SEISMIC ANALYSIS OF A FLOATING NUCLEAR PLANT

J.S. SHULMAN, R.S. ORR

Structural Engineering, Offshore Power Systems,
8000 Arlington Expressway, Jacksonville, Florida 32211, U.S.A.

SUMMARY

The purpose of this paper is to present the results of analytical and experimental investigations that have been conducted by and for Offshore Power Systems for the prediction of the vertical seismic response of a Floating Nuclear Plant (FNP).

The vertical seismic analysis of a Floating Nuclear Plant is complicated by the following unique aspects of the problem:

1. The presence of water in the region between the seabed and the bottom shell of the FNP platform.
2. The nonhomogeneous, nonrigid stiffness characteristics of the platform structural assembly.
3. The three-dimensional, nonuniform stiffness and mass characteristics of the nuclear plant structures attached to the top deck of the FNP platform and the resulting coupled stiffness effects.

Initial efforts were concentrated on a two-dimensional representation of the water-structure dynamic system. A two-dimensional "fluid finite element" representation was established by the judicious manipulation of material properties for existing two-dimensional plane strain isoparametric finite elements. Verification of the acceptability of the "fluid finite element" was accomplished by direct comparison of the finite element solution with those obtained by closed form methods. The platform structure, in terms of its mass and stiffness, was represented by what was considered to be an optimum two-dimensional representation. The investigation of "fluid finite element" mesh refinement requirements are reported. The effects of superstructure flexibility on the total FNP response were investigated.

Results of the two-dimensional analyses indicated the need for a three-dimensional investigation; however, certain conclusions drawn during the two-dimensional efforts were utilized in their allowance for simplifying assumptions in the three-dimensional work. The three-dimensional vertical seismic analysis required the verification of a three-dimensional "fluid-finite element" similar to that discussed previously for the two-dimensional treatment. At that point, the analysis effort was augmented by dynamic test results, serving both as verification of the analytical representation of the fluid-structure interface and as a means for estimating fluid-structure system damping characteristics for incorporation in the FNP three-dimensional analysis.

The three-dimensional analysis involved the application of the dynamic substructuring technique for obtaining the reduced mass and stiffness matrices used to represent the complete dynamic system, consisting of water, platform and superstructure. The effect of variation in water depth is illustrated by means of comparative response spectra.

The results of the three-dimensional analyses are presented, by means of floor response spectra at the top deck of the platform, together with a summary of the simplifying assumptions involved and their justification.