Quicker and Safer Deployment of Deepwater MODU Moorings



Deepwater MODU Mooring

- Deepwater exploration increasing – further offshore
- Deeper moorings over 7,000ft
- Larger MODUs now drilling to greater depths, typically over 14,000 ft
- Moorings longer and more complex

Offshore Mooring - Installation

- Two-part moorings: piles installed ahead of MODU mooring lines
- Anchor handling vessels used to deploy moorings
- Cost of installation rising as moorings go deeper
- Vessel day rate driving changes to mooring deployment

Deepwater Mooring Line

- Mooring line - synthetic fibre rope connected by shackle / H-links, and short lengths of top chain, anchor chain and subsea mooring connector

- Time needed to make up line significantly increasing with longer lines

- Testing and deployment exceeding cost of mooring system

Deepwater Mooring Developments

- Evolution of mooring systems from shallow to deepwater
- Rope testing and materials developments (PE/HMPE) – new insights into performance and ‘What If’ scenarios
- Deepwater mooring developments based on Lean Installation Methodologies

Lean Installation

- Reduce mooring systems installation, deployment and maintenance costs using Lean principles
- Reduce waste – cut installation, maintenance and boat time
- Add value – optimised mooring systems, greater connector integrity
- Transform mooring process – changes to mooring deployment

Mooring Line – Next Steps

- Traditional H-links and plate links – difficult to handle / make-up
- Time to make up multiple connectors per fibre rope mooring line is significant
- Deeper moorings will mean more connectors per line, more time for deployment

Lankofirst Fibre Rope Connector

- Lankofirst is joint development between Offspring International, First Subsea and Lankhorst Ropes
- Smaller and lighter, forged metal construction
- Easier to handle and make-up offshore

Connections include:

- Fibre rope to Fibre rope (R2R)
- Fibre rope to Wire rope (R2W)
- Fibre rope to Chain (R2C)

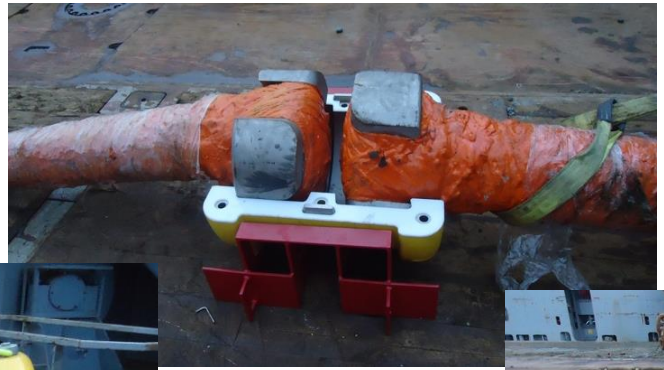
Lankofirst Fibre Rope Connector

- Smaller sub-connector – smaller donut splice is easier to handle offshore
- Insert rope sub-connectors into the open clan, and bolt clam shut
- Shackle connection – insert shackle into the splice eye and hammer in large diameter retaining bolt

Lankofirst – Field Trial

- Lankofirst trial conducted in the North Sea, offshore Norway
- Comparative trial: Rope to Rope connection

Lankofirst – Field Trial



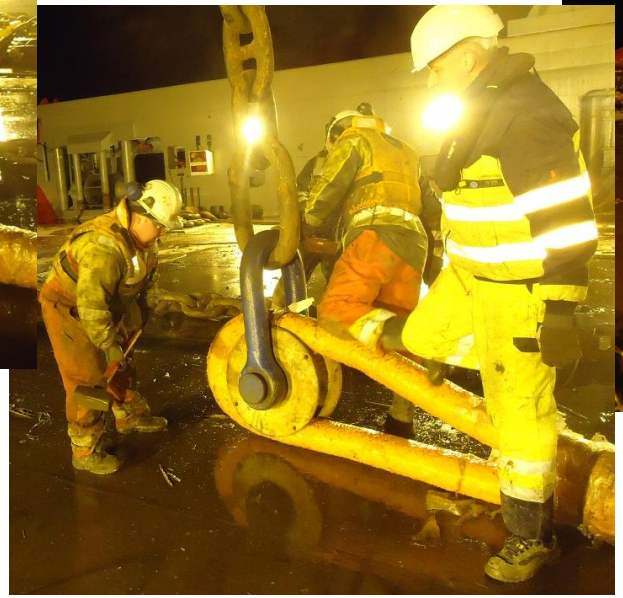
Lankofirst – Field Trial

- Lankofirst rope-to-rope connection overboarded and lowered to seabed
- Successfully passed through vessel's stern rollers
- 200mT load applied to rope and connector

Lankofirst – Field Trial

Shackle and Bobbin Connection

Shackle and Bobbin Connection



Lankofirst vs Shackle and Bobbin

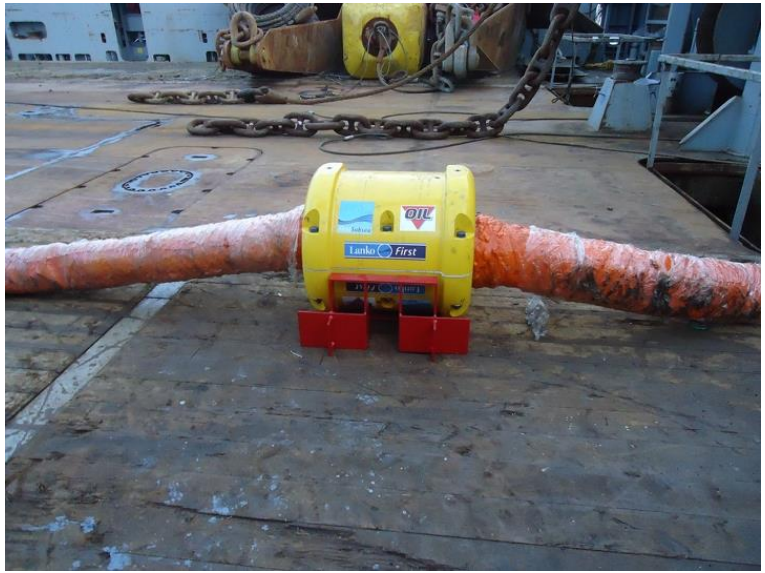
Shackle and Bobbin	Lankofirst
Current linkage is 3m (approx.) in length	1/3 of current linkage
Linkage constitutes of: 1. Thimbles 2 off 2. Kentner Links 2 Off 3. Stud Chain 76mm or 84mm Length 4. Rubber Mats – 4-5m 1 off	Lankofirst Clam only
Stern roller requires adjustment during the pull-in of a traditional linkage	No adjustment necessary – Lankofirst designed to pass easily over stern roller
Requires rubber mat during spooling to protect the rope from damage by linkage	Not required, Lankofirst spools directly
Crew member required to use steps near spool to check if the mat is in place – potential Trip / Fall Hazard	Not applicable to Lankofirst
Mats can get tangled and ripped – losing time and requiring replacement	Not applicable to Lankofirst
Assembly takes up to 90 mins	15 mins for Lankofirst clam

Lankofirst vs Shackle and Bobbin

- Rope to rope connection
  - 15 mins for Lankofirst
  - 1 hour 30 mins Shackle

- Health and safety benefit
  - Lankofirst: two person assembly
  - Shackle: three person assembly

- Opportunity to reduce personnel on deck during high risk events



Implications for Deepwater Mooring

- Connector storage on winch drum easier with Lankofirst – no need to protect mooring rope
- Potential time saving using Lankofirst for MODU / FPSO mooring is substantial
- Up to 48 rope to rope, rope to chain connections per rig. Over 1 hour saving per connection – significant savings in vessel time

Lankofirst Fibre Rope Connector

- Field trials shows Lankofirst is viable alternative to traditional H-link and shackle connectors
- Easier and quicker to assemble
- Safer rope connection – less personnel needed to assemble on deck
- Significant time savings with each rope connection – reducing vessel time and thus deepwater mooring systems deployment costs for MODUs, and FPSOs