Statistics of Second-Order Stokes Waves and of their Extremes

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In safety analysis of offshore structures and vessels there are mainly two types of problems that have to be considered: the estimation of the probability of exceedance of a critical level, and the estimation of the variability of the stresses that causes fatigue. Most of the research has been carried out under the assumption that both the wave loads and the responses of the offshore structures are Gaussian processes. However, the statistical analysis of real sea data shows that the high and steep waves deviate from this assumption. Moreover, it is well known that most of the offshores structures are non-linear systems, therefore the response process is also non-Gaussian.

This work deals mainly with the non-linear process of the second-order description of the sea, Stokes waves. We apply Rice's formula in order to estimate the mean up-crossing intensities of different sea levels. The numerically computed intensities can then be used to compute the probability of exceedence of extreme levels, and to determine approximately the distributions of the characteristic wave parameters of the non-Gaussian sea. The results are compared with simulations and some real data sets.

Finally, some other applications of the method are discussed. For example, the processes under study could represent the response of a linear structure subjected to a Gaussian wind velocity or the response of a floating offshore platform in a random sea.