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New Industry Guidelines for Fatigue Analysis of Unbonded Flexible Risers

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Abstract

This paper reviews the Fatigue Analysis Methodology Guidelines for flexible risers as produced by the Real Life Joint Industry Project (JIP). The overall objective of Real Life is to obtain industry consensus on methodologies for computing the design fatigue life of a flexible riser with particular emphasis on fatigue critical designs; for example deepwater catenary risers. The paper also reviews the reasons for initiating Real Life.

Real Life tested a range of analysis methodologies based on existing practices and new proposals, and produced a Fatigue Analysis Guidelines document that will be submitted to API to be considered for publication as an API standard.

The fatigue analysis encompasses the riser global response and the local stress in the tensile armour wires. The Guidelines are also broadly applicable to the pressure armour, which is not formally part of Real Life.

Introduction

The Real Life JIP is driven by the need to increase the engineering rigour with which the industry currently computes flexible pipe fatigue life so that we can continue to demonstrate the safe design of flexible pipe in ever more challenging offshore loading conditions combined with realistic environments in the flexible pipe annulus. (The pipe annulus contains the pressure and tensile armour layers and is located between the pressure and external sheaths.) Equally, existing methodologies lack the consistency and level of transparency that is required to independently demonstrate the level of safety and conservatism in new flexible riser designs.

The Real Life JIP addresses these issues by establishing an independent, consistent and transparent fatigue analysis methodology such that the level of safety and conservatism in new flexible riser designs can become more easily demonstrated. This has been achieved through the integration of the following key tasks:

1. Improved characterisation of the global fatigue environment.
2. Time domain global riser analysis techniques that are refined to realistically, yet efficiently, represent fatigue loading conditions on a flexible riser system.
3. Local cross-section fatigue analysis techniques that are technically consistent with global fatigue load calculations.

Real Life has established a best-practice approach to flexible pipe fatigue analysis by combining current industry knowledge with new developments within the JIP, and has encapsulated the results into a set of Guidelines that can ultimately be published as an industry standard or code of practice.

The fatigue analysis methodologies recommended by the Guidelines developed in Real Life have been demonstrated using trial applications based on sample projects provided by the JIP participants. These trial applications include a harsh environmental North Sea location, an ultra-deepwater West of Africa project and an offshore Brazil application.

The fatigue analysis methodologies established in Real Life are reproducible using existing global and local tools available to designers, manufacturers and operators of flexible pipe.

Background

The accurate prediction of the fatigue performance of unbonded flexible risers is dependent on a wide range of service life factors that include material, environment, global riser and local pipe cross-section response. It is generally acknowledged that there are limitations associated with the current state-of-practice regarding the selection and application of these factors in computing flexible pipe fatigue life. Furthermore, existing flexible pipe codes of practice do not provide sufficient guidance on fatigue design for ultra-deep and harsh environments. As a result, existing methodologies tend to suffer from a lack of consistency of application and transparency of approach.

A review of the fatigue analysis approaches being used by designers, end users and flexible pipe manufacturers shows that, notwithstanding some industry exceptions, a number of key issues directly affecting fatigue performance can be over-simplified. These key issues include:

1. Considerable over simplification of global loads such as the use of max./min. curvature values that have been derived from regular wave analyses. Irregular