ABSTRACT

The present thesis focuses on fundamental solutions for inhomogeneous plates resting on an elastic foundation. More specifically, the solutions are for the displacement field generated in thin, circular elastic plates with variable thickness under a vertical point load at the center. Subsequently, these solutions are integrated over the surface of the plate so as to yield impedance functions (or stiffness coefficients) that are used within the context of dynamic soil-structure-interaction (SSI) analyses involving discrete parameter (or multiple degree-of-freedom, MDOF) representations of the structure-foundation-soil system.

The inhomogeneous plates examined herein have variable thickness, which is gradually reduced as we move away from the center. The reduced thickness may follow a quadratic law or an exponential law, although other variations are possible as well. It is believed that variable thickness plates are an improvement over plates with constant thickness, especially when point loads are involved, as would be the case of columns reaching ground level and resting on spread footings. The fundamental solutions for such plates come from recent work reported in the literature, whereby techniques such as conformal mapping in conjunction with the Radon transformation have been used. Both free-standing as well as elastically supported inhomogeneous plates are examined. In addition, classical solutions for plates on a Winkler foundation (i.e., the floating plate case solved by Hertz) and plates on the elastic half-space (Boussinesq's solution) are considered as a means to gauge the effect of inhomogeneity on the displacement field.

Once these solutions have been appropriately processed so as to yield impedance functions, the next step is to conduct a series of time history analyses using Newmark's time integration algorithm for the MDOF model.

The resulting time histories are used as a means to gauge the effects of the soil-foundation system on the building's response (relative displacement at the top). The baseline solution for comparison purposes is that of the structural model with fixed base. Parameters that influence the structural response are rigid versus flexible foundation, type of supporting soil, and degree of plate inhomogeneity when the foundation is flexible.

Finally, the impedance functions derived herein can be used within the context of more complex discrete parameter models for the structure and can further be supplemented by appropriate mass and damping coefficients.