Design and Hydrodynamic Analysis of a New Concept of ETLP

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ABSTRACT

In this paper, a new concept of ETLP has been proposed. It is composed of four square columns and a ring pontoon which is consisted of four box beams. The new platform has lesser blocks and welds compared to ETLP, so it can be built at a lower cost and in a shorter construction period. Meanwhile, the pontoon extensions in the new platform is part of pontoons, therefore, the fatigue problem in the welds at the root of extensions in ETLP is solved. A hydrodynamic analysis is conducted to prove the structure’s dynamically stabilities. The results showed the new design has a reasonable hydrodynamic characteristic.

KEY WORDS: TLP; ETLP; structural design; hydrodynamic analysis; hydrodynamic characteristics

INTRODUCTION

With the depletion of onshore and offshore shallow water reserves, the exploration and production of oil is advancing into deep water and even ultra-deep water. Therefore continued developments of new types of structures are required in the offshore industry. Many floating structures have already been installed worldwide, such as Tension Leg Platforms (TLP), Spar, Float Production Storage and Offloading (FPSO) and Semi-submersibles. TLP is a kind of compliant type offshore platform, consisting of deck, hull and mooring system. The mooring system is consisted of vertical tendons (or tethers), which restrain the heave motion and make dry trees possible on a TLP (Subrata and Chakrabarti, 2005).

Since the early sixties, different designs of TLP have been developed. In the seventies, a one-third-scale version was designed, installed and tested in the sea through a joint industry project by Deep Oil Technology Inc. (DOT) (Kurian, Idichandy and Ganapathy, 1993). The first commercial application of this structure and the first dry tree completion from a floating platform, was the Conoco Hutton TLP installed in the UK sector of the North Sea in 1984(Mercier and Bliault, 1982) and the second (Jolliet TLWP) in the Gulf of Mexico 1989(Koon and Wybro, 2002). Since then, many novel structures have been developed, such as Moses MiniTLP, Seastar MiniTLP and Extended Tension Leg Platform (ETLP). Seastar is a small TLP with a single surface-piercing column and is a deepwater production and utility mini-platform (Kibbee, Leverette, Davies and Matten, 1999), like Chevron’s Typhoon MiniTLP (Young and Matten, 2002) in the Gulf of Mexico. Moses MiniTLP appears to be a miniaturized TLP as the deck structure is supported by four closely spaced columns and columns are connected by pontoons at the keel. Eight tethers, two at each pontoon extensions connected the unit to the seafloor (Koon and Wybro, 2002).

In design of TLP, one important challenge is to keep the nature period of heave and pitch below the range of significant wave period. Heave period may be reduced by increasing wall thickness of the pipes in tendons. And pitch period may be controlled by placing the tendons on a wide spacing to increase restoring effort. However, it may induce the deck structure with large spans. Therefore, the Extended Tension Leg Platform (ETLP) was introduced (Fig. 1). The ETLP is a variation of the conventional tension leg platform and consists of three or four columns, on a closer spacing than normal, connected underwater by pontoons and pontoon extensions (Huang, Bhat, Luo and Zou, 2002). The pontoon extensions move the tendon connection point outboard of the columns. The extensions effectively increase the restoring effect of the tendons while reducing the column spacing. This reduces the deck span between columns and thereby reduces deck structure steel weight. But the construction period may be increased due to building four more pontoon extensions and the relative welds, and fatigue damage and structural failure may be induced by the weld connection between extensions and columns.

A new ETLP is proposed in this paper, and it is composed of four columns and a ring pontoon which is consisted of four box beams. The new design has lesser blocks and welds compared to ETLP, so it can be built at a lower cost and in a shorter construction period. Meanwhile, the extensions in the new design are parts of the pontoons instead of welded to the columns as the ETLP. Therefore, the fatigue problem in the welds at the root of extended beam in ETLP will not be a consideration in the design. Afterwards, a hydrodynamic analysis is carried out to prove the structure’s dynamically stabilities. The results show the new concept of platform has a reasonable hydrodynamic characteristic.