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Offloading Operability Analysis of Side-by-Side Moored LNG FPSO

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ABSTRACT

Dynamic load acting on side-by-side mooring system is one of key factors to estimate the offloading operability of the LNG FPSO. In this paper, a numerical mooring analysis for the side-by-side moored LNG FPSO is carried out.
As input data for mooring analysis, two-body motion responses are computed using a three-dimensional diffraction/radiation program. Wind and current loads including shielding effects are also applied to the mooring analysis. Results of the mooring analysis are validated by a comparison with another numerical program. In order to estimate the STS(ship to ship) offloading operability, dynamic loads acting on the side-by-side mooring system are calculated for two different mooring system configurations. Through the present study, it is found that the calculation results of two numerical programs are almost similar. The STS offloading operability is affected by the side-by-side mooring configuration.

KEY WORDS: LNG FPSO; STS offloading operability;
side-by-side mooring; two-body motion analysis; mooring analysis.

INTRODUCTION

As the demand of natural gas is increasing, a LNG-related offshore plant such as LNG FPSO(Floating Production Storage and offloading) and LNG FSRU(Floating Storage and Re-Gasification Unit) is receiving much attention these days. In case of the LNG-related offshore plant, a side-by-side offloading system is applied instead of a typical tandem offloading system.
The side-by-side moored vessels show different characteristics from the tandem moored vessels. Hydrodynamic interaction between the vessels is highly increased and it gives an effect on relative motion and drift forces due to their close proximity (Kim and Ha, 2002, 2003, Ha and Kim, 2004). The shielding effect on current and wind load is another important consideration (Yuck et al. 2007).
This paper presents a numerical investigation on the STS (ship-to-ship) offloading operability for the side-by-side moored LNG FPSO and LNG carrier. A two-body motion analysis is carried out by a three-dimensional hydrodynamic analysis program. In order to estimate the accurate offloading operability, dynamic load acting on the mooring system is computed considering motion responses of vessels and environmental load. Results of the mooring analysis are validated by a comparison with another mooring analysis program. Various environmental conditions and two mooring configurations are considered to investigate their effects on the offloading operability.

TWO-BODY MOTION ANALYSIS

As important input data for mooring analysis, motion responses are calculated for side-by-side moored LNG FPSO and LNG carrier. A commercial program, WADAM is used for the computation of motion responses.

Mathematical modeling

Figure 1 shows the right-hand coordinate system of the ship motion and wave heading angle. Three right-hand coordinate systems are considered in order to describe the motion responses of vessels. O-XYZ coordinate is the space fixed coordinate system. O_A-$X_AY_AZ_A$ and O_B-$X_BY_BZ_B$ are the body fixed coordinate system for ship A and B respectively. ξ_j describes 6-DOF motions of vessel A and B.

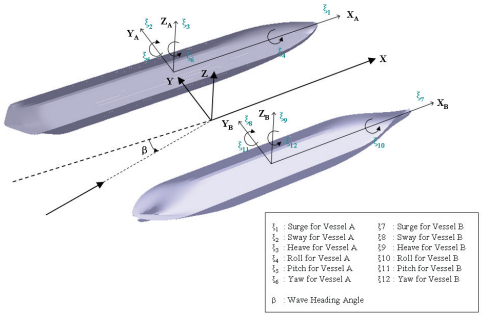

Fig. 1 Coordinate system of two-body motion analysis

Under the assumption that the motion responses are linear and harmonic, the linear coupled motion equation for two vessels can be expressed as the following equation.