, use of design duty versus rope position, and diameter versus rope position.

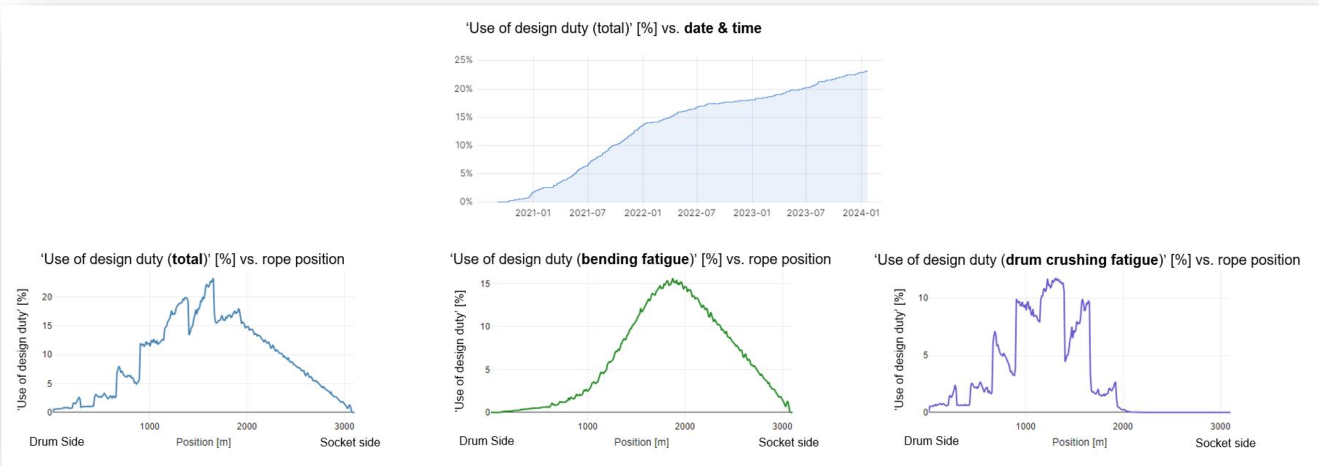


Figure 48 – Rope Usage Monitoring (RUM)

The presentation summary was as follows:

- With the current usage and utilisation of the cranes, a perfect integration between the crane, wire, and reeving set-up combined with modern maintenance, inspection and monitoring techniques is required.
- At the front of the process: Wire selection, sheave and groove diameter, lebus configuration, drum pitch, fleet angles, the perfect reeving set-up combined with perfect reeving equipment and wire training are required to ensure maximum possible wire lifetime.
- During the wire lifetime, data-based inspection and subsequent maintenance, such as lubrication, slip and cut procedures and pre-tension sequences, are essential to stretch wire lifetime.
- And last but not least. We need to learn, learn from the data, and compare the data with failure cases to improve system design, improve wire design, improve reeving methods, set up and equipment and improve the wire usage processes
    - Wire rope selection: Fit for purpose/Quality wire ropes
    - Installation: Optimised knowledge/Perfect tooling
    - Maintenance: Frequent maintenance with perfect tooling
    - Inspection: Management registration and inspection tooling
    - Monitoring: Digitalisation and optimised IT landscapes.

3.3 Fatigue Broken Wires as a Major Threat for the safety of Crane Wire ropes – Prioritisation of MRT Inspections – Maciej Martyna, LRM-NDE

David Cannell introduced Maciej Martyna of LRM-NDE, who commenced his presentation on 'Fatigue Broken Wires as a Major Threat for the Safety of Crane Wire Ropes – Prioritisation of MRT Inspections'.

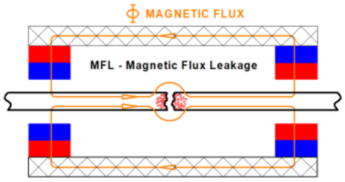
Maciej presented the goals of MRT inspection as follows:

- An MRT inspection is performed to determine the technical condition of the object under examination – the wire rope.
- Defining the safety service life of the wire rope.
- It allows scheduling wire rope replacement at a convenient time.
- Prevention of accidents caused by wear of the wire rope.

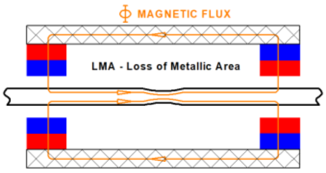
Figure 49 – Maciej Martyna

The two detection possibilities were said to be as follows:

1 Magnetic Flux Leakage (MFL) – Magnetic non-destructive method detecting magnetic flux leakage over the defect.



2 Loss of Metallic Area (LMA) – Magnetic non-destructive method detecting the change in magnetic flux density inside the test object.



Maciej said that MRT can detect, locate, and evaluate wire rope defects such as:

- Wire discontinuities:
  - External/Internal broken wires, with possible identification of the gap between broken ends
- Loss of Metallic Cross Section Area associated with:
  - Corrosion
  - Abrasion
- Change of wire rope geometry:
  - Mechanical deformations
  - Loosening of the strands.

The presentation then turned to fatigue related to wire ropes and how the MRT device can detect fatigue.

He said that with the MRT device, the constant magnetic flux generated by the measuring head flows in a ferromagnetic conductor (wire rope). The magnetic flux encounters a change in the material's structure caused by fatigue. A change in the structure of the ferromagnetic material disrupts the flow of magnetic flux. The magnetic flux changes the density in the conductor and leaks over the change in structure. The MRT device can detect the magnetic flux leakage and the change in magnetic flux density.

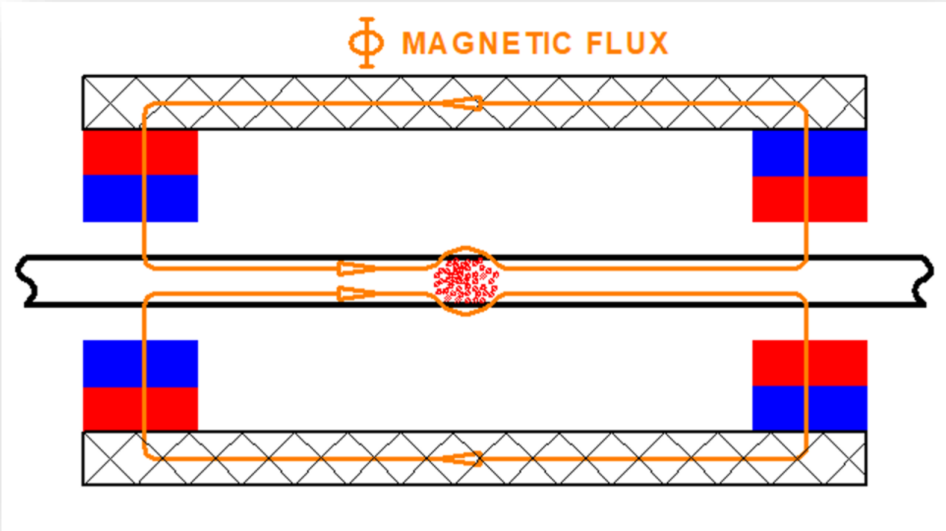


Figure 50 – Fatigue detection using MRT

Maciej said that there were factors affecting the reduction of fatigue durability of wires, such as:

- The range of the number of achievable bending cycles after which wire discontinuities for a specific wire rope construction can be determined in laboratory tests.
- Wire rope defects such as corrosion or abrasion can reduce this range by 50%.

It was noted that the fatigued broken wires significantly threaten the safety of crane wire ropes. The symptoms of fatigue related to rope construction were presented using round wires in strands (RW) and compacted strands (CW). With the RW, there was a noticeable increase in the number of fatigue broken wires throughout the service life, and with the CW, there was a long service life with no signs of wear. The rapid growth of the number of fatigued broken wires in the final period of service. The graph shown in Figure 51 Illustrates this.

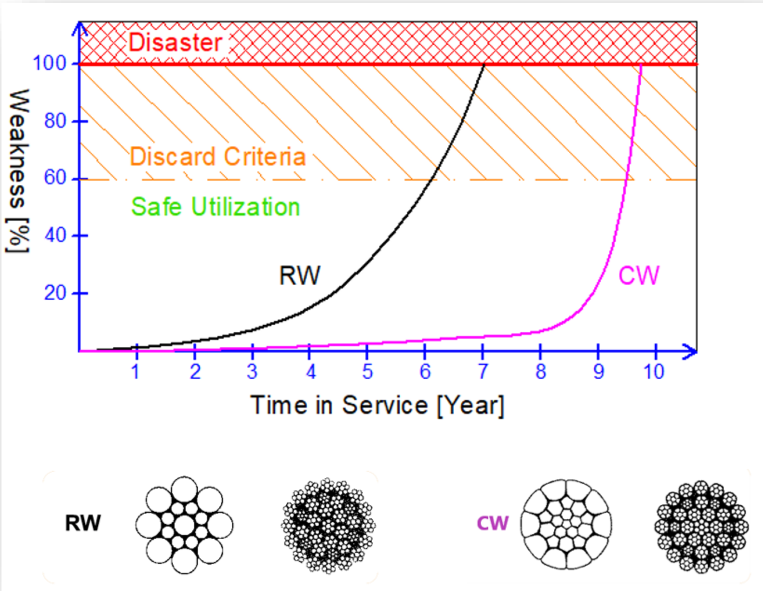


Figure 51 – Fatigue related to wire rope construction

What followed was a case study on the failure of a crane wire rope. It was noted that analysis of the broken rope showed only five broken wires, but the internal corrosion was severe, which caused the core wire to have an 80% reduction in tensile strength.

Another case study from a crane rope showed an MRT and visual inspection had been carried out on the rope after 24 months in service, which showed no broken wires, no visible damage and no visible corrosion. However, the inspection carried out 12 months later showed an increase in LF/LMA indications between the two MRTs. It showed a rapid deterioration in the technical condition of the first 160m section of the wire rope.

Maciej summarised his presentation as follows:

- The material fatigue is a key factor in the safe use of crane wire ropes – FLEXIBILITY.
- Fatigue broken wires propagation can proceed rapidly.
- Corrosion and abrasion reduce the lifetime of wire rope due to the accelerated formation of fatigued broken wires.
- Due to the construction of wire ropes used on offshore cranes, particularly their non-rotating properties, the loss of continuity strands can lead to an imbalance of torque between the wire rope layers, resulting in the wire rope unravelling and breaking.
- Using only visual inspection to evaluate the technical condition of the crane's wire rope was not sufficient – we can see only symptoms of fatigue and broken wire.
- MRT equipment can detect changes in the material's structure before wire discontinuities appear in the wire.
- Special attention should be given to the rate of wear growth, not only to its value, in evaluating the technical condition of the offshore crane's wire ropes.

3.4 Continuous Rope Monitoring Systems – Bruno Vusini, AMC Instruments

David Cannell introduced Bruno Vusini of AMC Instruments. He commenced the presentation on Continuous Rope Monitoring Systems.

The presentation immediately turned to using the Internet of Things (IoT) and rope inspection to create a continuous 'Rope Watcher'. This involved an MRT device permanently installed to provide 24/7 rope monitoring.

It was said that this brought several advantages as follows:

Figure 52 – Bruno Vusini

- Manage the life cycle of the rope
- Manage data coming from the rope
- Knowing the right time for rope replacement (scheduling the replacement)
- Avoiding accident and production downtime
- Productivity optimisation
- It creates a safer working environment

The technology was said to utilise complex algorithms and computations that take into account vibrations, oscillations, and start/stop disturbances. It did this using vibration, gyroscopic, current, and speed sensors. The data was then produced in a raw format and then processed.

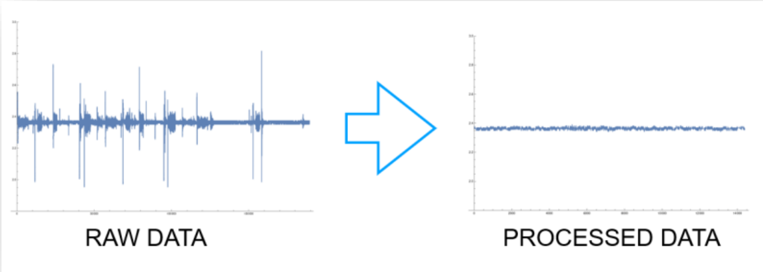


Figure 53 – Raw data versus processed data

The explanation of how the raw data was processed and transformed into a gauge signal was described.

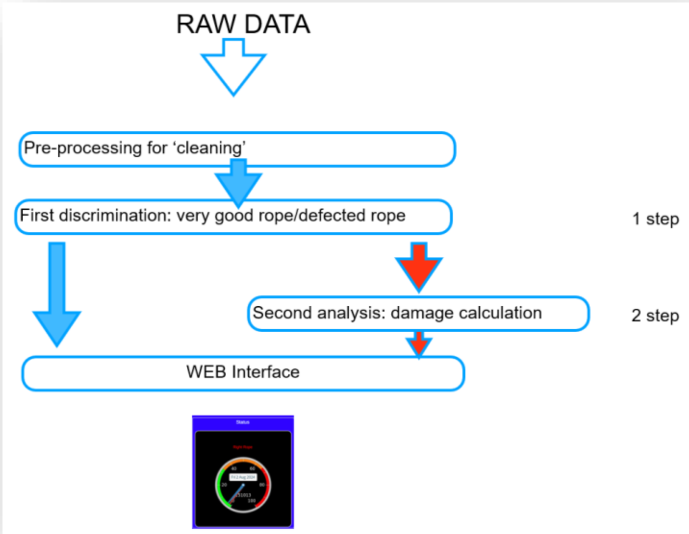


Figure 54 – Data processing to gauge visual

The first step (first discrimination) was checking for good/not good. The data then progressed through Project CAT-EYE 12, which used a correct machine learning algorithm and correctly trained it to recognise a good rope. Starting from images and not data.....

The software analysed around 500,000 diagrams and processed 300,000 for training and 200,000 for validation. The project was stated to be available for mobile or permanent applications on cranes, hoists, automatic machines and stacker cranes.

An example of the dashboard was presented.

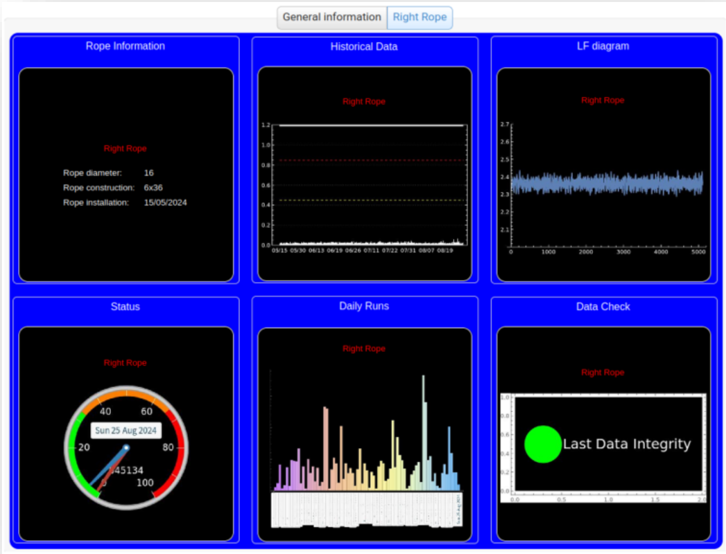


Figure 55 – Typical user dashboard

3.5 NDT Panel Session – Suppliers Q&A

David Cannell and Mark Ford commenced the suppliers' Q&A session, which stemmed from the presenters from Session 3 – NDE of Wire Ropes.

The following is a selection of some of the questions that were asked via Slido and the audience:

Q: Bridon Bekaert – Should we store the boom out of the cradle whenever possible?

A: If you can avoid returning to the rest position with the boom, the answer is 'yes'; do not put the crane back into the cradle. Bringing the crane out of the cradle to full height and returning to the cradle has the same effect on the rope as performing a heavy load lift. Safety has to be considered when doing this.

Figure 56 – Supplier Panel Session

Q: Huisman – Will you offer the rope vision system on newly built cranes and equipment?

A: Yes, it will be offered. Also, an inspection service will be offered to monitor the rope and ensure you can plan rope replacements when required.

Q: Huisman – How does Rope Vision cope with grease on the rope? Will grease impact the measurements?

A: You can use the automatic rope greasing systems to clean a rope before it is inspected. As this is a visual inspection tool, it should be used before the inspection takes place.

Q: LRM NDE – Do you see continuous MRT as the way forward?

A: The use of MRT brings some clear advantages but also has some disadvantages, such as the device must be calibrated. Also, the rope must pass very close to the device to ensure a good reading, so any damage to the rope could result in the device being damaged. Finally, interpreting the data is a skill that needs to be performed by trained and competent personnel.

Q: AMC Instruments – The AMC system focuses on MRT testing, but can wire damages from visual inspection also be integrated? For instance, cameras with image recognition?

A: The visual part is not integrated with the AMC system, as this only performs MRT inspection.

Q: Huisman – The number one issue was drum-crushing fatigue. Is this not a fault with the design of the drum or wire specification? How can drum-crushing fatigue be removed/reduced?

A: Ropes and wear whilst on the drum is indeed a question regarding how fast they are allowed to wear. Solutions are there, such as lowering the line pull for newly built cranes, which means you have a relatively larger rope and drum, which would add to the cost. Larger drums with fewer layers, such as a single-layer drum with a capstan storage winch, can be used. So, solutions are there; it's just a matter of cost. Conversely, we can learn more about how the rope behaves to reject it at the right point.

Q: Huisman – What is the weight of the system? And the speed of inspection?

A: The box is 40 cm x 40 cm x 40 cm and weighs 20 kg. It is stored in a case and can be taken onboard an aircraft when required.

Q: Bridon Bekaert – Regarding rope properties. The MBL has been mentioned numerous times today. However, the axial stiffness properties are very important in predicting resonance for deep water lowering operations. Has the axial stiffness of the rope been tested as well?

A: It is not tested for every rope for every production, but with the values for construction, there is some scatter. However, there are standard values to calculate the actual stiffness.

Q: Bridon Bekaert – How do you account for the difference between one wire broken in many strands versus many wires broken in one strand in the permanent rope monitoring systems??

A: We are guided by ISO 4309, which says 60 is the number of relevant wire breaks. It does not determine if the breaks are in one strand or spread over the length between various strands.

Q: AMC Instruments – How is the data security handled?

A: All the security protocols, including encryption, are ensured to avoid some external person reading the data.

Q: Huisman – Can the device cover the entire rope surface 360 degrees?

A: Yes, it can. Four cameras check the edges of the rope to measure the diameter and determine if something is protruding. The lay length is also measured very accurately, providing us with good data.

Q: All the panel – Based on all the presented info ... should ISO 4309 criteria be revised? If so, to what?

A: Yes, concerning the MRT annexe C; currently, there is knowledge for visual inspection, but for the MRT, the discard criteria are not very precise.

The monitoring of changes in conditions should be explicitly mentioned in the standard. What we experience in conversations with our clients is discussions regarding breaking loads, which are not mentioned in ISO 4309, so guidance there would be helpful.


Figure 57 – All panel question

At the moment, I can see no reason for it to be changed. Still, some minor points are as follows: for the rotation-resistant ropes where we know there are contact situations between the core and outer strands, there are situations, especially with repetitive lifts, where the rope can be damaged from the inside. It could be changed to be more conservative for cranes operating with repetitive lifts. Breaking load in is potentially an issue because we know we can accept a certain amount of corrosion and wire breaks that affect the breaking load. There are also things like strain ageing that will affect the breaking load, and there is no clear understanding of whether this is considered normal or problematic if the rope has a -2% breaking load because of strain ageing. The standard needs some work to cover the above items.

Q: Huisman – Would you advise combining the outcomes and data derived from the Huisman Vision System with visual and MRT inspection outcomes?

A: If desired, we would certainly combine them. The more you inspect, the better, but it is also an economic question. However, I think MRT is good for finding suspicious locations in the wire rope and checking for corrosion, which is a valuable addition. But, without a view, it's hard to assess.

Q: AMC Instruments – Is the rope watcher a self-learning system? Have these permanent monitoring systems been successfully installed, and are they operating in an offshore environment? Or still in the trial phase?

A: Yes, we have some tools installed on offshore installations. Of course, the behaviour differs from that of a tool installed in a factory, but the technology behind it remains more or less the same.

Q: AMC Instruments – Is the inspection data being analysed fully automatic?

Artificial intelligence will happen even more, and I also see some need for the vision box for the rope images; Bridon Bekaert also has a vision box called Vision Tek. Systems like this can learn from the data, classify the images using their algorithms, and connect them to rope lifetime calculations.

The next steps will be super exciting as we will link the change in condition with the actual usage and predict the future very accurately. That will happen in the next year. We can also see the rope performance and compare the performance with different rope constructions or brands. It's very exciting, and we will learn a lot and improve.

The basics of MRT inspection remain the same, as we have the same magnetic flux and more or less the same limitations. Digitalisation will bring some benefits to MRT. I anticipate the measuring and interpretation of the data will be entirely digital. We can also look at other environments, such as underwater or in space.

Q: Audience question – The accreditation or competence of inspectors, how do you become accredited, is there an international or national accreditation scheme for MRT inspectors, and is it globally recognised? What is the future for that, and is there a need to keep up to date with this new technology? How do you maintain competence with those inspectors?

Figure 58 – Audience question

A: We have the possibility of obtaining certification according to ISO 9712. However, for the offshore crane, this is quite an empty field as there are no specific regulations for a competent person or no regulation even to perform MRT. There are other standards on which to base a training standard, such as the ski lift industry, where MRT operators have to be certified.

This is a good point; it is a potential change for ISO 4309 regarding who is competent for MRT.

Typically, the inspector sees there is damage, and it is written down, and we have a damage pattern. But also to make an analysis of what is the root cause and how it can be prevented or repaired. More training is needed to understand the system, application, and rope type.

For us, it is essential to have training and competence. We work with ISO 9712, and we are a training centre together with Bureau Veritas. It is necessary to prove competence. It is essential to demonstrate competence. To put an MRT into the hands of the untrained and to judge whether a rope is ok or not without the current knowledge is like putting a gun in the hand of a child. The risk is to lose millions of dollars or the ultimate risk of losing a life.

Session 4 – Advancing Rope Technology

David Cannell introduced session 4, the academia session focusing on Prolonging rope service life, and introduced Max Stök of Clausthal University of Technology.

4.1 Prolonging Rope Service Life: Evaluating Plastic Coated Ropes in Multi-Layer Spooling Applications – Max Stök, Clausthal University

Max commenced his presentation on using plastic-coated wire ropes and their performance when spooling on a multilayer drum.

He looked at the parallel section of the rope when multilayer spooling and said that underloading the rope deformed it into hexagons.

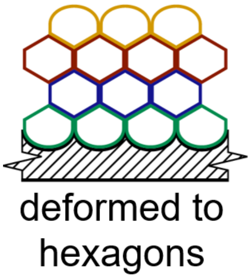
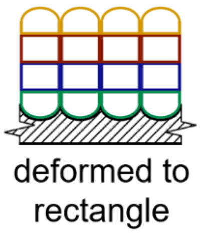


Figure 59 – Max Stök

On the crossing section of the drum, during multilayer spooling, the rope deformed into rectangles.



It was also presented that during ascending winding, the deformation varied, as shown below.

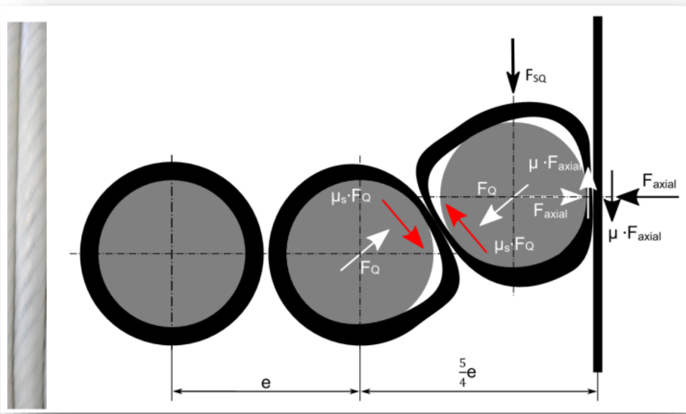


Figure 60 – Deformation during ascending winding

Apostolos presented the stress imparted onto the drum from the first layer. It was noted that having ascension aids for the rope lowered the drum pressure and lateral elasticity of the rope.

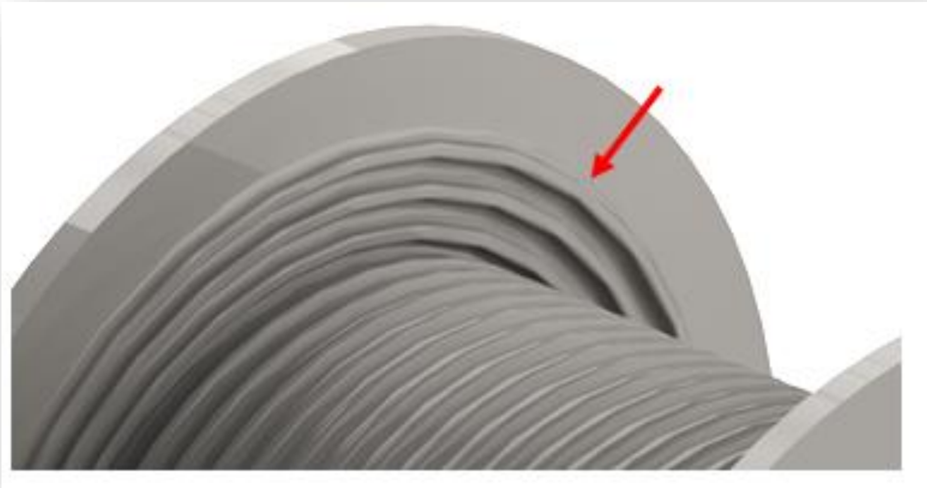


Figure 61 – Drum ascension aids

Session 5 – Review of the Day

5.1 Review of the Day and Final Comments/Questions – David Cannell, Chair

The Chair of the event, David Cannell, presented a brief overview of the day covering some comments and quotes of the day as follows:

Comments	Quotes of the day
LR001 – 6 tools to provide wire rope integrity assurance	LR001 – Please make sure you use it
Rope terminologies	We cannot become complacent.
We need to ensure we have the rope in the right place at the right time to do the change-out	Some cranes can be fatigue-testing machines.
Rope specifications should be live documents – continuously check technical & operational changes.	There are ropes everywhere.
IMCA Safety Flashes – very useful	Can we do it? Yes, but how long do you want the rope to last?
Important to take the whole lifetime of the rope into account	Is anyone here from X? Good, so I can lie a lot
We are increasing the lifetime of ropes in subsea activities (knowledge & materials)– but reducing in wind (due to very repetitive tasks)	Do two presentations, one for management and one for the actual presentation
Discard between 5 years and 9 months	$1-2M for a high-value rope
Between 1999 and 2013, more than 60 persons died from wire rope incidents	Crane wires are only a link in a chain
Rope training for optimised performance	Crane is now in complete downtime as they investigate an incident.
The high cost of wires is nothing compared to the vessel waiting for a week.	ABL Guarantee Clause
Comparisons and differences to cable car wire ropes	Better to learn from other's mistakes than your own
Lubricating once we see wire breaks is too late	We seem to think that working through winter is a good idea
"Preserving the inner lubrication is essential."	A baby crane compared to my colleagues here
Even for specialists, it is very difficult to see what is happening – MRT	Touch base with the manufacturers for improvements
5 top reasons for wire replacement from Huisman 1. Drum crushing fatigue 2. Faulty Use (incl. lack of lube) 3. Installation of the rope (avoid rotations) 4. Quality and wrong spec of rope 5. Bending Fatigue – (studies required on multi-layer drum at FoS of 3)	NDT are the good guys
The first MRT was performed in Poland in 1947	Eco-friendly = no grease
Can we introduce AI into the inspection of NDE test data on ropes	If it is bio-degradable, the environment will eat it

Comments	Quotes of the day
Measure the changes	Too much grease – everyone on deck will hate you
Do not forget about the reel – (compression) when buying a rope	Removing grease from your clothes is a nightmare
	I prefer the rope to last – bio-degradable
	The more you inspect, the more you expect
	RUM = Rope usage monitoring
	Real life – the best laboratory
	Rapid rotation can cut the wire–layer failure.
	They lost $1M in 5 minutes due to something they thought of as a consumable.
	Is it easy? … No

5.2 Closing words by IMCA CEO

Iain Grainger, IMCA's CEO, presented the final word of the day.

Figure 62 – IMCA CEO, Iain Grainger

The Chair thanked IMCA for hosting the event and thanked the speakers and the sponsors. Finally, all attendees were thanked for participating and input into the event.

Figure 63 – David Cannell – Summing up and closing the event

Stand-out quotes

“Crane is now in complete downtime as they investigate an incident.”

“The more you inspect, the more you expect.”

“They lost $1M in 5 minutes due to something they thought of as a consumable.”

“$1-2M for a high-value rope”

We look forward to meeting you at the next seminar

Figure 64 – Group photograph

International Marine Contractors Association

T: +44 (0) 20 7824 5520
E: imca@imca-int.com
W: www.imca-int.com