I-512 **SEISMIC RESPONSE OF OFFSHORE PLATFORMS IN RANDOM SEAS**

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INTRODUCTION: Dynamic response of offshore platforms simultaneously subjected to random sea waves and strong earthquake motions is investigated. Effects of sea waves on seismic response computations are clarified. Response quantities are compared by employing the principles of first-passage probabilities across specific barriers.

RESPONSE ANALYSIS METHOD: Fig.1 shows the elevation of an offshore platform model resting on pile-soil foundation. The main members have an outer diameter of 2.8m. Random sea waves are represented by Bretschneider's wave energy spectrum and Morison equation is used to define the wave forcing function. Earthquake ground motions are modelled stochastically using Tajimi-Kanai power spectrum for stationary conditions. Response analysis is carried out using frequency-domain random vibration approach. The equation of motion is derived by the substructure method for simultaneous loadings due to sea waves and earthquake motions and is expressed as:

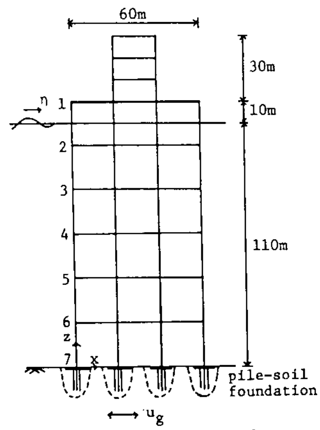

Fig.1 Analytical model of structure-pile-soil system

$$[M+C_A]\{\ddot{u}\} + [C+C_D]\{\dot{u}\} + [K]\{u\} = [P]_{wave} + [P]_{earthquake}$$

$$\text{where} \quad [C_D] = [\rho C_d A\sqrt{\tfrac{8}{\pi}}\sigma_r], \quad r = \dot{u}_{wave} - \dot{u}_{structure}$$

in which $[C_A]$ is the added mass term, $[C_D]$ is the linearized damping term and σ_r is the rms value of the relative velocity between the wave and the structure. $[C_D]$ is obtained by an iterative procedure.

RESULTS AND DISCUSSIONS: The values of natural periods for first vibration mode are 2.83sec for rigidly supported base condition and 3.90sec for soil-structure interaction condition. Figs.2 and 3 show the rms response displacement at node 1 considering soil-structure interaction condition for: i) only wave loadings, ii) only earthquake loadings, and iii) simultaneous wave and earthquake loadings. The rms displacement is plotted against rms ground acceleration $\sigma_{\ddot{u}_g}$ in Fig.2 and against mean wave period $\bar{T}$ in Fig.3. In the absence of sea waves, damping forces, which are proportional to the structural velocities, are relatively small. On the other hand, if damping effects by sea waves are considered, damping forces are now proportional to the relative velocities between the wave and the structure. Since the wave velocities are very much higher than the structural velocities, damping forces become larger than those without waves. Therefore, earthquake responses diminish if the hydrodynamic damping effects of sea waves are included. It is interesting to note that in typical cases of combinations of sea waves of small wave heights and earthquakes of moderate to severe intensities, wherein earthquake responses are very much higher than the wave responses, the combined wave and earthquake responses may be even smaller than considering earthquakes alone.

The reliabilities on the first passage are presented in Figs.4 and 5 for the soil-structure interaction condition. The duration time t_0 is expressed in terms of the first natural period T_0 of the structure-pile-soil system. Since, the wave motion has the duration time of a few hours, reliable displacement can be evaluated for a large value of peak factor. On the other hand, the corresponding displacement may be caused by very severe earthquakes because earthquake ground motion has comparitively short duration time of less than a few minutes. Therefore, the reliabilities of seismic responses are higher than those of the wave responses for the numerical examples of this study. Further, reliabilities of seismic responses are higher when the effects of sea waves are included.

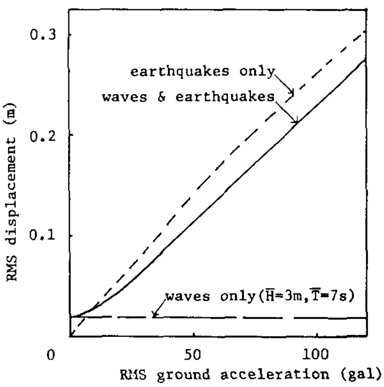

Fig.2 RMS displacement at node 1

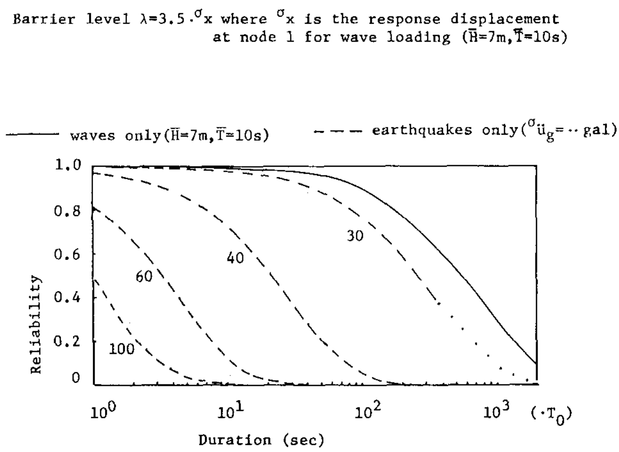

Fig. 4 Reliability of wave and earthquake loadings

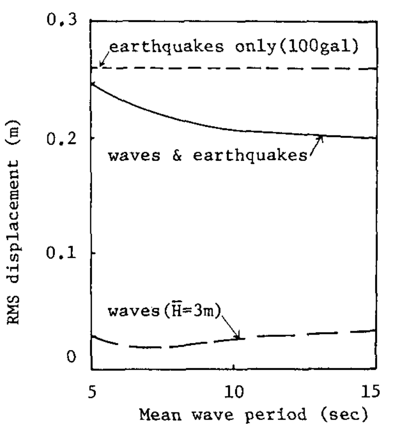

Fig.3 RMS displacement at node 1

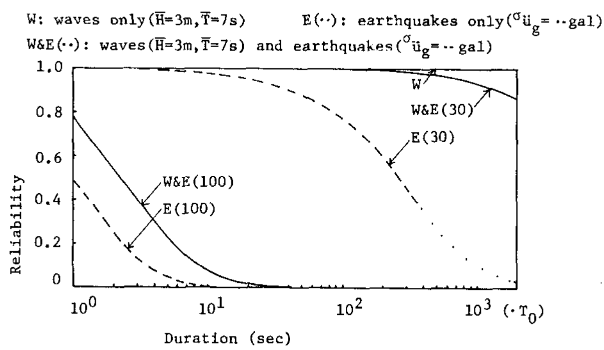

Fig.5 Reliability of wave and earthquake loadings