ABSTRACT

Model Test is an important step to verify the numerical prediction of global responses of offshore structures, and a lot of research has been conducted in the testing of deepwater platforms in existing basins with dimensional constraints. This paper presents the work on the model testing of a deepwater FPSO in the new basin (50m×30m×10m) recently being completed in Harbin engineering university. The FPSO is turret moored by 12 anchoring legs in 914m water depth. Research on mooring line and riser truncation method has been carried out by repeating the tests of the FPSO responses in 10m, 7m and 5m basin depths. The truncation methods and schemes are proposed for these corresponding basin depths, and the numerical simulation results are compared with the test results in the full depth (non-truncated) testing results. It is found that both the static characteristics and the global responses calculated through the time-domain coupled analysis agree well with the prototype water depth results. The model test design and truncation methods proposed in this paper are proven to be reliable.

KEY WORDS: Model test technology; internal turret FPSO; equivalent water depth truncation; global response.

INTRODUCTION

Model test of offshore structures in ocean basins is an important means to check the initial designs of floating structures, and it can reveal phenomenon that cannot be observed in the theoretical analysis. However, with the increasing demand for energy, the offshore oil exploration and production are extending to greater water depth. Most of the existing ocean basins can not simulate the entire mooring system in a reasonable test scale. The hybrid model testing is a popular method and is also recognized as an effective method. The procedure of this method is: equivalent truncation to mooring lines and risers, model tests of the truncated system, and finally numerically extrapolate to derive the full depth results. The truncation technique is the key to ensure the success of the whole model tests. The truncation scheme is restricted by the vessel type and size, the components and characteristics of mooring line, top pretension, truncation factor, etc. “Trial and error”, empirical formula and optimization design are commonly used at present, but further truncation research is still needed to adapt to different kinds of platform and their mooring/riser systems, especially when the truncation factor is small.

Although model testing is important, it is usually conducted alongside the numerical simulation as the latter is a convenient and efficient tool to design and analyze all kinds of cases and predict the results prior to the model test and even post process after model tests. The coupled dynamic analysis of floating structure and their mooring/riser in time domain is the relatively accurate analytical method at present, but it is also complex and time consuming, and uncertainties still exist which may affect the accuracy of the analysis, such as how the coupling is modeled, how the large elongation of mooring line and riser is handled, and how the wave drift force and system damping are calculated. Apart from the coupled time domain simulations, frequency domain, non-coupled or semi coupled analysis, and quasi-static method for mooring tension, are still acceptable for many cases, it depends on the types of structures, design conditions and requirements experience of analysts. In view of the diversified analysis methods, further investigations are required in order to identify the efficient and accurate analysis tools.

A number of model tests for an internal turret FPSO will be carried out in Harbin Engineering University in its wave basin 50m x 30m x 10m. The model will be made to a scale of 1:92 which can satisfy the designed water depth 914m. The water depth will also be reduced to 644m and 460m respectively for calibration and validation of the equivalent truncation designs of FPSO mooring/riser system. A series of numerical simulations are conducted for the full water depth and truncated depth before model tests. The AQWA program is selected for the FPSO hydrodynamic radiation/diffraction and time domain coupled analysis, and the mooring tensions are calculated quasi-statically. The risers are simplified to lessen the operating difficulties of model tests. The truncation method and formulas for main parameters of mooring lines and risers are proposed. The static characteristics are maintained in the truncated system, the global response and mooring tensions are