I-475 STOCHASTIC RESPONSE OF OFFSHORE STRUCTURES TO SEA WAVE EXCITATIONS

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INTRODUCTION: The analysis and design of offshore structures is a complicated process and requires several assumptions and approximations. Empirical models such as the Morison equation for the wave force involve several coefficients which have to be determined by experiments or field observations and must be extrapolated to a particular problem. To minimize the computer time and to obtain a reasonably accurate result, simplified discriptions of the complex mechanisms of ocean environment are usually assumed. This paper is devoted to investigations on the effects of those simplified descriptions on response evaluations. Parametric studies based on the perturbation method are presented to assesss the influence of the uncertainties associated with the various assumptions and formulations of response analysis method.

RESPONSE ANALYSIS METHOD: The following parameters are considered for the study: (i) Inertia coefficient C_M, (ii) Drag coefficient C_D, (iii) Mean wave height $\overline{H}$ and (iv) Shear wave velocity in the subsoil V_s. Using perturbation technique, each of the wave force parameters is separated into two parts, one containing a constant value and a second part with randomly varying value. The constant value is equal to the mean value of the parameter whereas the randomly varying part has a zero-mean. The equations of motion are obtained by the substructure method and the response analysis is carried out using the frequency-domain random vibration approach.

NUMERICAL RESULTS AND DISCUSSIONS: An offshore tower shown in Fig.1 is considered as the numerical example. Fig.2 shows the rms response displacement at node 1 for constant values of the wave force parameters with C_M=2, C_D=1, $\overline{H}$=3m or 7m and V_s=100m/sec. The inertia and drag components of this response are shown in Fig.3.

Figs. 4 to 9 show the random variable effects of wave force parameters on the response with C_M=2, C_D=1 and V_s=100m/sec. It is seen that, in general, the variations in the response increase with the increase in the randomness of wave force parameters. Among all the parameters considered in the present study, variations in the wave height provide most significant contributions to the response. The random variable effects of the inertia coefficient are larger for smaller wave heights and shorter wave periods whereas random variable effects of the drag coefficient become dominant for larger wave heights and longer wave periods.

The random variable effects of shear wave velocity in the soil are larger when the mean wave period is nearer to the fundamental period of the structure. When the mean wave period and the fundamental period of the structure are well-separated, the structural responses are less influenced by the fluctuations in the shear wave velocity because the soil-structure interaction effects are small.

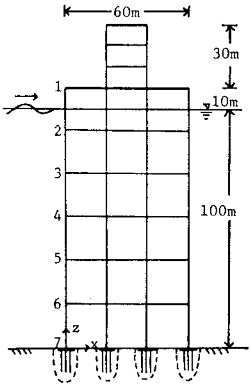

Fig.1 Offshore tower model

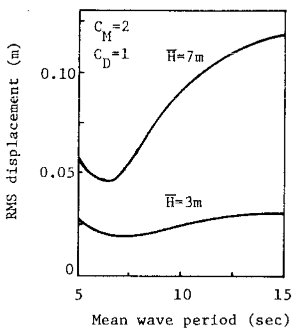

Fig.2 RMS displacement at node 1

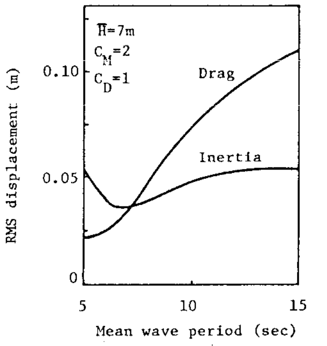

Fig.3 Inertia and Drag components of the response

$\frac{\delta\sigma_x}{\sigma_x} = \frac{\text{random response contribution}}{\text{total response}}$

ϵ^2 = Variance of randomly varying part of ··

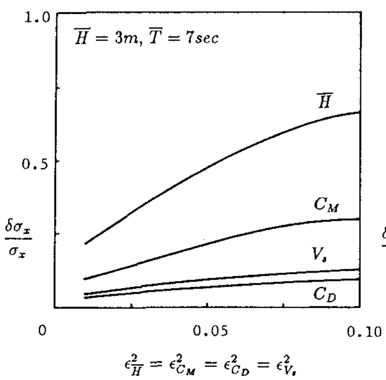

Fig.4 Random variable effects of wave force parameters

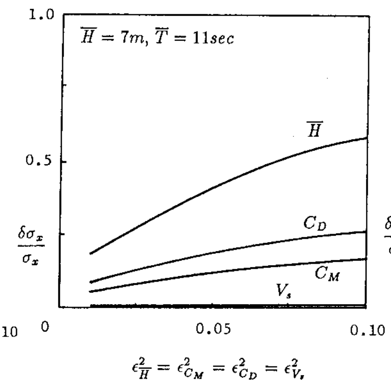

Fig.5 Random variable effects of wave force parameters

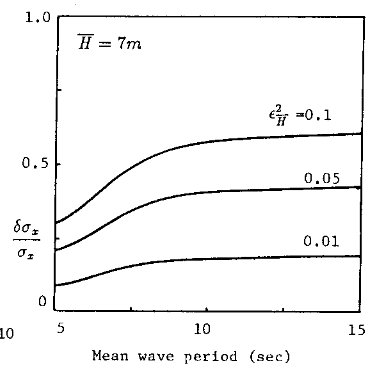

Fig.6 Random variable effects of $\overline{H}$

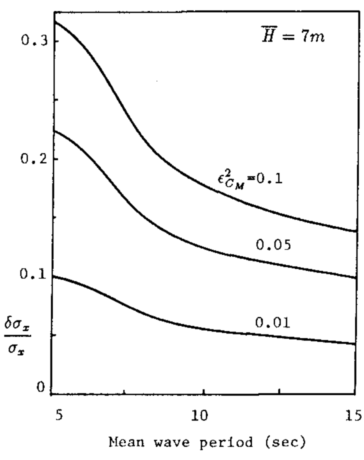

Fig.7 Random variable effects of C_M

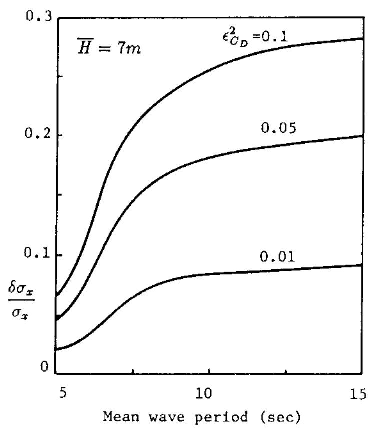

Fig.8 Random variable effects of C_D

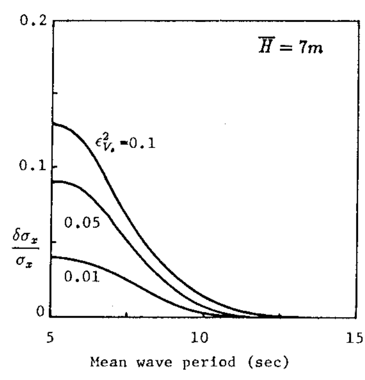

Fig.9 Random variable effects of V_s