OCIMF Europe & Africa Regional Marine Forum

19 June 2018

MAIB investigation: Failure of an HMPE mooring line on board LNG carrier *Zarga*

Howard Flegg
Inspector of Marine Accidents

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MARINE ACCIDENT INVESTIGATION BRANCH

Milford Haven 2 March 2015

Failure of HMPE mooring line on board LNG carrier *Zarga* resulting in serious injury to one crewman

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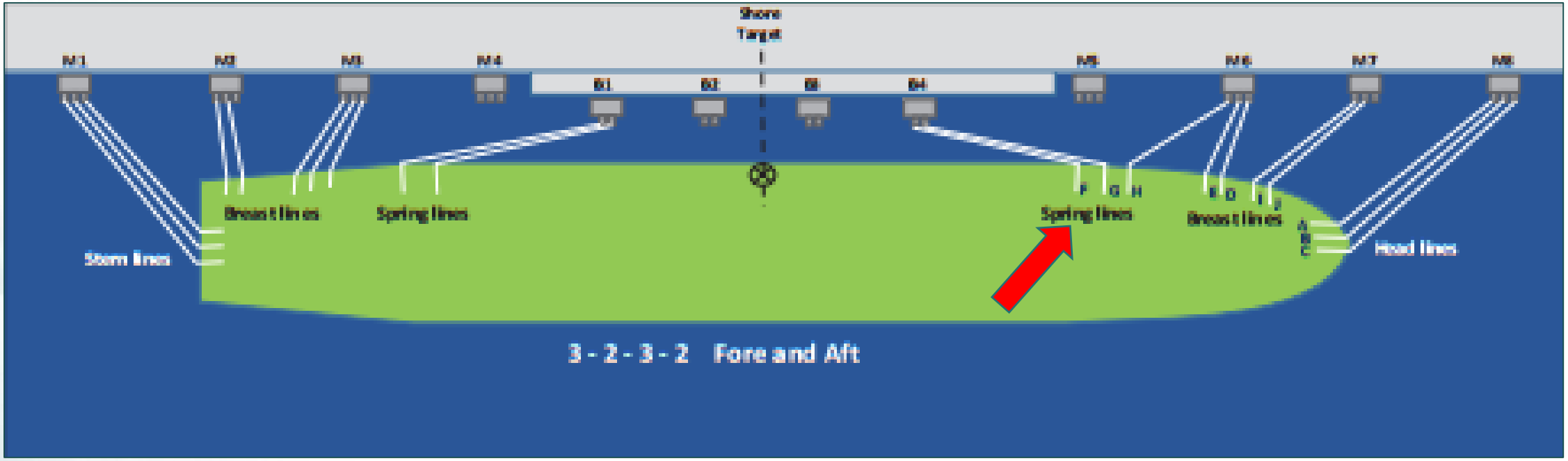
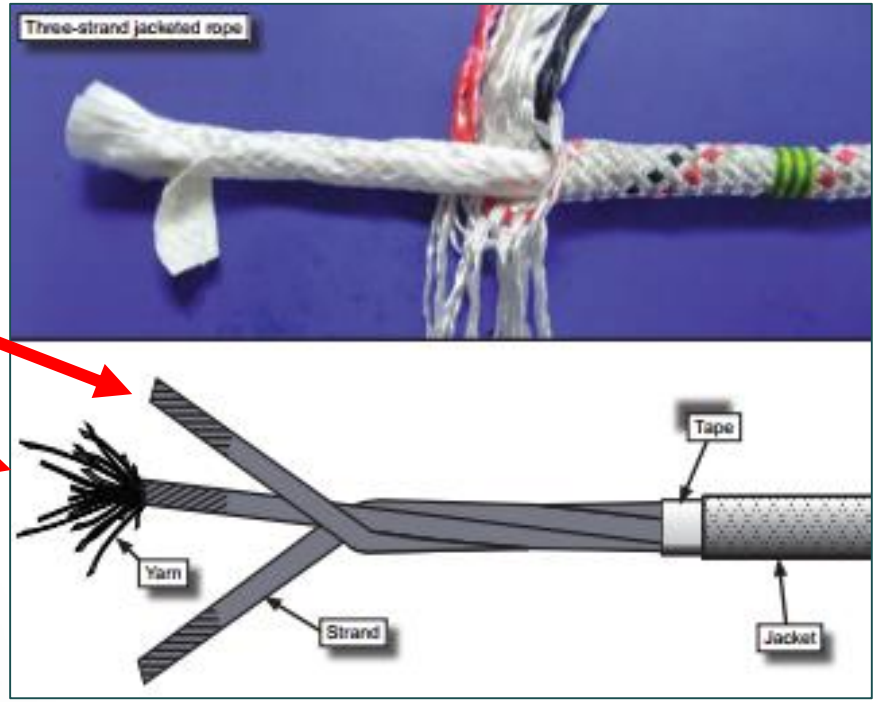


Three strands

36 yarns/strand



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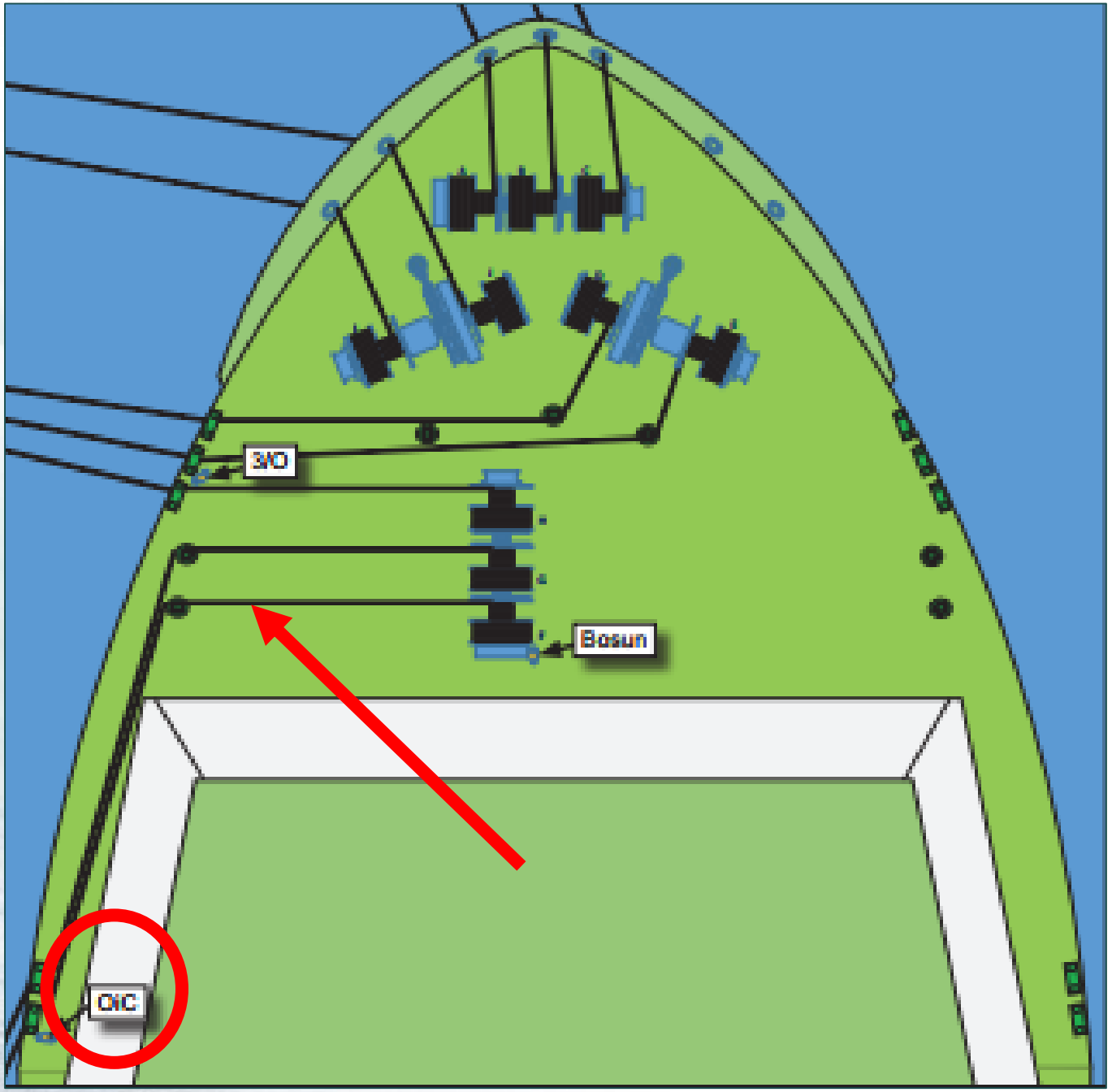

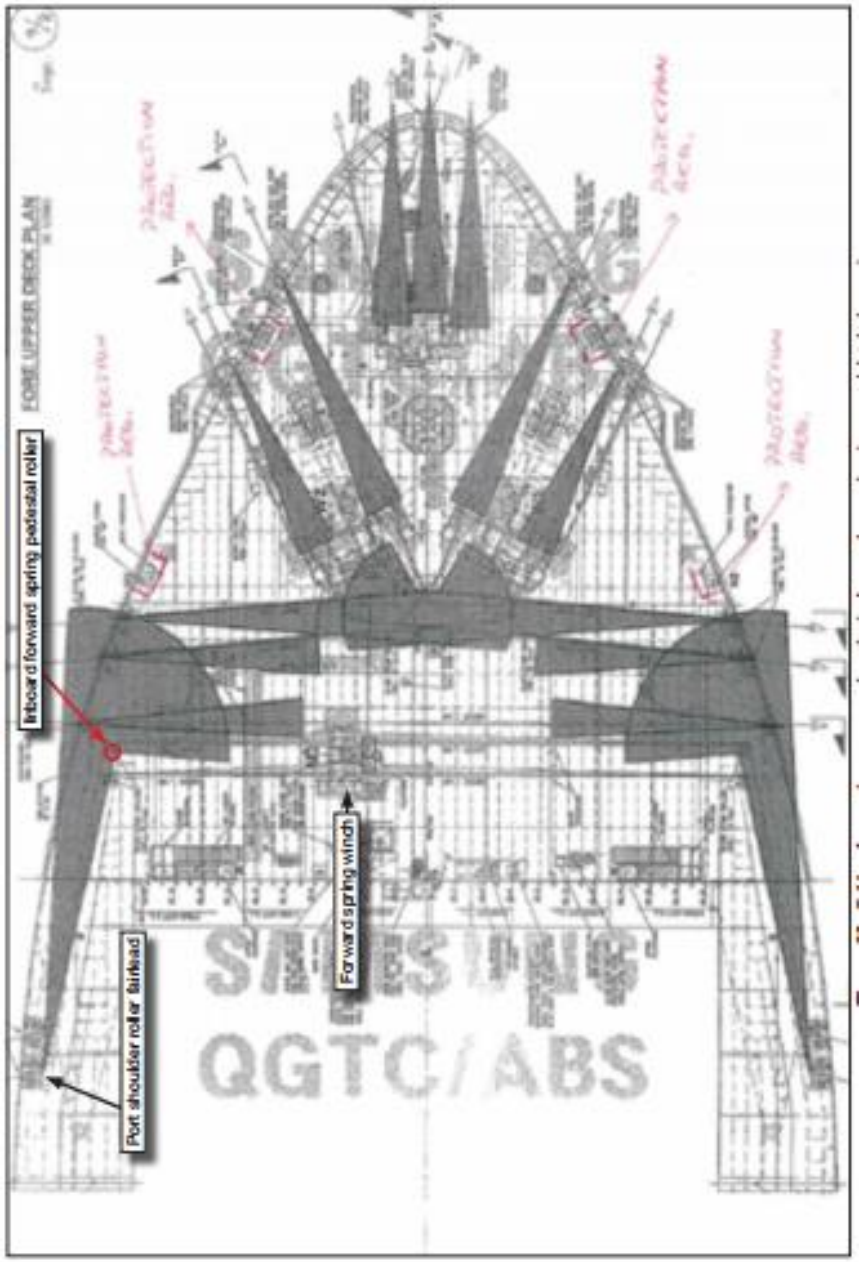

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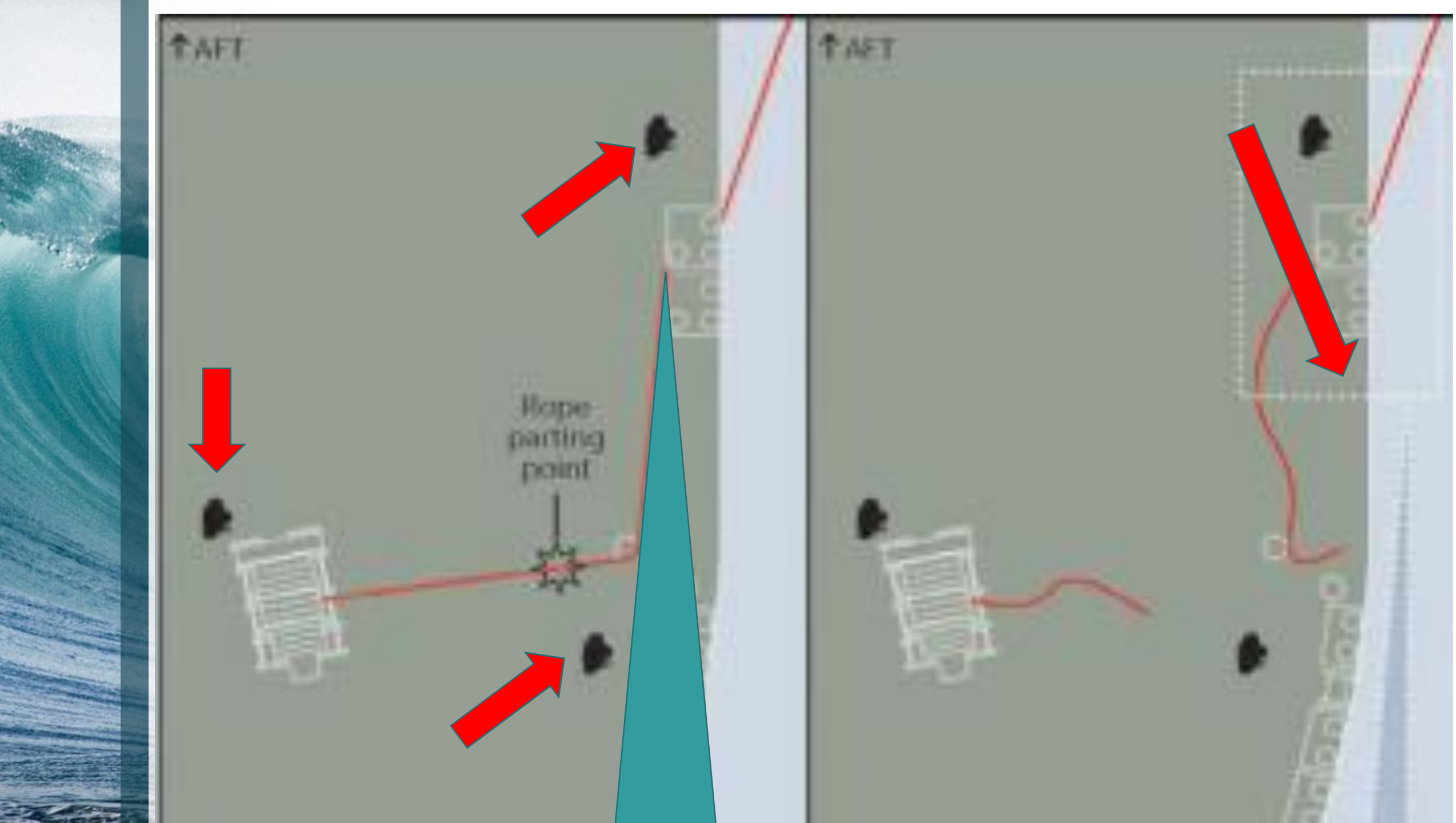
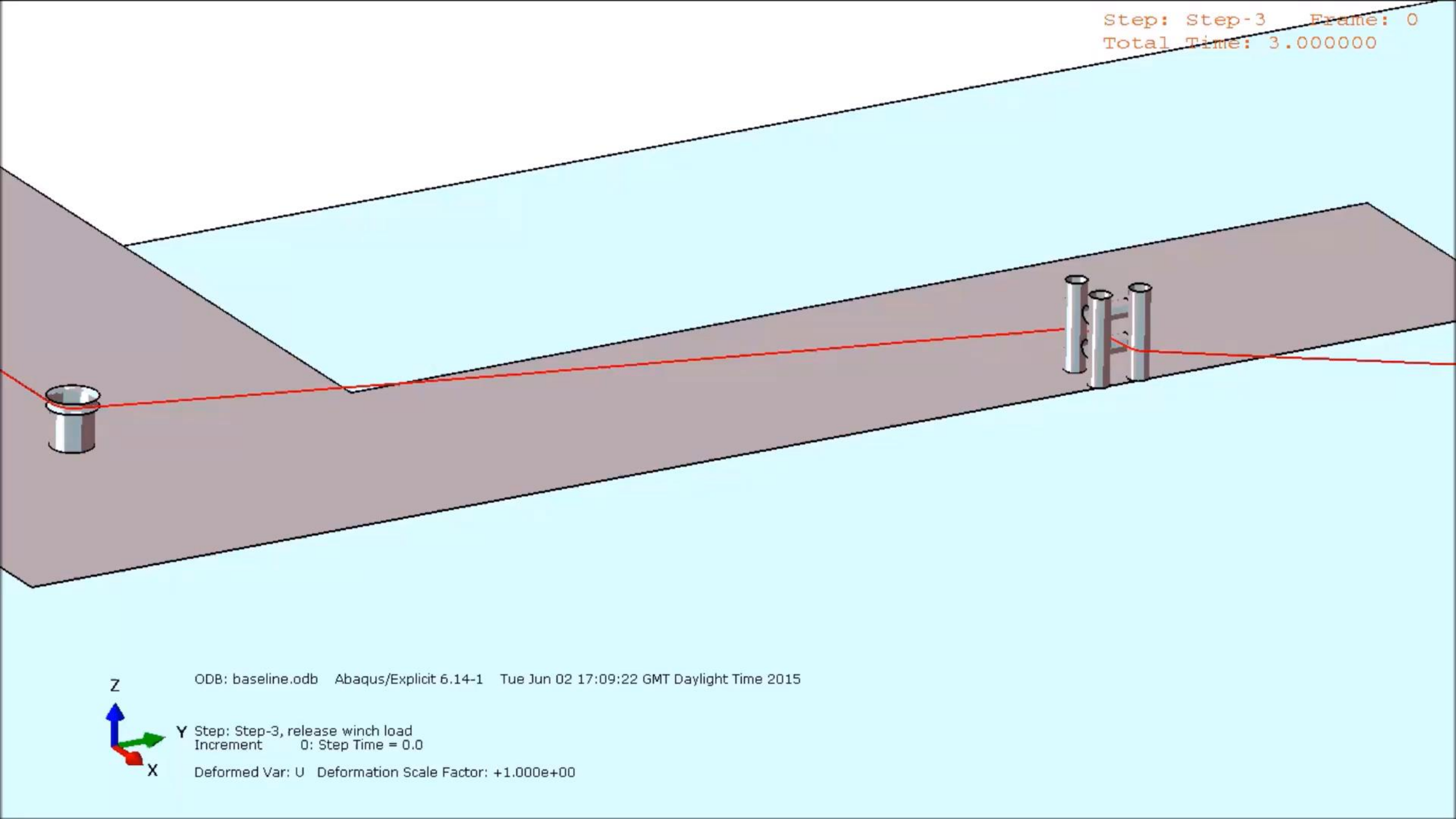
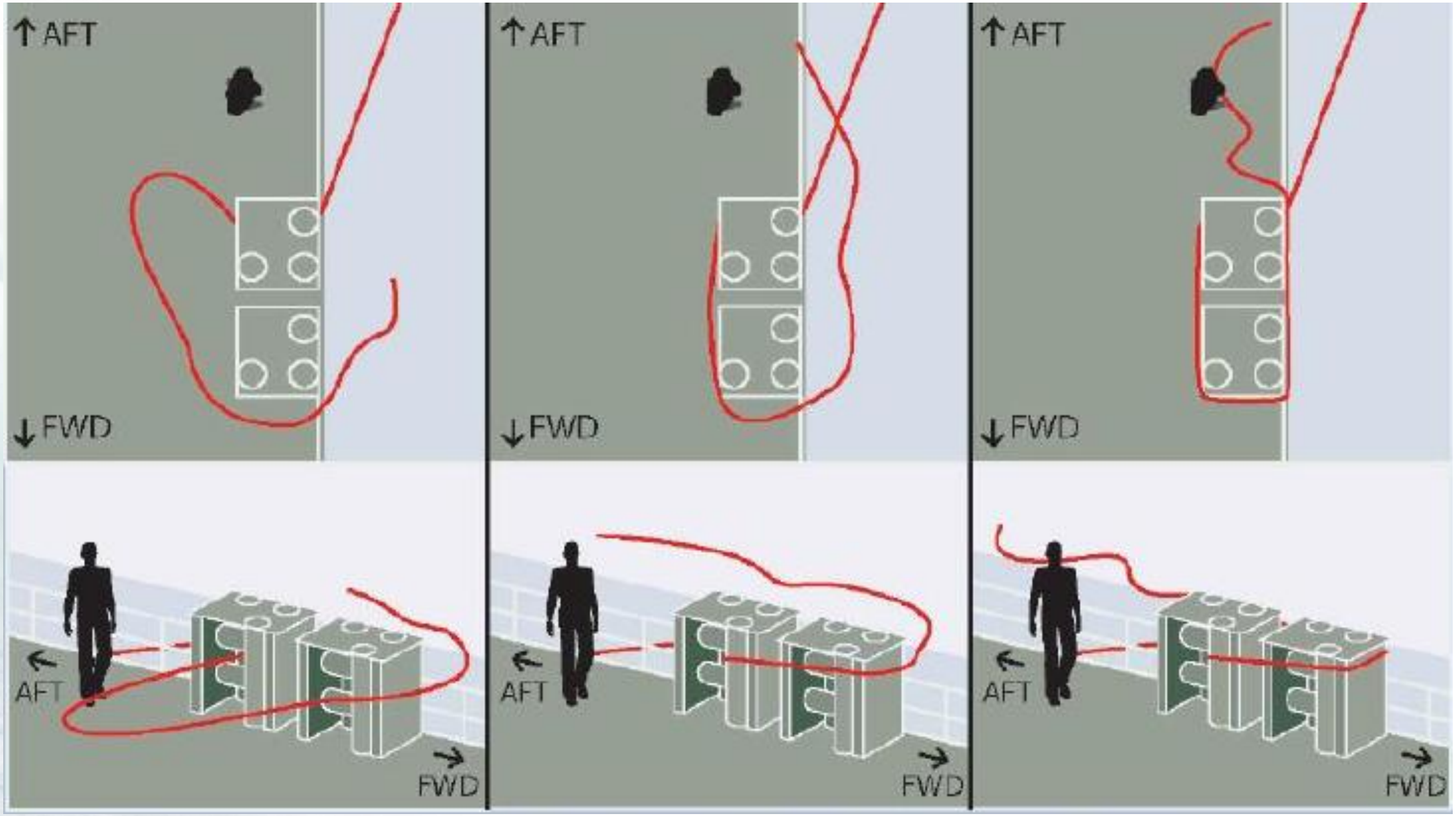

AFT
Rope parting point
AFT


Step: Step-3 Frame: 0
Total Time: 3.000000
Z
Y
X
ODB: baseline.odb Abaqus/Explicit 6.14-1 Tue Jun 02 17:09:22 GMT Daylight Time 2015
Step: Step-3, release winch load
Increment 0: Step Time = 0.0
Deformed Var: U Deformation Scale Factor: +1.000e+00



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SAFETY BULLETIN

SB1/2015 July 2015

Extracts from
The United Kingdom Merchant Shipping (Accident Reporting and Investigation) Regulations 2012

Regulation 5:
"The sole objective of a safety investigation into an accident under these Regulations shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of such an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

Regulation 16(1):
"The Chief Inspector may at any time make recommendations as to how future accidents may be prevented."

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NOTE
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Fax: 023 8023 2459

Mooring line failure resulting in serious injury to a deck officer on board
Zarga
alongside South Hook LNG terminal,
Milford Haven
on 2 March 2015

Figure 1: Zarga alongside South Hook LNG terminal

1

Safety Bulletin 1/2015

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HMPE Users Group Report 2007 - 2011

- **Mooring rope failures:**
  - Average mooring hours – 1011
  - Minimum hours – 62
  - Maximum hours - 1940
- **Failure loads:**
  - 50% - 20 tonnes-force or less (≤16% rope MBL)
  - 13% - ~80 tonnes-force
- **Construction:**
  - 99% - long lay jacketed

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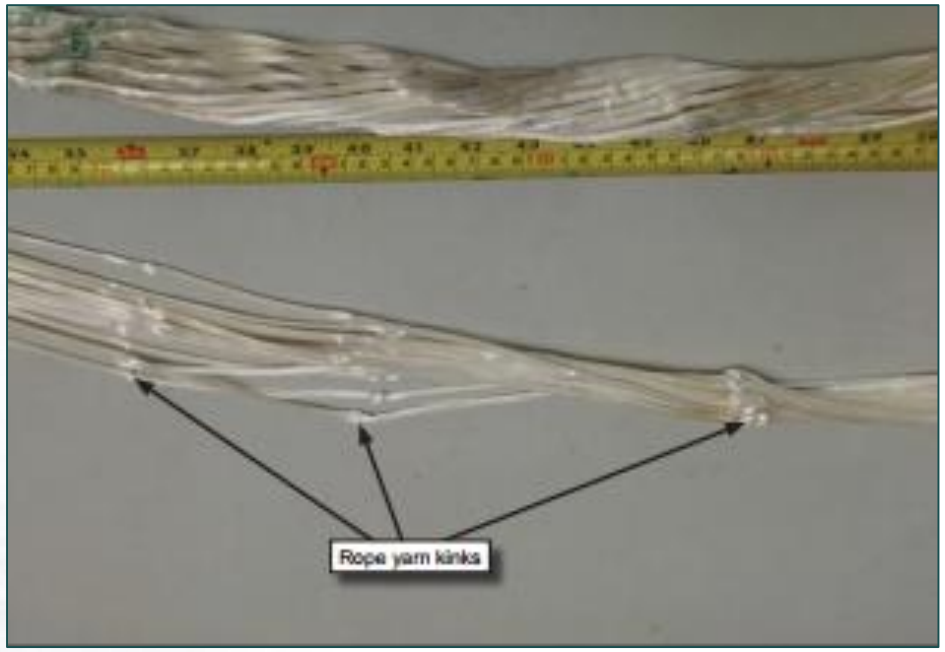
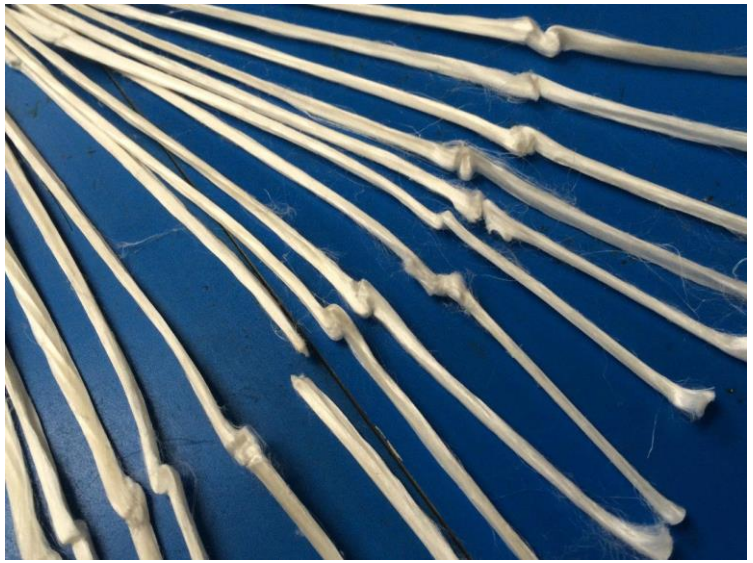
Failed rope inspection





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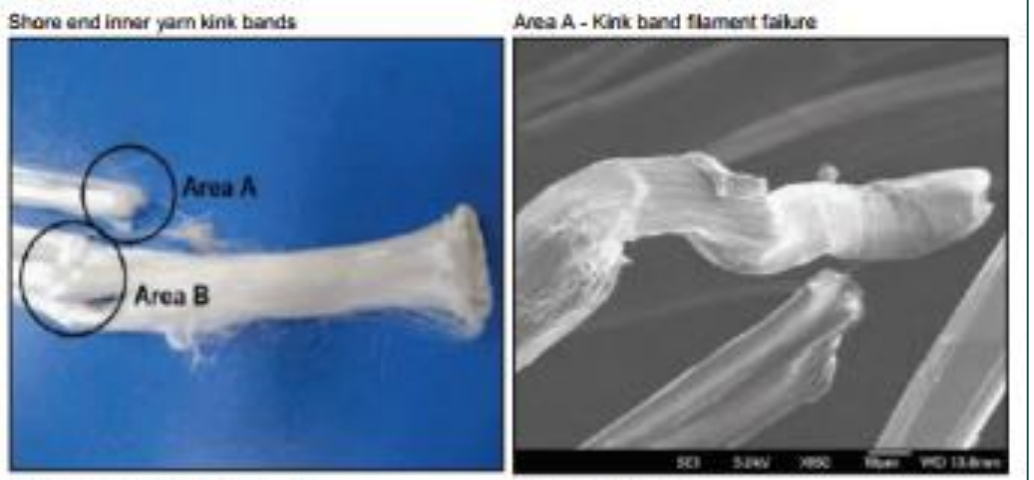

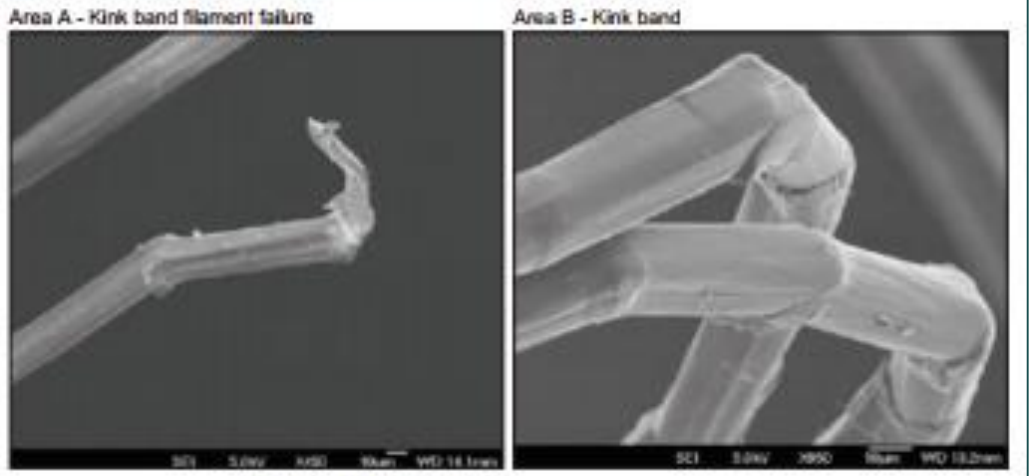

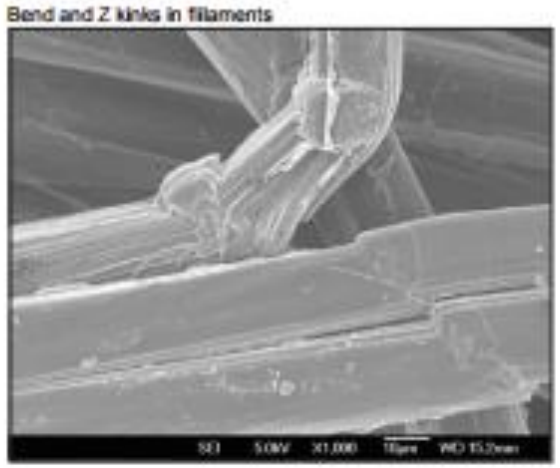

SEM Examination

- ***Failure due to axial compression fatigue***
- ***HMPE is widely accepted in the industry as not being sensitive to axial compression fatigue … something has occurred either in the application, material, rope design or use of mooring tail ..***

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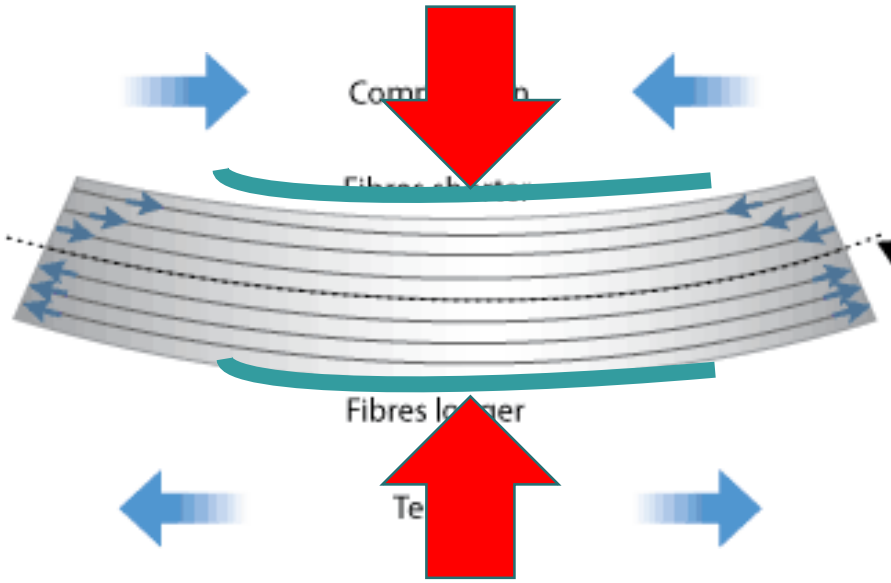
Zarga rope analysis report

- Yarns restrained under tension
- Bending under tension
- Radial compression of tight jackets
- Calculated full rope break strength (0.998)



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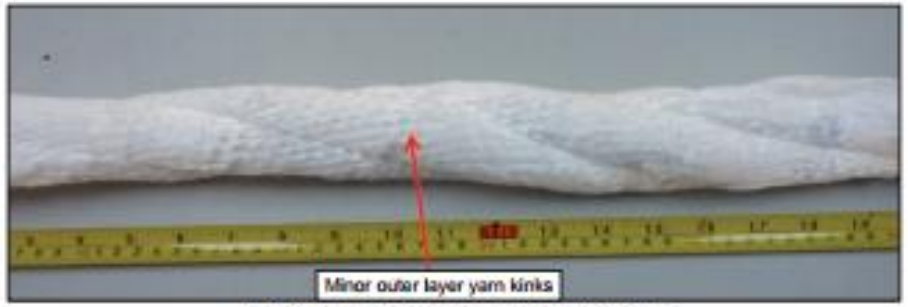

Figure 37: New rope minor kinks in outer yarns

New rope manufactured and tested

- identify the causes of axial compression fatigue and the yarn kinking or buckling
- Identify if the design and manufacturing process contributed to the development of yarn kinks
- Assess the validity of the calculated break tests and the realisation factor applied

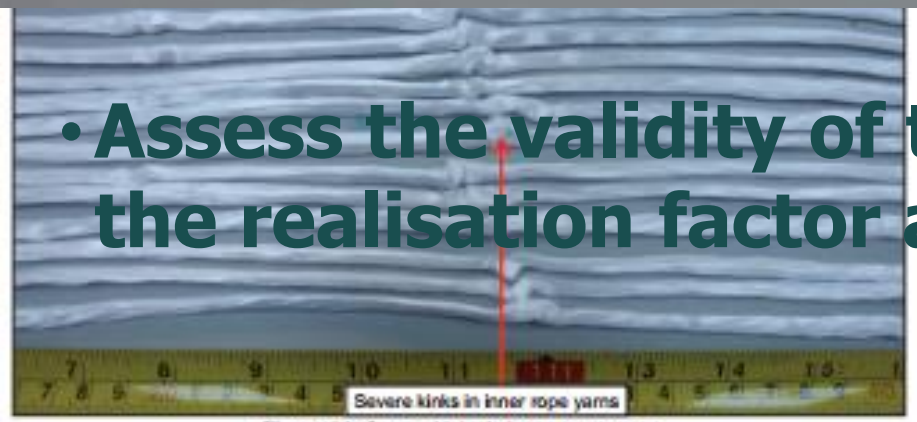

Figure 39: Severe kinks in inner rope yarns

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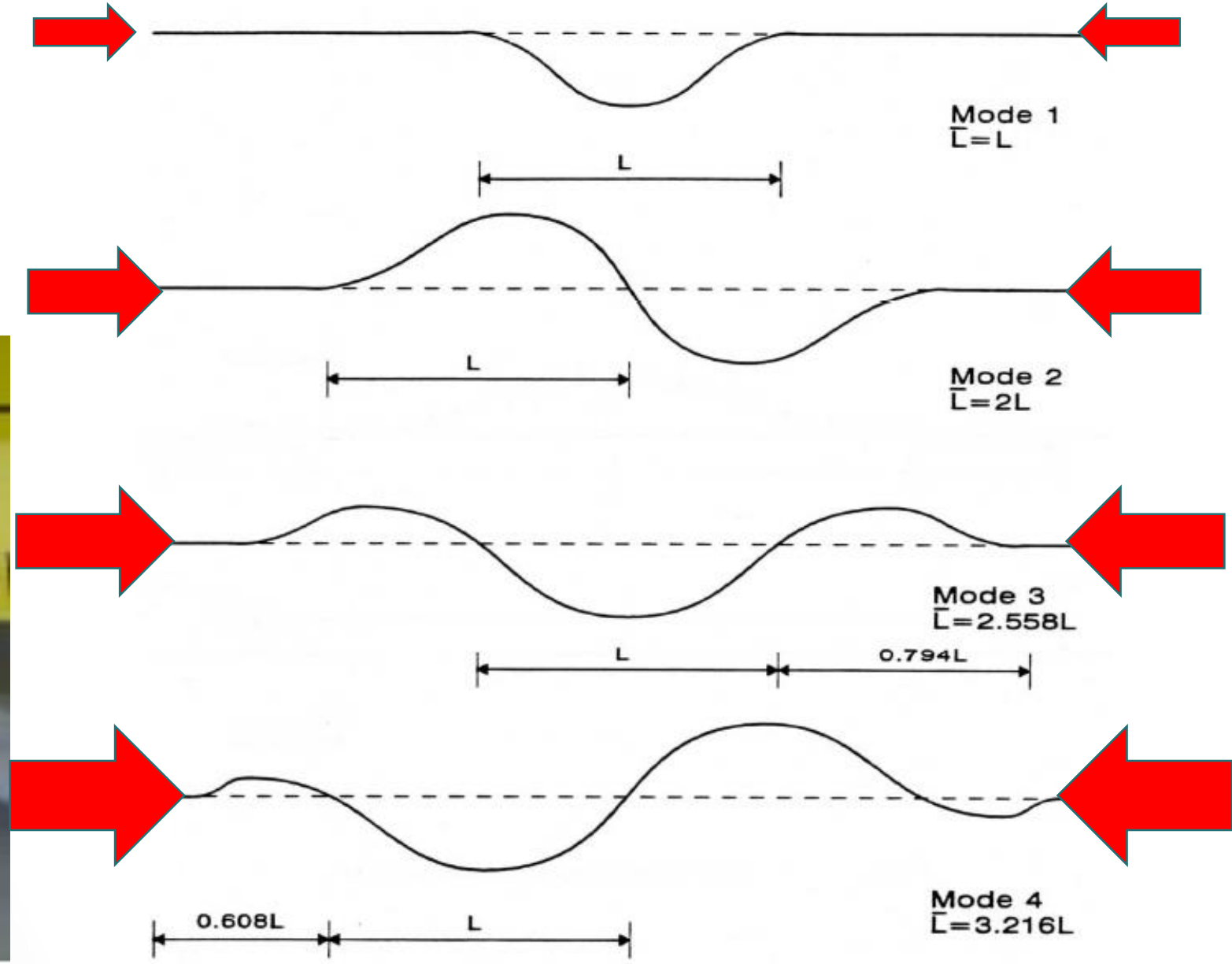
Unrestrained yarn



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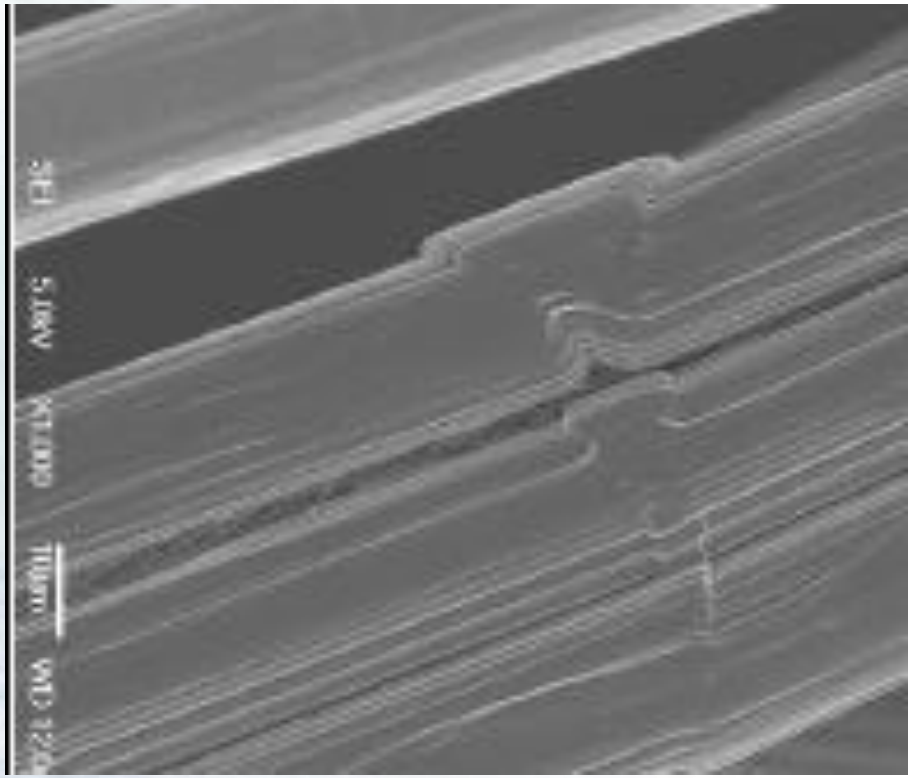
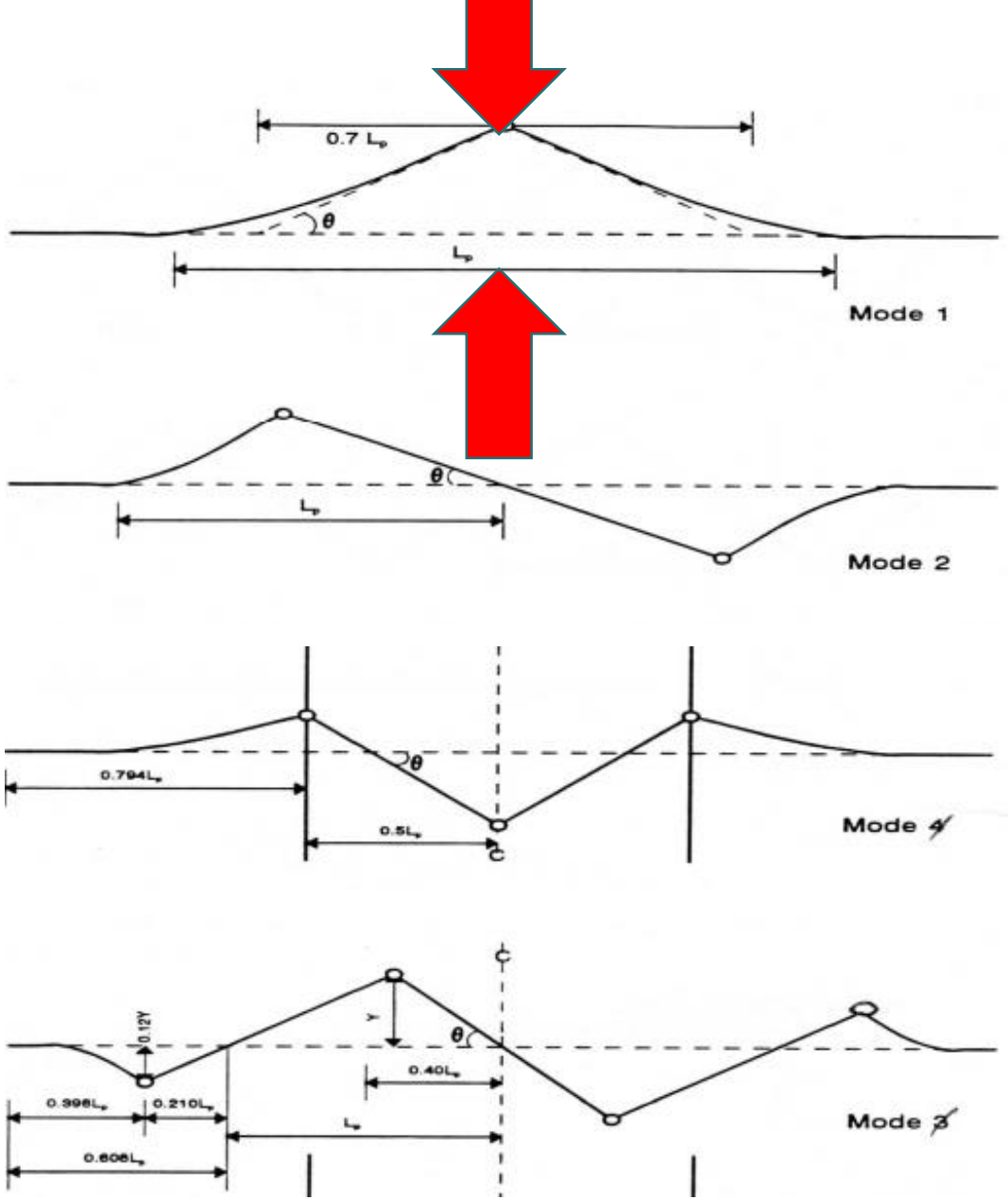
Restrained fibre





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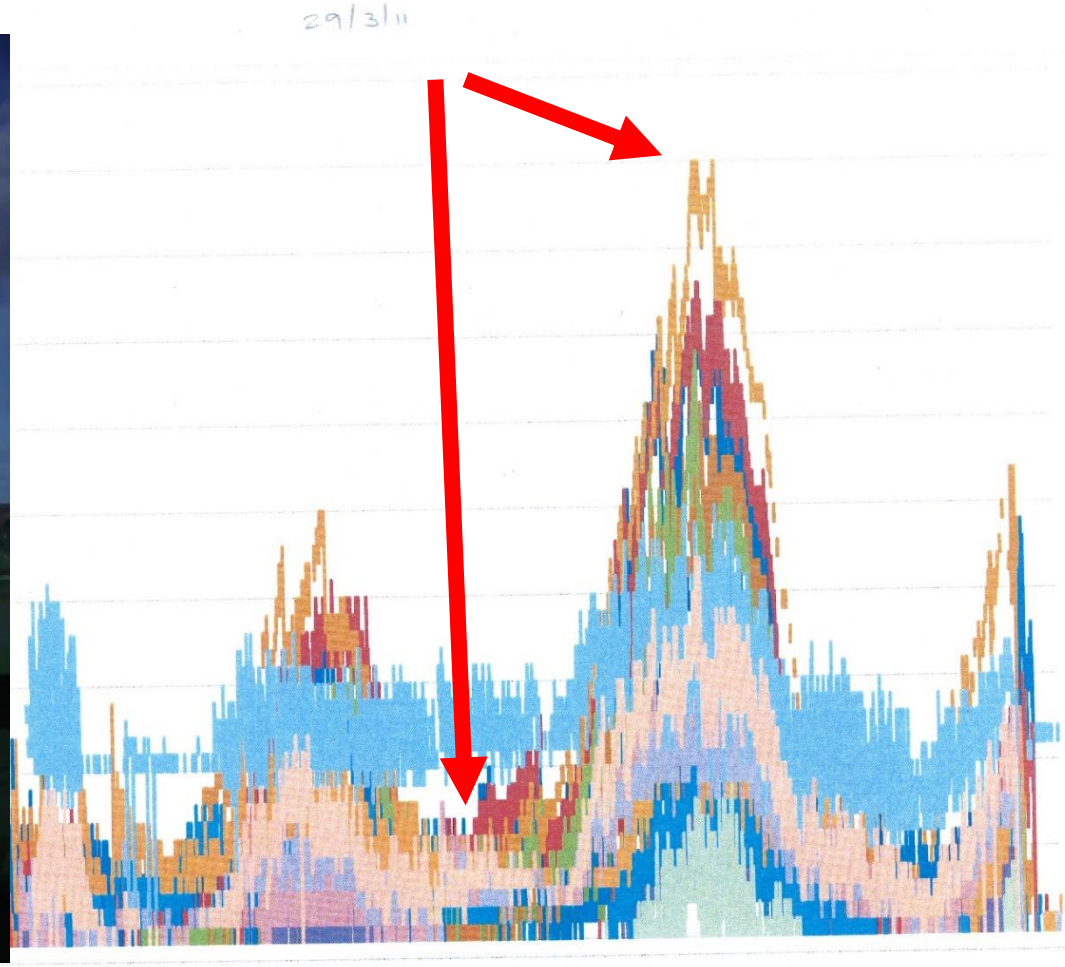
D/d ratios and cyclic mooring line loads



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New rope dissection and modelling conclusions

- Small D/d ratios
- Compressive strain
- Rope jacket
- High cyclic loads

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New Rope Full Load Break Tests
vs
Realisation Factors

- Specified MBL: 137T
- Realisation factor 0.998

<u>New rope full load break tests</u>

- Sample 1 break test: 101.46T
- Sample 2 break test: 105.64T

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SB1/2016 February 2016

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Mooring line failure resulting in serious injury to a deck officer on board *Zarga* alongside South Hook LNG terminal, Milford Haven on 2 March 2015

Photograph courtesy of Exkofila.com

Zarga

ACCIDENT REPORT

MAIB
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Report on the investigation of

the failure of a mooring line

on board the LNG carrier

Zarga

while alongside the South Hook Liquefied

Natural Gas terminal, Milford Haven

resulting in serious injury to an officer

on 2 March 2015

SERIOUS MARINE CASUALTY REPORT NO 13/2017 JUNE 2017

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Final Report Conclusions

- The entire mooring deck was a snap-back zone
- The rope safety factors were not taken in to account when the mooring lines were originally specified
- The mooring line failed due to tensile overload at less that 25% of its specified minimum breaking load
- The ropes did not have the required minimum breaking load
- The ropes were incompatible with the vessel's deck fittings
- The rope's jacketed design prevented adequate assessment of the load-bearing core

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