Offshore & Dredging Engineering

Technische Universiteit Delft

Global loads for mooring integration calculations

Floating Production, Storage & Offloading (FPSO) units are extensively utilized in remote offshore areas for deep water developments where a pipeline infrastructure is not an economically viable solution. Traditionally, FPSOs are converted from oil tankers, which entails that they are not equipped with an appropriate mooring system. A spread mooring system is often employed to allow the FPSO to maintain its position offshore. The mooring loads from the catenary system further contribute to the internal loads in the hull structure.

Currently, only the highest wave-induced section loads along with the still water section loads are taken into consideration in longitudinal strength. In the design of the mooring integration structure, which is the structure that transfers the loads from the mooring system to the vessel, the highest wave-induced section loads are combined with the highest local mooring loads. However, it is unclear whether the present adopted approaches lead to safe, unsafe or unnecessarily conservative designs for the hull and the mooring integration structures.

Catenary Mooring System

The goal of this thesis is to assess the contribution of the slowly varying mooring loads to the global design loads. The study aims to investigate the effect of concomitant wave and mooring load-induced section loads. To this end, a numerical tool is developed in order to facilitate the synchronization between wave and mooring load-induced section loads.

In this thesis, a linear hydrodynamic model is employed for the calculation of first and second order motions and loads in the frequency domain. Then, a time domain mooring model is utilized to compute the mooring line loads on the basis of a quasi-static approach while taking into account second order drift loads under the combined action of wind, waves and current. Subsequently, the mooring line tensions, the internal load response operators and the low frequency vessel position are implemented in the developed numerical tool that computes the internal load time traces due to mooring loads and synchronizes the latter with the wave-induced internal load time traces.

A large number of extreme environmental conditions is considered to allow for a reliable statistical analysis. Under this scope, a statistical tool for extreme value and probabilistic dependence analysis is developed. It is concluded from this analysis that current practice according to which the contribution from the mooring loads in the global design loads is not taken into account is valid. However, considering the design of the integration structure, this study shows that it is significantly conservative to assume that the highest wave-induced section loads will coincide with the highest local mooring loads.

Student
Marios Koen
21 March 2017

Sponsor
SBM Offshore

Thesis committee
Prof.dr. A. V. Metrikine
Dr.ir. O. Morales-Napoles
Ir. C. Keijdener
Ir. T. Bosman
Ir. J. Eestermans