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Experimental Investigations on a Non-ship Shaped FPSO Vessel

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ABSTRACT

Off late, nontraditional structures and concepts are being explored for use in offshore industry. Experiments were carried out on a 1:45 non-ship shaped FPSO model. The main objective of the model test was to study the response of the vessel (heave and pitch) under regular and random waves. The vessel was tested for three different mooring configurations. Tests were also conducted on models with and without damping plates. In the present paper, the effect of mooring configurations in the heave response of the FPSO and the effect of damping plates in the heave and pitch responses of the FPSO under regular waves have been presented. Salient features of the details of the experiments carried out are also included.

KEY WORDS: Non-ship shaped FPSO; Mooring; Turret mooring; Free vibration; Regular waves; Random waves; Heave response; Pitch response;

INTRODUCTION

Floating, Production, Storage and Offloading systems (FPSO) are increasingly competitive to the traditional deepwater production solutions, e.g., SPAR, TLP and semi submersible in the current offshore oil and gas environment. Traditional solutions do not have on-site storage and rely on transport of crude via pipelines, whereas FPSO with its in-house storage uses offloading of the crude oil to a shuttle tanker. It is a great benefit and truly a cost and time effective to use FPSO in remote areas when new oil is discovered. Some of the ship shaped FPSO have a turret buoy system. During inclement weather conditions the vessel is disconnected from the system and re-connected back during favorable weather conditions for production operations. These operations of disconnecting and reconnecting involve lots of time, and interrupts in the production of oil and gas.

Several researchers have studied the dynamic characteristics of ship shaped FPSO in winds and currents. Fernandes and Rossi (2005) studied the response of FPSO moored using linear spring lines and distorted polyester lines under regular and random waves. Guedes et al., (2005) conducted experiment to study six degrees of freedom motion, relative motion, and mooring forces and compared the experimental results with numerical results, obtained using Green's function panel method and strip theory program. Kim et al., (2005) studied the vessel, mooring, riser coupled dynamic analysis of turret moored FPSO. Morishita and Bolognani (2005) investigated the dynamic behavior of turret FPSO systematically by varying the wind speed and position of the turret. Wang et al., (2002) formulated a direct calculation approach for designing a ship shaped FPSO's bow against wave slamming load.

Today oil and gas industry is looking for environmentally challenging technologies for their large production fields in deep water as well as in arctic environment. In such situation need for an FPSO suitable for harsh environments and deepwater location arises. A new design of a non-ship shaped FPSO is being developed and studied which is suitable for these locations.

NON SHIP SHAPED FPSO VESSEL

A conventional ship shaped FPSO has several disadvantages, for example, operational and maintenance complexity, reduced structural strength due to large beam length, vertical bending moment in abnormal waves, unexpected motion for storm waves over 10 sec period. To overcome such disadvantages a nine sided polygon shaped FPSO vessel is proposed by Deepwater Structures Inc. (DSI), Houston, Texas. The vessel is designed in such a way that it performs well in winter storms in an arctic field and equally challenging North sea type environment in a deep water application. Currently different caisson type structures are used for oil and gas production in the arctic region namely, Tar suit caisson, Single Steel Drilling Caisson, Caisson Retained Island, Mobile Arctic Caisson Molikpaq etc. Salient features and measurement of ice loads on these structures can be found in the literature (Timco and Johnston, 2004; Wright and Timco, 2001; Cornett and Timco, 1998). Molikpaq is used for Sakhalin Russia project for oil and gas development and production in shallow water less than 40m as a fixed ice resistance vessel.

The vessel designed by DSI is arctic class vessel first of the kind in the state of the art of offshore technology designed with large storage over 1.2 million oil capacity and 25000 mt top side load capacity. It is designed innovatively to work in the ice-covered water as well in the open sea of clear water environment with large waves. The mooring