EVALUATION OF SOIL-STRUCTURE INTERACTION EFFECTS USING SEISMIC CODES

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ABSTRACT

Seismic codes nowadays include design requirements in order to taking Soil-Structure Interaction (SSI) into account for realistic modelling of structures. This study is conducted to assess the behaviour of steel structure-soil systems using Standard No. 2800 and FEMA-440. Steel frame buildings are assumed to have various heights and different lateral resistant systems. The buildings are supported by shallow foundation resting on soft and also very dense soil. The strong ground motions are selected and scaled according to 2800 code. Both kinematic and inertial interaction effects are considered. SSI is investigated through the equivalent spring-dashpot method on the basis of nonlinear Winkler beam concept in the OpenSees framework. Numerical results show that period lengthening have overall agreement in both simulations and regulations. In addition, It is observed that when SSI is considered, base shear and inter-story drift demand reduces; indicating a beneficial effect of the foundation flexibility. However, the story displacement demand is observed to increase with SSI. In addition, depending on the structural building and soil type, the obtained results may differ from each other and the most significant SSI effects are related to braced frame structures on soft soil.

INTRODUCTION

The response of a structure to earthquake shaking is affected by interactions between three linked systems; the structure, the foundation, and the soil underlying and surrounding the foundation (NIST, 2012). Soil-structure interaction analysis evaluates the collective response of these systems to a specified ground motion. The dynamic response of a structure to earthquake excitation can be affected significantly by its interaction with the supporting soil. The role of SSI is usually considered beneficial to the structural system under seismic loading since it lengthens the lateral fundamental period and leads to higher damping of the system (Khalil et al., 2007). This conclusion could be misleading. Indeed, recent case studies and postseismic observations suggest that the SSI can be detrimental and neglecting its influence could lead to unsafe design for both the superstructure and the foundation especially for structures founded on soft soil (i.e. Mylonakis and Gazetas, 2000).

The development of realistic numerical models of the foundation with its supporting subgrade soil, which can reasonably capture its nonlinear rocking behaviour, has been recognized as an important and complex problem in earthquake engineering. Numerous studies have been conducted to model the behaviour of structures supported on shallow foundations. Allotey and Naggar (2007) developed a Winkler-based approach utilizing multi-linear, no-tension backbone curves. Most recently, Harden and Hutchinson (2009) developed a Winkler-based model using pile-calibrated nonlinear backbone curves to model the behaviour of