Effect of Heave Motions of the Platform on the VIV of a Top Tensioned Riser

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Abstract: Vortex-induced vibration of marine risers has been paid much attention for many years. In the complex and changeable ocean environment with many influence factors, the riser exhibits complex dynamic characteristics, which has a great impact on the safety production leading to huge economic losses and environment disasters. Among all the factors, the effect of heave motions of the top platform cannot be ignored.

This paper presents a numerical study of VIV of top-tensioned risers under the effect of heave motions of the platform through viv-FOAM-SJTU, an original solver developed by our team based on OpenFOAM. Strip theory is used to calculate the fluid field. The influence of heave motions is reflected on continuous change of top tension, which can mainly be reflected on the amplitude and frequency. The superposition of time-varying top tension and VIV increases the dynamic response of risers.

In this paper, heave motions of the platform are assumed to be simple harmonic and the variation of axial force because of gravity along the riser is under consideration. Firstly, the top tension varies at different amplitudes with fixed frequency twice of first order natural frequency and then different frequencies with fixed amplitude are studied, analyzing the effect of heave motions. Results show that heave motions of the platform exacerbate responses of the riser. Under the selected conditions, the amplitude of vibration increases in larger heave amplitude. Bending stresses has larger influence on the lower part of the riser than the upper segment. Frequency of heave motions have large effect on the VIV of the riser, especially under low velocity flows.

Key Words: Vortex-Induced Vibration, Heave Motions of the Platform, OpenFOAM, viv-FOAM-SJTU