EXPERIMENTAL INVESTIGATION ON WAVE RUN-UP CHARACTERISTICS ALONG COLUMNS AND AIR GAP RESPONSE OF SEMI-SUBMERSIBLE PLATFORM

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Abstract: This article mainly concentrates on a large-volume drilling semi-submersible platform, aiming to reveal wave run-up characteristics along square columns and give the relationship between air gap distributions and wave parameters. The tests with fixed model were conducted firstly on its encountering a series of monochromatic waves. A wide range of wave slope ($H/L$) were selected to investigate the air gap response in detail. As can be seen, larger wave steepness will generally cause smaller air gap in the same wave period, which indicates nonlinear effects of incoming wave can amplify wave elevation. Model tests with mooring condition were also conducted in the same wave conditions. As was expected, the maximum relative wave elevation reduces obviously compared with the fixed one. However, wave shape close to columns show higher harmonic characteristics due to interaction between waves and the columns of semi-submersible platform. Meaningful conclusions from the model tests are drawn in this article, which is helpful in air gap design of floating offshore platform to a certain extent. In addition, the experimental results will provide an important reference for further research on validation and update of theoretical models of air gap.

key words: wave run-up, air gap, diffraction-radiation effects, wave steepness

Introduction

With the exploration and production activities of oil and gas resources moving into the deep water, many new types of floating structures such as semi-submersible, TLP and spar platforms have been developed. A hot topic in designing these platforms is how to determine the calm water deck clearance in order to avoid serious wave-deck impacts, even in harsh environments. For traditional design concept in floating structures it is used to neglecting any deck slamming through increasing initial air gap which is defined to be the vertical distance between still water surface and under-deck of platforms. However, an unnecessary increase in air gap will considerably affect structure stability and project cost. Moreover, it is believed that allowing wave impacts on some places is more sensible from overall consideration than avoiding any wave hitting the deck[1]. So it is extremely important to predict air gap response of platforms precisely for the purpose of increasing local intensity of the deck places which withstand wave impact due to negative air gap[2].

For slender platforms such as jackets, due to small perturbation to incident waves, air gap can normally be estimated by linear theory. Air gap prediction is relatively difficult for gravity platforms because of the significant diffraction effects which is always associated with large volume[3].

For floating structures of large volume such as column-based platforms, the motion of platform and local wave crest amplification due to nonlinear interaction among columns can even increase complexity of prediction[4]. In addition, wave climbs up along columns will affect the air-gap response, especially in steep waves. However, wave run-up generally associated with some phenomena, such as wave impacts, green water, wave deformation, rolling, spray, etc., always shows highly nonlinear characteristics and difficult to predict through current theories.

Several authors have investigated wave run-up...