Synthetic rope technologies

Addressing the mooring industries evolving requirements

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BRIDON SYNTHETICS

Confidentiality

The Bridon you probably know

Spiral Strand Deepwater Mooring

Bridon Neptune Quay, UK

FLNG Prelude

FOW Tampen

Bridon Synthetics … growing beyond steel

Grangemouth, UK

Mining

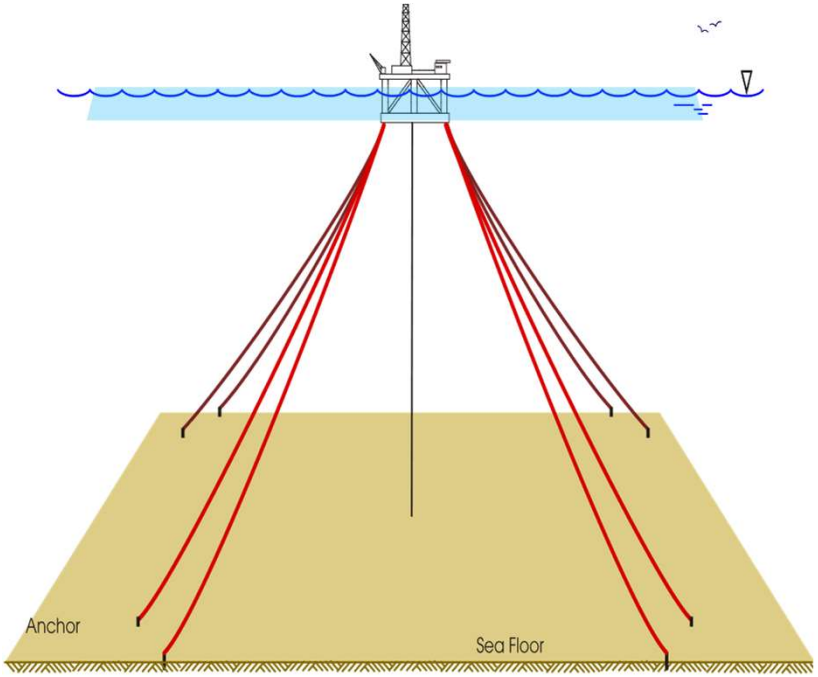
Synthetic lifting

Deepwater mooring

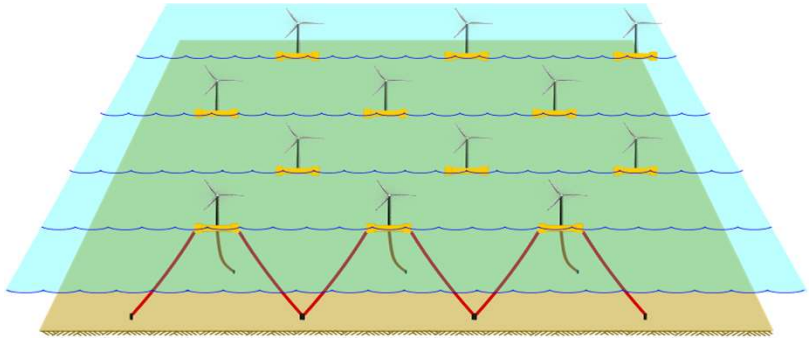
Shallow water mooring

Mooring technology – evolving continuously

Mooring as we know it



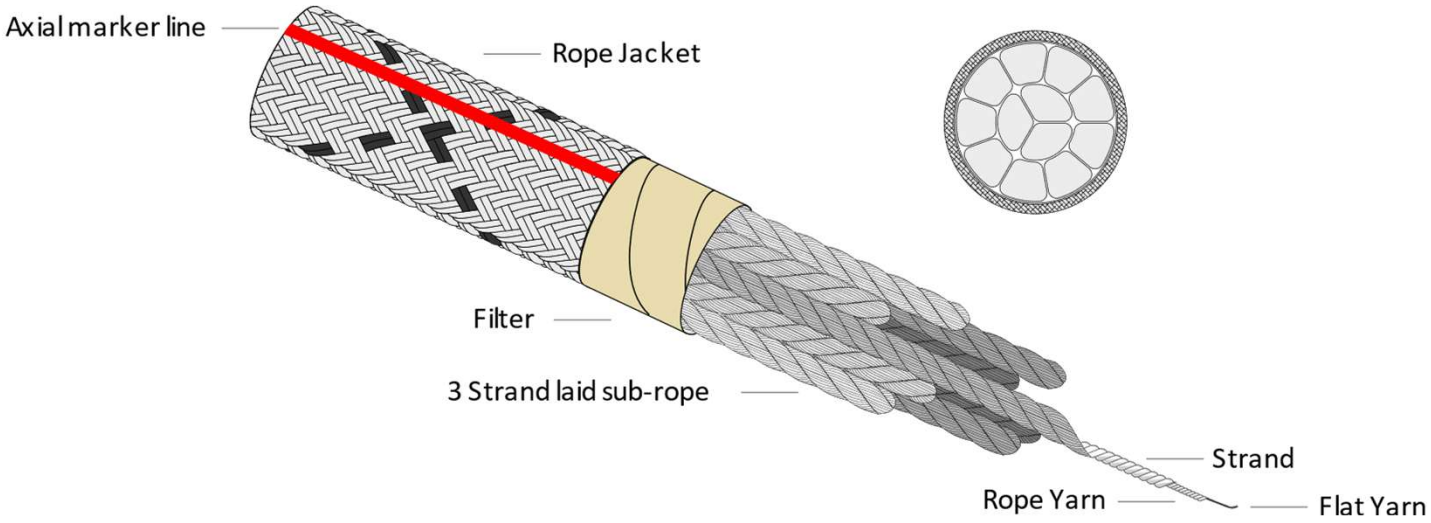
A new agenda emerging



- Shallow water renewables requirements
  - Higher dynamic loads
  - Reduced footprints
  - Even tighter cost effectiveness
  - Step change in supply rhythm
  - Prelay as norm
  - Platform stability
  - Cut resistance
  - Fouling
  - Seabed contact

Bridon MoorLine

- Bridon Synthetics MoorLine rope consists of:
  - Core of multiple, parallel laid sub-ropes
    - Polyester, Nylon or HMPE fibres
  - Braided jacket
    - High performance fabric filter
    - Binds structure of the rope together and protects the core and filter



Mooring rope technology

- High tenacity Polyester
  - 20+ years of proven performance and reliability
  - Mid range stiffness characteristics
- Low creep HMPE:
  - Suitable for TLP moorings due to its high tensile strength and high stiffness
  - Lifetime can be engineered for 25 years, in accordance to predicted load scenario
  - Lower weight and easier installation when compared to steel
- High tenacity Coated Nylon
  - Next slide

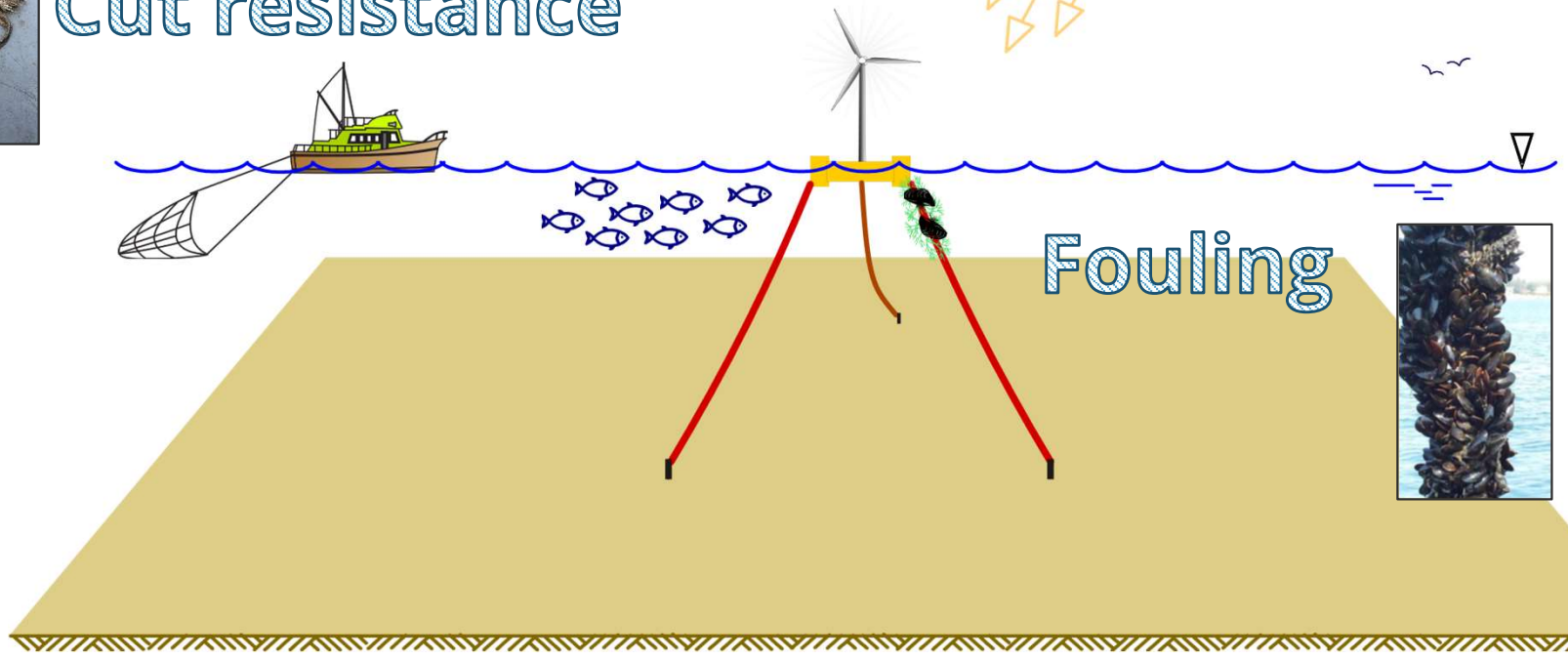
Mooring rope technology

- High tenacity Coated Nylon
  - Lower stiffness than polyester to reduce dynamic loads
  - Fatigue performance
    - Testing demonstrates much longer fatigue life than previous reported in literature
    - Field data from renewable energy demonstrators confirms results from laboratory
  - Currently executing DNV Qualification of Technology to ensure safe use of MoorLine Nylon in permanent mooring of FOWT

Mooring rope technology

- Solving the existing/new challenges

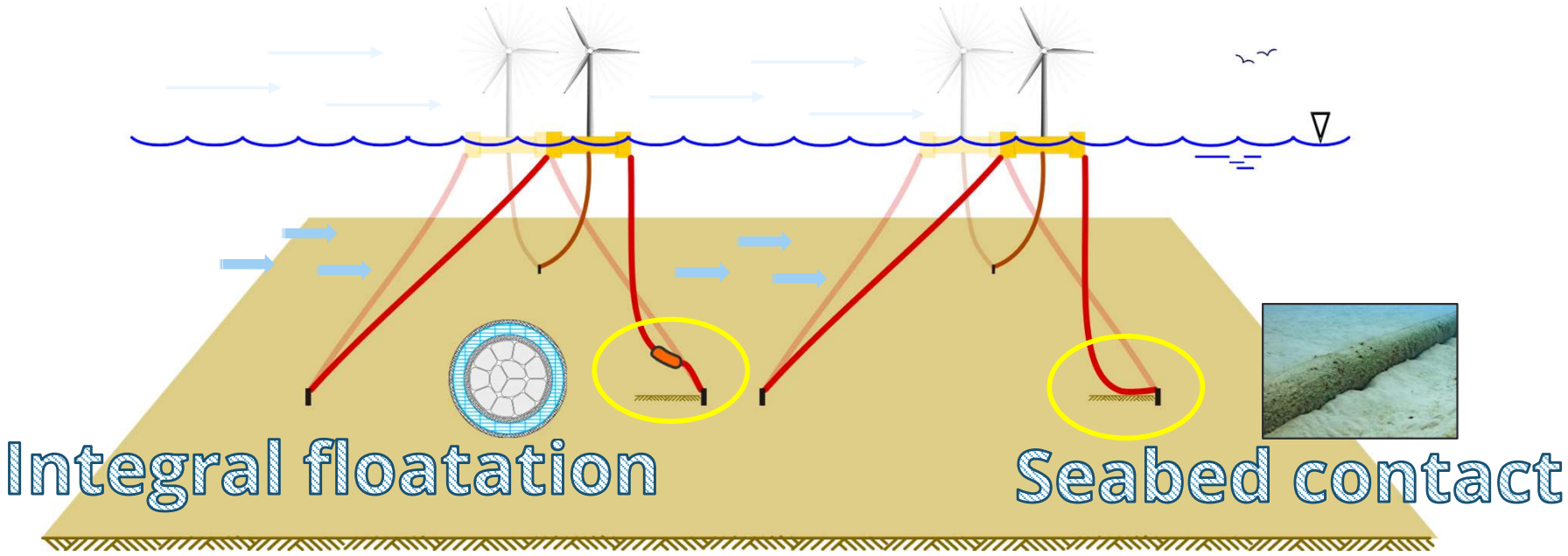
Cut resistance



Fouling

Mooring rope technology

- Solving the existing/new challenges
  - Example: leeward line on floater, as shown below.

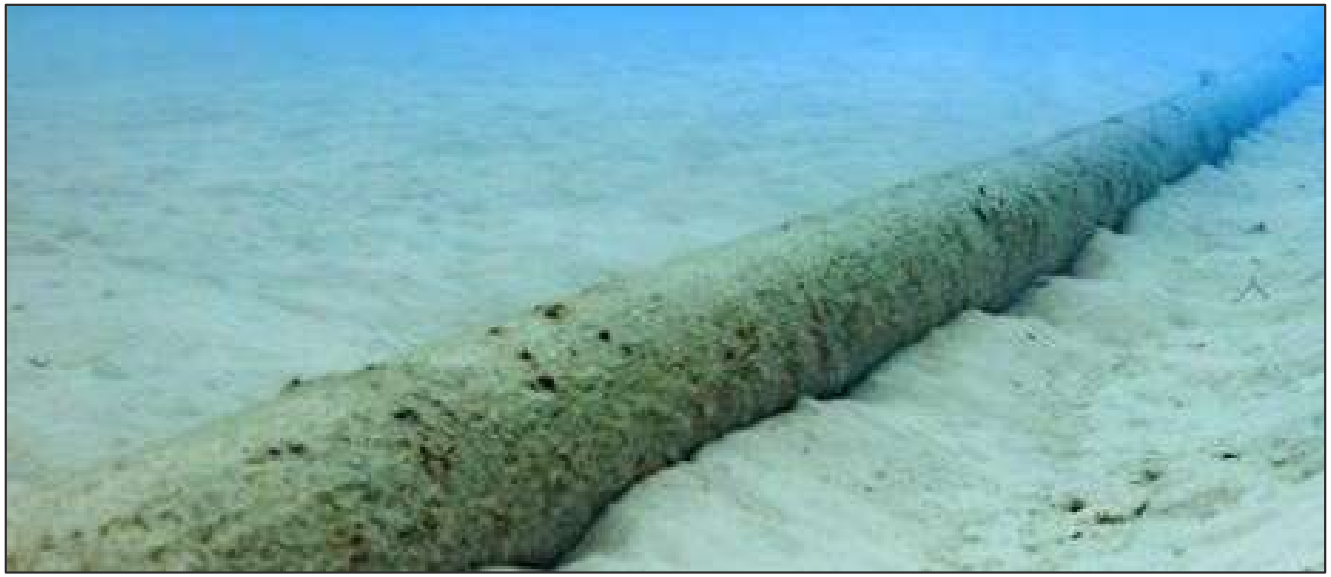


Fouling

- Fouling growth most severe in shallow waters
- Negative impact
  - Additional weight and drag changing mooring dynamics over time
    - Difficult to measure fouling weight and volume (see next slide)
      - Line retrevial process removes much
  - Ingress of hard shell sea life into the rope core
    - 5 micron filters proven effective
- Cleaning is possible
  - Available technologies
    - Mechanical: brushes, cutters, knives
    - Water jet
  - Durability is key

Seabed contact

- For synthetic fibre ropes, on tension and previously tensioned ropes are not normally allowed to contact the seabed.
  - Shallow waters and high static loading a challenge for designers
- Ropes capable of seabed contact simplify for complex mooring systems (buoys, etc.)



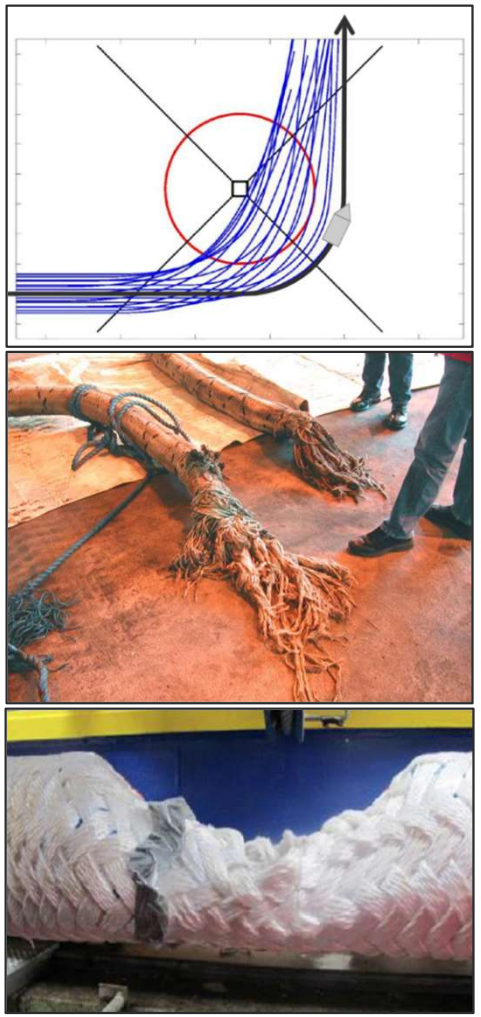
Seabed contact

- Particle ingress
  - Major reduction of rope life demonstrated
  - Most projects require a protection against particle ingress
    - Typically stipulate a filter layer with *"protection against particle of 5µm and larger"*.

- External Abrasion
  - Due to repetitive seabed contact the jacket can wear or rupture
  - Exposure of core -> Reduced service life
    - Reduced particle ingress resistance (damage filter layer)
    - Damage to sub-ropes (in extreme cases)

Cut resistance

- FWT farms will attract fisherman…
  - Fishing lobbies strong at many FWT sites “lines must be over trawlable”
  - Current safety perimeters are insufficient to protect lines
    - Mooring footprint typically much larger than safety zone
    - Fishermen will “cut the corner”
- Cut resistance is synthetics enabler?
  - Line/cluster failure can lead to power cable rupture
- “only defined requirement available in the industry is Statoil (Equinor) requirements to cut-resistant jackets” – DNV
  - Based on simulations from Aasta Hansteen platform
  - single point cutting, worst case vessel speed/size combo



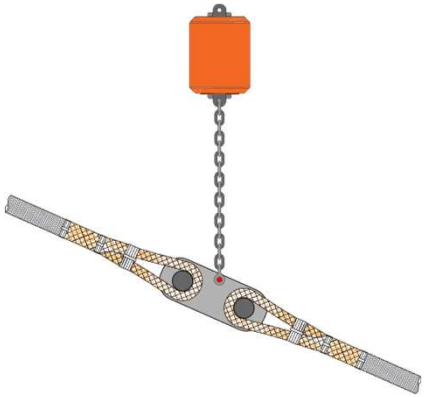
Seabed contact / Cut resistance

- Advanced Composite Structure

  An enhanced protection layer has been developed, that combines the know characteristics of the Polyester Braided Jacket with a polymeric matrix. This creates a composite structure that addresses the main failure mechanisms that were identified from seabed contact field trials:
  - High abrasion resistance
  - High tear resistance
  - High elongation (low/no effect axial stiffness)
  - Chemically inert
  - Long lifetime
- Cutting protection is also based on the same platform
  - Composite structure enables adding different levels of cut protection
- Testing of Jacket composite structure
  - Lab tests and field trials made to confirm the suitability of the protection layer.
  - Seabed drag testing conducted vs. base case Moorline rope.
    - Specimens were repeatedly dragged, lifted/dropped, and abandoned
    - Damage due to abrasion and particle ingress of each rope was documented..
- Currently under discussion with class societies and lead users

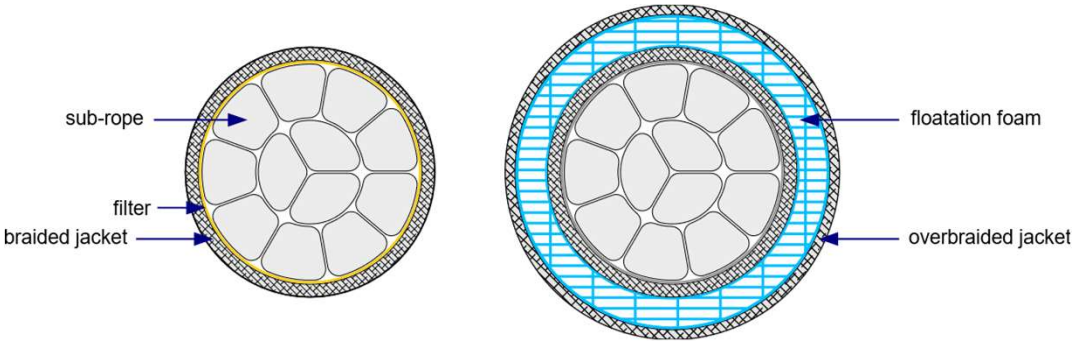
Integral floatation

- Why is buoyancy needed:
  - Keep rope off sea bed (e.g. Fouling weight, Leeward lines)
  - Modify mooring response
    - Inverse catenary
- Effective, economical solution developed compatible with all other line features
  - Fully integrated (protected), flexible and scalable
  - Drastic reduction in component count.



Integral floatation

- BBRG integral floatation solution
  - Compact design fully integrated into the rope
  - Rigid foam certified for sub-suface use
  - High foam density for maximizing floatability
  - Can be placed in specific locations of the rope – distributed buoyancy
  - Reduces number of mooring line components
  - Rope keeps its bending stiffness (bendable/spoolable)
  - Different foam thickness available to meet buoyancy requirements
  - Increases the rope overal diameter (depends on the amount of floatation needed), which increases size of transportation reels



Industrial grade rope terminations

- Human-factor
- Labor and time intensive
- Splice setting variation

APPLIED FIBER

100% Strength efficiency

100% length accurate

100% repeatable

- Industrial process
  - Higher output
  - Easier to scale (Industry 4.0)
  - Subrope condition monitoring functionality
  - Reducing human factor variation
  - Suitable hardware substrate for **monitoring**

We’re wondering…

-What do you see as major opportunities for synthetic mooring ahead? What are major obstacles?

-Any shallow water developments relevant in deepwater?

-Accelerating innovation in a low volume low risk market?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