EFFECTS OF FOUNDATION EMBEDMENT ON SOIL-STRUCTURE INTERACTION

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SUMMARY

The response to seismic excitation of a three-dimensional rigid hemispherical foundation embedded in a homogeneous elastic half-space is analyzed. The results from exact series solutions of the mixed boundary value problem are compared with those of a circular flat disc foundation. This shows that the embedment has a marked influence on foundation response. For incident P, SV and SH waves, scattering due to the embedment reduces the foundation translational motion at high frequencies, but leads to large rocking and torsional motions.

THE ANALYSIS

The three-dimensional model studied in this paper consists of an elastic half-space in which a hemisphere of radius a is placed to represent a rigid foundation [1]. For a rigid foundation in an elastic medium, a decomposition method for analyzing its response is used. In this approach, the complete solution is obtained from the solutions of two distinct independent problems. The first problem corresponds to the determination of the impedance matrix, $[K_S]$, whose elements are the restraining forces due to the motion of the rigid foundation. The second problem is the evaluation of the driving forces from the scattering of seismic waves by the fixed foundation. The details of the analyses and the calculations of the responses have been presented by the author elsewhere [1].

THE RESULTS

Figs. 1 and 2 give the dimensionless stiffness and damping coefficients associated with the real and imaginary parts of $[K_S]$ for dimensionless frequencies $\eta = \omega a/\pi\beta$. All symbols used in the figures are as defined in [1]. The coefficients shown exhibit similar frequency dependence with those of a circular disc foundation [2], but are larger in magnitude. A finite element approximation of those coefficients [3] appears as dashed lines in the figures.

The excitations of the half-space consist of plane P, SV and SH waves. The incident P and SV waves excite vertical, horizontal translations and rocking at the center of the foundation, while the incident SH waves excite torsion, horizontal translation and rocking. Figs. 3 and 4 give the dimensionless amplitudes of foundation motion of the hemisphere and disc for incident P waves at angles of incidence $\gamma = 30°$ and $60°$. The translational responses of the disc decrease only slightly with increasing frequency from the free-field motion, while those of the hemisphere decrease faster, as a result

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of embedment. As shown in Figs. 1 and 2, the coupling impedance coefficients for the hemisphere are comparable in magnitude to the diagonal coefficients, which are larger in magnitude than the corresponding coefficients of the disc. This results in the rocking of the hemisphere being smaller than that of the disc, but still significant when compared with the corresponding translational motion.

Figs. 5 and 6 give the dimensionless amplitudes for incident SV waves at angles of incidence $\delta = 0°$ and $60°$. For vertical incidence ($\delta=0°$), there is no vertical translation for both the disc and the hemisphere. For the disc, only the horizontal translation motion is present and there is no rocking. For the hemispherical foundation, the embedment reduces the horizontal motion with increasing frequency, but the coupling introduces a significant component of rocking. Fig. 7 and 8 give the amplitude for incident SH waves at angles of incidence $\delta = 30°$ and $85°$. Similar conclusions can be drawn.

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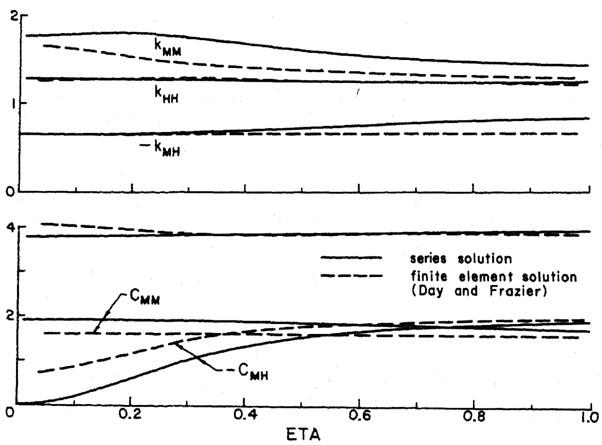


Fig. 1

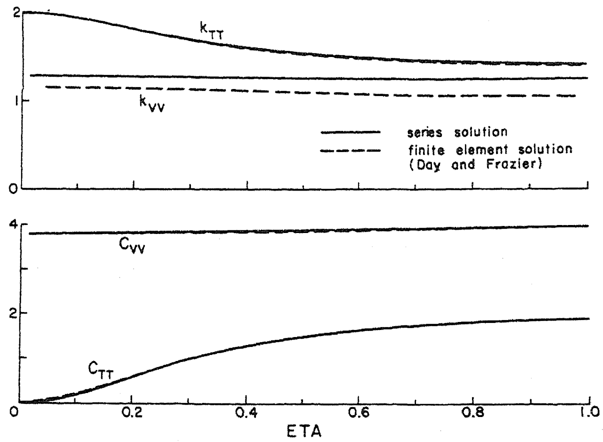


Fig. 2

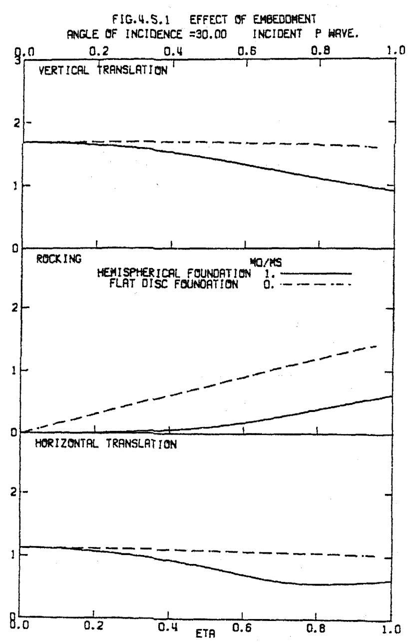


Fig. 3

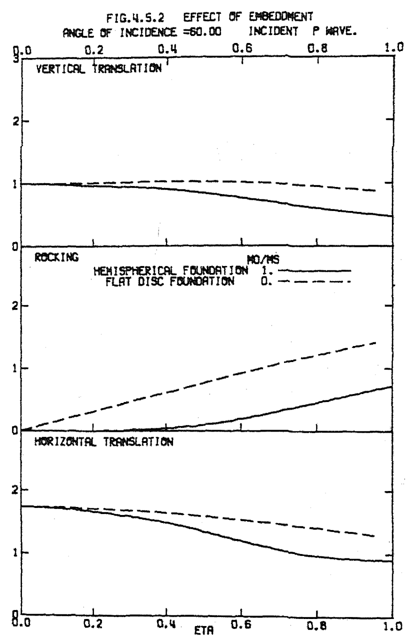


Fig. 4

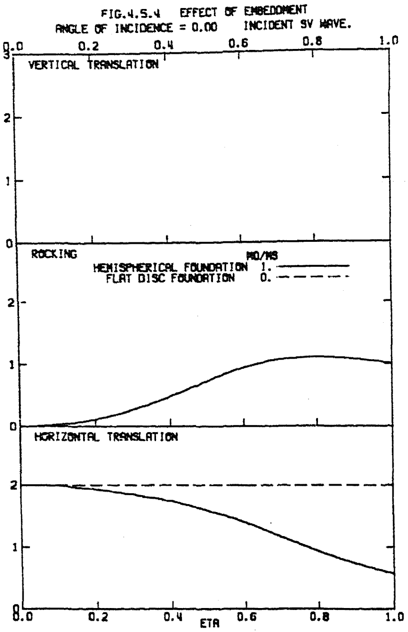
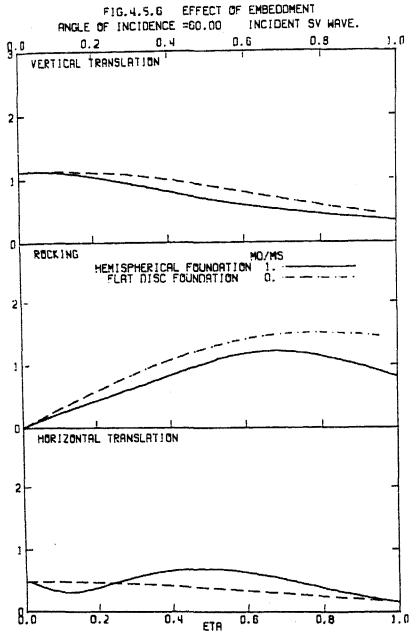


Fig. 5



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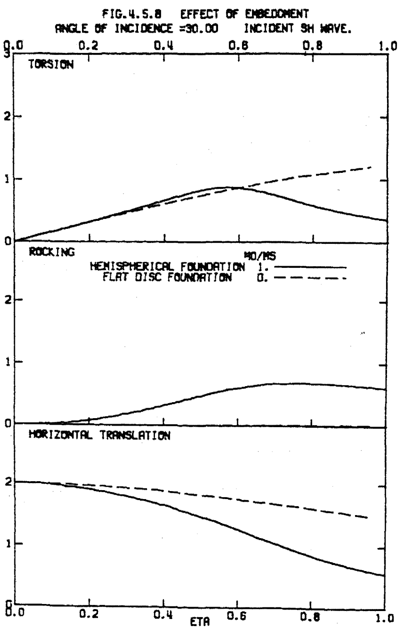

Fig. 7

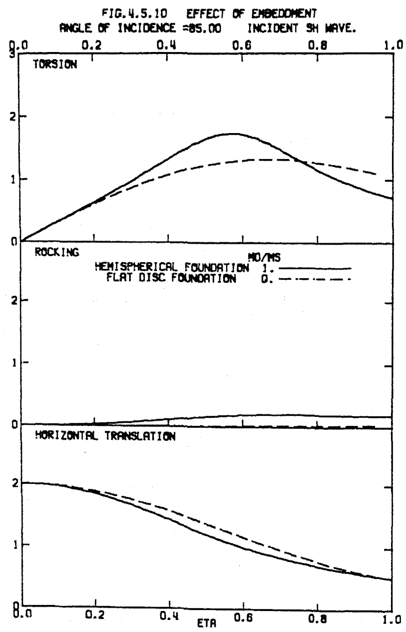

Fig. 8