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Wave endurance time: A new concept for structural assessment under extreme waves

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Abstract

The wave endurance time method is a novel dynamic approach to conveniently estimate structural performance under various extreme wave conditions. In this method, offshore structures are subjected to a gradually intensifying sea surface profile called wave function, and their performance is assessed in different sea state conditions by a single time history analysis. From a wave endurance time analysis perspective, structural behavior is judged based on the maximum time duration that a structure can withstand the wave function. In this study, a description of the wave endurance time concept is presented, and generation of the initial type of wave functions is thoroughly addressed. In addition, the evaluation of a simplified model of a realistic jacket platform under extreme wave conditions is viewed through the lens of a wave endurance time study. The accuracy of this approach is investigated by a comparative study between the wave endurance time approach and typical 3-h time history analyses. The results indicate that the wave endurance time approach is capable of estimating the results of 3-h simulations with acceptable accuracy and less computational effort.

Keywords

Wave endurance time, wave function, extreme waves, assessment, jacket platforms

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Introduction

The successful design of an offshore structure requires reliable estimation of structural response against environmental loads. As usual, among different metocean loading, wave loads play a key role in the design procedure of offshore platforms. In reality, waves are inherently irregular and complex phenomena, so for practical applications, research has progressively striven toward a convenient and reliable estimation of the sea surface.[1–4] The proposed methods are generally time history–based approaches and try to present a reliable and time-saving way for simulation of sea states.

Pushover, spectral, and time history analysis are three approaches recommended for wave analysis in typical standard codes,[5,6] and each of these approaches has its own advantages and drawbacks. Among them, time domain is the most accurate method to obtain statistics of the extreme response, especially in severe storms.[7] However, simulation of the time history procedure is conceptually time-consuming, especially when different excitation levels are taken into account. In this regard, several forms of the time history approach have recently emerged to more thoroughly estimate structural performance in various sea states.[8–10] Assessment in various excitation levels is not a mandatory requirement in the standards and these methods have so far been developed in the scientific research. One of the reasons is the computational burden of such methods. In these methods, separated time history records of special sea states are joined together to form a single record. In other words, more excitation levels give a longer time history record. Because of the extra time involved, practical engineers do not like to utilize these methods in routine applications.

The goal of this investigation is to introduce a novel time history–based approach that is computationally

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