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Enhanced Fatigue Methodologies for Flexible Risers and Applications for Brazilian Offshore Conditions

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Abstract

The Real Life Joint Industry Project (JIP) coordinated by MCS aimed to develop a fatigue analysis methodology for flexible pipes with independence, consistency and level of transparency that is increasingly being demanded by the industry. This is to ensure that the safe design of flexible pipe, in ever more challenging offshore loading conditions, combined with realistic pipe annulus environments can continue to be demonstrated.

Petrobras, one of the main participants in the Real Life JIP, has expressed an interest in working with MCS in a follow on project to address some key technology issues that have been identified in the JIP and to evaluate further some specific aspects for Brazilian offshore conditions that take bi-modal and bi-directional seastates into account.

This paper presents the main outputs of the work performed. Amongst the main benefits of the project are the comparisons between different deterministic and stochastic methodologies of global fatigue analysis, the recommendation to convert multi-modal and multi-directional seastates into an equivalent single seastate, and the global hysteresis model that supplies more realistic results in comparison with the simplified model that can lead to results that exceed the design criteria in fatigue analysis involving wet armor wires.

Introduction

To design flexible risers for a deepwater application, the evaluation of the fatigue performance is of paramount importance, especially for Brazilian offshore conditions where a multi-modal and multi-directional wave climate is constant. The correct choice of the fatigue methodology to be applied in this case, could mean the difference in applying a free catenary configuration or lazy wave configuration or even worse, the acceptance of an converted FPSOs with high movements or have to build a purpose vessel with smaller motions.

From 2004 to 2006 MCS conducted the Real Life JIP which aimed to develop and evaluate fatigue analysis methodologies for flexible risers and had the participation of several oil companies and the three flexible pipe manufacturers. This JIP addressed both global and local analysis methodologies and global to local transformation methodologies and basically two trial applications have been fully addressed, one considering North Sea conditions and other the West of Africa Environment and a Fatigue Analysis Guidelines (MCS, 2005) was issued. These guidelines will also be considered in the new revision of the API Recommended Practice (API 17B, 2002) and the ISO code (ISO 13628-11, 2007). The Brazilian offshore environment was just briefly addressed on this JIP and a specific conclusion of the applicability of the Guidelines to bi-modal and bi-directional wave climate was not presented.

For this purpose, Petrobras contracted MCS to perform a follow on project to the Real Life JIP to address some key technology issues that have been identified in the JIP and to evaluate further the implications of the Guidelines for Brazilian offshore conditions. The focus of the work scope is on the fatigue response of flexible pipes in the critical top bend stiffener and TDZ (Touch Down Zone) regions subjected to bi-directional conditions. The key objectives of the study are:

i. Analyze and compare fatigue calculation using recommended procedures from Real Life JIP for two different types of FPV - Floating Production Vessels, a turret moored FPSO (Floating Production Storage and Offloading vessel), and a Semi-submersible and two different flexible risers with different diameter to weight ratio (one for oil and other for gas export);