NONLINEAR SOIL-STRUCTURE INTERACTION ANALYSIS WITH SUBSTRUCTURING METHOD

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ABSTRACT

Soil-structure interaction (SSI) has been inspected through various methods so far. One simple and effective way of formulating the problem is using substructures, yet the superposition done in this approach yields to linear assumption of the interactional responses, while it is contrary to the reality. To reach more practical responses, manipulations can be done to the substructuring method to generalize the results to the nonlinear case, which leads to more realistic results based on which more exact engineering judgements can be performed. Instead of assuming the foundation-underlying soil to react like linearly-behaving springs, Terzaghi's ultimate bearing capacity concept through the UCD model is supposed adjoining this substructure. The springs replacing the soil will react linearly only to a level of incoming loads, and will enter their nonlinear phase after a threshold. The structure is supposed to be a reinforced concrete frame placed upon shallow footings. The input motion is the seismic load derived from the Loma Prieta earthquake (1989). Properties corresponding to different densities of sand, namely loose (15% < Dr < 35%), medium dense (65% < Dr < 85%) and dense (Dr > 35%) are examined. Modelling is done using the OpenSees software with programming in the Active Tcl environment. Maximum displacements of the structure and base reactions considering nonlinear seismic SSI are recorded and compared with a study previously done in Turkey using Plaxis. Average displacements of stories for all densities of sand are less for the UDC model compared to those from the Mohr-Coulomb. Denser sand results in base shears slightly bigger than those of sands with other density states.

INTRODUCTION

For more than a century researchers have been aware of the impact of the underlying soil on structural responses. The studies began primarily with inspecting static effects and settlements of the structure along with stress distribution caused by the superstructure loads through the soil. It was soon discovered that it is especially during dynamic loadings that the underlying soil shows itself off and can be entangling to engineers. To inspect the effects of the soil, one common approach is to model the soil with springs and dashpots under the structure, which is called *substructuring* method. The substructures are modelled as a series of springs and dashpots in parallel and serial and their locations are chosen to fit the system characteristics best. Soil-structure interaction through substructures in time and frequency domains is described in full details by Wolf (1965, 1988). Figure 1 depicts a simple model taking up this approach.