A MULTI-LEVEL IDENTIFICATION ANALYSIS OF GEOTECHNICAL SYSTEMS

M. ZEGHAL* AND A. ELMIKATY†

* Civil and Environmental Engineering Department
Rensselaer Polytechnic Institute
Troy, NY 12180, USA
zeghal@rpi.edu

† Civil and Environmental Engineering Department
Rensselaer Polytechnic Institute
Troy, NY 12180, USA

Natural deposits and geotechnical structures are massive multi-phase particulate systems which exhibit complex dynamic response patterns and mechanisms under severe loading conditions. Some of these mechanisms are localized in space, but impact significantly the entire system response and stability. A thorough monitoring of the entire response of a distributed soil system commonly constitutes a significant challenge, and would generally be prohibitively expensive. Thus, identification of the response characteristics and mechanisms of such a system is commonly based on response records provided by a restricted number of sensors, and the associated problem is generally ill-conditioned.

This study presents a multi-level system identification technique to analyze the dynamic response of massive geotechnical systems. This technique couples local and global identifications in order to reduce the problem indeterminacy. The local analysis relies on the motion recorded by a cluster of closely spaced accelerometers. This analysis focuses on critical system zones, such as for instance regions with softer stiffness properties, a propensity to liquefaction, or large deformation gradients. Other critical zones are those corresponding to significant soil-structure interactions. In contrast, the global analysis relies on the accelerations recorded by sparse array of sensors. The global analysis tackles zones with mostly uniform material properties that are expected to exhibit a response with relatively small deformations and no localized phenomena. Thus, the global identification analysis commonly has better conditioning than the local one. The local and global identifications are coupled at the interface of the global and local zones. The global system response in the vicinity of the local domain is used to supplement the accelerations recorded by the local array of sensors. Such a coupling reduces the local problem indeterminacy. Numerical simulations of a soil-retaining wall system were conducted to assess the capabilities of the developed multi-level identification technique.

Keywords: system identification, dynamics