Numerical Study of Effect of KC Number on the Vortex-Induced Vibration of a Flexible Riser in the Oscillatory Flow

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Abstract

In offshore oil and gas drilling, relative oscillatory flow is generated between the platform and the riser by the effect of wind, waves and currents. The riser in the deep-water not only bears the weight and the top tension, but its amplitude increases obviously when the vortex shedding frequency is close to the natural frequency of the riser which does harm to the safety of the platform. So the study of Vortex-induced vibration (VIV) of an isolated riser in relative oscillatory flow is necessary to prevent the fatigue damage of the platform structure.

In this paper, numerical simulations are carried out by our in-house CFD code viv-FOAM-SJTU, which is developed based on the open source code OpenFOAM. The strip theory and the Reynolds Averaged Navier-Stokes(RANS) equations are used to analyze the flow field. The Bernoulli-Euler beam theory with the FEM method is used to obtain the structural dynamics response. The oscillatory flow is simulated by forced excitation added at both ends. To achieve the fluid-structure interaction, interpolation module is developed to transmit data between the fluid and structure model.

In this paper, numerical simulation of a flexible riser is carried out at first. Results are compared with the model test to verify the validity of the solver. Then, cases with different motion amplitudes and the same KC number are presented. Diameters of the cylinder change to assure the same KC number. Mechanism of the vibration are articulated through modal decomposition and wavelet transformation. Finally, cases with different KC number with the same motion amplitudes are simulated to explain the effect of KC number in the VIV of the riser in the oscillatory flow. Typical characteristics of the vibration are observed including the modal transition and the “build-up-lock-in-die-out” process.

Keyword: *VIV, Strip theory, viv-FOAMO-SJTU solver, Riser*