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Vortex-Induced Motion of a Deep-Draft Semi-Submersible in Current and Waves

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ABSTRACT

A deep-draft semi-submersible (DDS) has better vertical motion characteristics than a conventional semi-submersible due to the smaller wave exciting forces on the pontoon structure, but elongated submerged column and enlarged projected area to current may induce larger in-line and transverse horizontal motions in current due to the increase of drag force and vortex-induced lift force. A seakeeping model test of a newly developed DDS is carried out to assess the global motion performance in wind, wave and current environments. Model test results showed that a DDS may experience significant vortex-induced motion (VIM) in the direction normal to the current, and its amplitude is strongly dependent not only on the current speed but also on the wave excited particle velocity.

KEY WORDS: DDS; Deep Draft Semi-submersible; VIM; Vortex-induced motion; Current

INTRODUCTION

Recently the effect of current environment on the behavior of offshore structures has been becoming an important design factor. For example, the strong loop current in the Gulf of Mexico delayed installation projects and resulted in the VIM of spar platforms, circular sectioned column structures with very deep draft.
The constant current load on the offshore structures is one of the main components in the operability of DP and mooring operations. Towing tests or wind tunnel tests can be carried out to determine these loads, but the results of these are not available in the early phases of the design and fast estimation methods for current loads are still to be developed.
The effect of VIM on single-column (spar-type) floating structures in strong currents has extensively been studied during the previous years (Dijk et. al., 2003). This research has recently been extended to the effect of VIM on multi-column structures (Rijken et al., 2004), such as DDSs and TLPs.
This research confirmed that VIM should be taken into account in the design process of these structures. MARIN's on-going JIP project "Current Affairs" is the example for the research effort on the VIM of multi column offshore structures.
In this paper, seakeeping model tests for a newly developed DDS are carried out in order to assess the global motion performance in wind, waves and current environments. During the tests, the DDS model experienced a VIM in strong current conditions. The measured results are analyzed and discussed in view of the vortex shedding and its effect on the VIM.

MODEL TEST

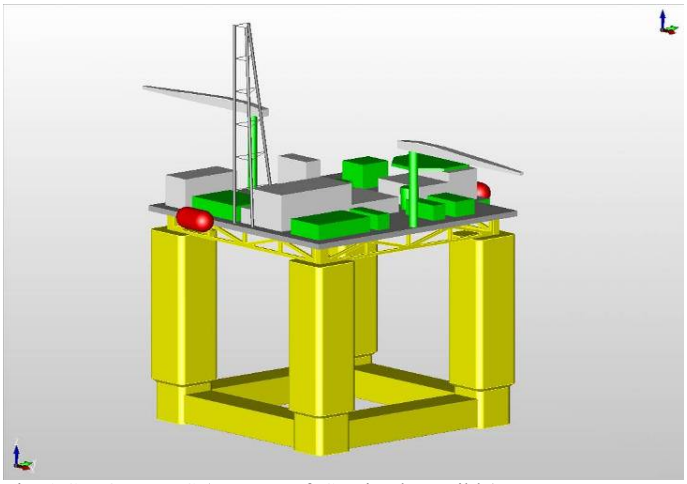

Fig. 1 *SHIOPT* DDS (Deep-Draft Semi-submersible)

Fig. 1 shows a 3D view of the DDS model, which is named as "*SHIOPT*." The model has deeper draft than a conventional semi-submersible, and is developed by Samsung Heavy Industry by using an automated hull optimization procedure based on Hull/Mooring/Riser coupled analysis. Table 1 shows the main data of *SHIOPT* DDS.

Seakeeping model tests are carried out with the scale ratio of 1:60 at the Ocean Engineering Basin in MOERI (Maritime and Ocean Engineering Research Institute, Korea).