

821. Study on analysis method for deepwater TTR coupled vibration of parameter vibration and vortex-induced vibration

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(Received 13 April 2012; accepted 4 September 2012)

Abstract. Considering the vertical vibration, caused by floating platform, of top tensioned riser (TTR), an analysis method for the coupled vibration of parameter excited vibration and vortex-induced vibration is presented in this paper. With the section rotation and shear deformation due to the bending large displacement of TTR, a coupled vibration model of parameter excited vibration and vortex-induced vibration is put forward. And the vortex-induced vibration (VIV) of a TTR for 1500 m water depth is analyzed based on the model. The results show that the vertical vibration caused by floating platform increases transverse vibration displacement of TTR.

Keywords: deepwater riser, TTR, vortex-induced vibration (VIV), fluid-structure interaction, parameter excited vibration.

1. Introduction

Riser system is the main constituent of ocean infrastructure, and its safety becomes more and more important. However, with the depth increasing, the design analysis of riser system faces great challenges. Now long flexible deepwater riser vortex-induced models can be divided into: empirical models, mixed models and CFD models. A complete description is conducted [1]. Hartlen and Currie [2] originally established vortex-induced transverse vibrations model and wake oscillator model. After them, many scholars have it amended and improved. For example, Skop-Griffin model, Iwan-Blevins model, Landl model, Iwan wake oscillator model, Skop-Griffin wake oscillator model, Krent-Nielsen two oscillator model and so on.

The development of computer provides favorable conditions for the research and application of CFD, and makes the numerical method be widely used [3, 4]. The emphasis on vortex-induced vibration of deepwater riser with two degrees of freedom (in-line and cross flow) is increasing [5]. When transverse bending vibration happened under wave load, the vertical vibration caused by floating platform does not only affect the vertical parametrically excited vibrations, but also affect the transverse bending vibration, thus there is a coupled vibration of parameter excited vibration and vortex-induced vibration.

2. Mathematical model

Long flexible deepwater riser will have parameter excited vibration caused by floating platform heave [6], so when analysis the dynamical response of deepwater riser, not only consider the transverse excitation, but also consider axial excitation, because axial excitation caused by floating platform heave increases transverse vibration amplitude of deepwater riser. Fig. 1 displays the principle of parameter excited vibration and D_1 , D_2 denote transverse load and axial load.

Existing deepwater riser bending vibration analysis methods generally doesn't consider transverse displacement caused by vertical displacement; only calculate the bending