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Frequency domain analysis of Froude-Krylov and diffraction forces on TLP

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Abstract. Tension Leg Platform (TLP) is a floating structure that consists of four columns with large diameter. The diffraction theory is used to calculate the wave force of floating structures with large dimensions (TLP). In this study, the diffraction and Froude-Krylov wave forces of TLP for surge, sway and heave motions and wave force moment for roll, pitch degrees of freedom in different wave periods and three wave approach angles have been investigated. From the numerical results, it can be concluded that the wave force for different wave approach angle is different. There are some humps and hollows in the curve of wave forces and moment in different wave periods (different wavelengths). When wave incidents with angle 0 degree, the moment of diffraction force for pitch in high wave periods (low frequencies) is dominant. The diffraction force for heave in low wave periods (high wave frequencies) is dominant. The phase difference between Froude-Krylov and diffraction forces is important to obtain total wave force.

Keywords: TLP; hydrodynamic; wave forces; diffraction; Froude-Krylov; phase difference

1. Introduction

TLP hull is similar to semisubmersible platform. Vertically small motions and high stability, low cost increases rate as increasing depth in comparison to other types of platforms, capability of production from deep seas are some advantages of TLPs. The disadvantages are: high cost subsea foundation installation, sensitive fatigue damage in tethers, tether connections repair and maintenance difficulty, low capacity storage tanks. There are important conceptual problems in dynamic analysis of such structures (Tabeshpour and Malayjerdi 2016).

The Morison equation is used to estimate the wave loads in the design of oil platforms and other offshore structures (Gudmestad *et al.* 1996, Veritas *et al.* 2005). This equation is used when the diameter of the cylinder is much smaller than the wavelength. If the diameter of the body is not small compared to the wavelength, diffraction effects have to be taken into account (Chaplin. 1984). Zeng *et al.* (2007) investigated 6-DOF coupled motions, time history of motions and wetted area, free surface and viscous drag effect and dynamic analysis of ISSC TLP in depth of 415 m in regular sea. Anitha *et al.* (2010) presented a new geometric configuration that could be a better

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Krylov forces and when the phase is low, higher total force is created.

When the wave approach angle is 45 degrees, the wave forces for surge and sway and the moment of wave force for roll and pitch motions are equal. When the wave approach angle is 90 degree, the wave force for sway is significant but for sway is insignificant. The Froude krylov and diffraction force for heave direction in three wave approach angles are approximately the same. The moment of Froude-Krylov force for roll and pitch is insignificant. The diffraction moment constitutes the greater portion of the total moment for roll and pitch.

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