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SPECTRAL ANALYSIS OF RANDOM WAVE UPLIFT FORCE ON A HORIZONTAL DECK *

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Abstract: This article presents a spectral analysis of wave uplift loads on a horizontal deck. The wave uplift force spectrum on the underside of the deck is obtained. It is shown that the wave uplift force spectral density decreases with the increase of the relative clearance $\Delta h / H_{1/3}$. The influences of different incident wave parameters, including the relative wave height $H_{1/3} / d$, the relative deck width B / L_s and the relative clearance $\Delta h / H_{1/3}$ on the dimensionless zeroth spectral moment of the uplift forces are discussed. It is found that the zeroth spectral moment of the uplift forces increases with the increase of the relative wave height $H_{1/3} / d$, and decreases with the increase of the relative clearance $\Delta h / H_{1/3}$. A new dimensionless prediction model for the zeroth spectral moment of wave uplift loads on the deck is proposed and the relationship between the wave uplift forces and the zeroth spectral moment of the uplift force are obtained.

Key words: spectral analysis, wave uplift force, spectral moment

Introduction

With the rapid development of coastal and ocean resource exploitations, more and more open structures were constructed, such as piled wharfs, offshore platforms, and offshore trestle bridges, etc., usually in open sea areas and without any protection, which would be subject to damages by large wave uplift forces. To protect against such damages, an accurate determination of wave uplift forces under various wave conditions is of significance.

In recent years, much effort has been made to study the wave uplift force through experimental and numerical methods. Laboratory experiments were carried out to estimate the wave uplift force. Ren and Wang[1-4] carried out laboratory experiments to study the wave slamming on a plate in the splash zone in the wave flume. Ren et al.[5] investigated the transient properties of the flow field of the wave slamming on the superstructure of a open structure and obtained the instantaneous velocity field of wave impacting using PIV system. Zhou et al.[6,7] and Chen et al.[8] investigated the wave uplift force on the deck and derived a formula based on the experimental data. Cuomo et al.[9,10] applied the wavelet method to filter out corruptions from the dynamic response of the model setup and to distinguish the impulsive and quasi-static wave loads, provided an insight on the dynamics of the wave load on coastal bridges and discussed the effect of opening in deck through experiments. Because the wave impact involves extremely complicated phemonena with strong non-linear interactions of waves, instantaneous effect, fluid viscosity and turbulence, the progress in this field is not satisfactory.

With the rapid development of computers and computational fluid dynamics, the numerical models based on the Navier-Stokes equations have become popular in the studies of wave impact loads. Ren and Wang[11,12] and Li et al.[13] investigated a numerical wave tank based on improved VOF method to study

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