A STUDY OF BOUNDARY EFFECTS IN THE ANALYSIS OF NUCLEAR POWER PLANT STRUCTURES

by

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This paper is concerned with the selection of a suitable finite element mesh of the soil medium for the analysis of a nuclear power plant structure including soil/structure interaction effects. In general, if the criterion free-field input motion is propagated in the soil model alone (without the presence of structures), the response motion at the structure foundation level may be quite different from the input motion, due to the inadequacies of the finite element model. Therefore, it is essential that the finite element model selected should assure that the response spectra at the foundation level, when the structure is not present, should envelop the input criteria spectra.

It is well known that finite element analyses of wave propagation problems must take into account the potential distortion of the response due to signals reflected from the fictitious side and bottom boundaries of the mesh. These distortions can be eliminated by locating the boundaries sufficiently far from the region of interest within the mesh that no signal reflected from the boundary reaches this region within the time frame of the problem. However, this approach is typically impractical because of the very large mesh that would be required. An alternative approach, one that is approximate but far more practical in terms of computer costs, uses special boundary conditions to absorb the signal that would otherwise be reflected into the interior of the grid.

To carry out this investigation, 2 two-dimensional finite element models of a power plant site were considered. The power plant is founded on a rock site, located in southern U.S.A. The seismic motion, consisting of the vertical component and a horizontal component of the Castaic (1971) record, was applied along the left side of each finite element mesh. The energy-absorbing boundary[III] was used along the right side of the two finite element models, while the bottom boundary of one was free (Case 1) and the other had the energy-absorbing mechanism (Case 2). The finite element meshes for the two cases were otherwise identical. Both had a length of about 1100 ft (335m) and a depth of approximately 800 ft (244m), whereas the power plant foundation had a length of about 500 ft (153m) and was embedded about 100 ft (30m) below the ground surface. All the analyses used the step-by-step integration option of a general finite element computer program.

The results from this investigation indicated that the energy-absorbing boundary at the base (Case 2) not only absorbed the energy of waves impinging on this boundary but also removed the energy of seismic waves propagating horizontally in this region. The response motions for Case 1, with the free boundary at the base, underwent fewer distortions than those from Case 2.[IV] Also, in Case 2 the response spectra at the foundation level enveloped the criteria spectra. The study also indicated that for a rock site, the depth of the finite element mesh should be made as great as possible, preferably more than two thirds of the length of the mesh, and that its boundary should be left free.

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IV *Use of Finite Element Techniques to Analyze Effect of Inclined Rock Strata on Site Response*, TOP-AA109, Agbabian Associates, El Segundo, CA, Mar. 1976.