Fatigue Performance of Mooring Chains in Seawater

PUBLISHABLE SUMMARY

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Background

Mooring chains are used for deep water oil and gas developments for mooring FPSO vessels, buoys and spars. Designs utilising larger links and higher strength materials (such as R5 grade) are being considered. However, the fatigue performance of higher grade chain is not well understood and it is possible that the increased static strength may not result in a higher fatigue performance in seawater. Industry has therefore expressed the need to obtain fatigue test data under true operating conditions to gain a detailed understanding of the factors affecting fatigue performance.

Fatigue design recommendations provided by API and DNV are based mainly on fatigue data obtained in the 1990s. The maximum diameter tested was 76mm for studless and 100mm for studlink chain in steel grades R3 and R4. The data are limited, especially for longer lives of the order of 1 million cycles.

This Joint Industry Project (JIP) has critically reviewed existing knowledge, provided full-scale fatigue data in seawater for high strength steel (grade R5) and large link diameter, and established the primary material properties affecting fatigue performance in seawater.

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Objectives

- Critically review previous experimental tests and FE studies to make best use of currently available information.
- Provide full-scale fatigue endurance data for high grade studless mooring chains in seawater.
- Establish the key material properties affecting corrosion fatigue resistance of mooring chain; characterise those properties for a range of chain grades.

Benefits

The outcome of this project will provide the following benefits:

- Relevant fatigue design data and improved design guidance for mooring chains.
- Independent fatigue data for higher chain grades and larger diameters.
- Improved safety, reliability and reduced costs.
- Possible weight savings through adoption of higher grades.

Participants

The Sponsor Group comprised:

- Shell Projects and Technology (formally BG International Ltd)
- BP Exploration Operating Co Ltd
- Statoil Petroleum AS
- ABS
- Vicinay
- Ramnas

Scope of Work

- Review of fatigue data and fatigue design standards for mooring chain
- Design and manufacture of full-scale fatigue test rig
- Conduct 23 full-scale fatigue tests of mooring chain in seawater, each test comprising 7 links for 127mm diameter and 11 links for 76mm diameter.
- Study studless chain grades R4 and R5 of 76 and 127mm diameter
- Conduct small-scale tests including fatigue crack growth frequency scanning tests in seawater

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Deliverables

Reports on work including full-scale fatigue endurance data for high grade (R5 and R4) and large diameter mooring chains in seawater

Price and Duration

The project was completed in June 2018. It had a duration of 6 years and a budget of £1,200,000. The fee for companies wishing to access the results by buying-back into the project is £195,000.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

http://www.twi.co.uk/services/research-and-consultancy/joint-industry-projects/

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