Floatover Mooring Analysis with Different Mooring Lines Property in Shallow Water

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ABSTRACT

This paper details the mooring analysis method and its application in the successful floatover installation of the JZ9-3 CEPD Topsides in shallow water. The main purpose of the mooring analysis is to investigate the mooring line capacity, check the clearance of the mooring lines above the seabed pipelines, and check the uplift force at anchors and mooring line length on the seabed, and check the heave motion due to the shallow water. The mooring analysis results with different mooring lines property are available for a comparison. The result indicates that both the HMPE lines and the steel wires combined with buoys are acceptable in theory. If the HMPE line is selected, the winches or associated equipments have to be updated to protect the damage to the HMPE lines. Therefore, it is more practical in the industry practice to use steel wires combined with buoys when considering the economic cost.

KEY WORDS: Numerical simulations; mooring analysis; shallow water; T-shaped barge; floatover, installation.

NOMENCLATURE

COC = Offshore Oil Engineering Co., Ltd.
COG = Center Of Gravity
DOF = Degrees of Freedom
HMPE = High Modulus Polyethylene
HYSY = Hai Yang Shi You
JZ9-3 = Jinzhou 9-3
MSL = Mean Sea Level
NPD = Norwegian Petroleum Directorate
RAO = Response Amplitude Operator
Rxx = Radius of Gyration about x-axis
Ryy = Radius of Gyration about y-axis
Rzz = Radius of Gyration about z-axis
SF = Safety Factor
Te = Tonne, or Metric Ton

INTRODUCTION

From Oct 2013 to Oct 2014, COOEC have successfully completed five topsides floatover in Bohai Bay with the new-built T-Shaped barge HYSY228 for the topsides with the weight of above 10,000 Te in one year. JZ9-3 CEPD Topsides floatover is the fifth success floatover using the T-shaped launch barge HYSY228 with a high-deck floatover scheme to install 10,500Te integrated topsides onto a pre-installed jacket standing at a water depth of 8.9 meters (with reference to Chart Datum) in northern Bohai Bay. Fig.1 shows the bow view of the T-Shaped floatover barge HYSY228 loaded with the JZ9-3 topsides arrives at the standby location.

Fig.1: Bow View of T-Shaped Floatover Barge HYSY228 Loaded with JZ9-3 Topsides Arriving at Standby Location.

This paper describes the mooring analysis of this challenging floatover standby condition performed to analyze mooring lines, buoys, and vertical clearance between mooring lines to existing subsea pipelines. The hydrodynamic program were used to calculate the hydrodynamic properties, which includes added-mass and damping coefficients, the 6-DOF wave exciting forces and moments and the mean wave drift forces. The calculated hydrodynamic coefficients were transformed into a database which can be used in the time domain simulation. The numerical findings of the time-domain simulations are used to properly define the limiting environmental conditions, the dynamic behavior of the floatover barge, the mooring lines tension, as well as the clearance between the mooring lines and the existing pipelines. Nonlinear time-domain simulations of mooring analyses were performed to investigate the maximum tension and their clearance to the existing pipelines, by studying with different mooring lines properties and surface buoy locations. The HMPE lines and the steel wires have been tested and made the recommendation for final operation.

ANALYSIS METHODOLOGY

Nonlinear time-domain simulations were performed to calculate the time series of motion responses for the selected design sea states. The hydrodynamics software WAMIT is used to analyze wave hydrodynamics for calculating the first-order motions, wave drift forces, wind and current force coefficients, as well as other hydrodynamic characteristics of the T-shaped barge for each given environmental condition. The linear hydrodynamic properties of the floatover barge are obtained by a three-dimensional panel model representing the geometry of the mean wet hull. It is also used to calculate the added mass, wave damping, linear wave forces and mean drift force for the float-over analysis. The calculated hydrodynamic coefficients calculated and transformed into a database so that installation analysis program can use the coefficients in the time domain simulation.