EFFECT OF SOIL-STRUCTURE INTERACTION ON SEISMIC DEMANDS OF STRUCTURES IN DESIGN PROCEDURES

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ABSTRACT

In this research, both kinematic interaction (KI) and inertial interaction (II) effects of soil-structure interaction (SSI) on seismic demands of structures are investigated by applying ground motions recorded at soil site E that SSI effect is considerable. Carrying out a parametric study, the structure and underlying soil are modeled as a Single Degree Of Freedom (SDOF) structure with elasto-plastic behaviour and a simplified 3DOF system, based on the concept of Cone Model, respectively. The foundation is considered as a rigid cylinder embedded in the soil. Then the soil-structure systems are analyzed under 15 ground motion recorded at site class E and a comprehensive parametric study is performed for a wide range of non-dimensional parameters defining SSI problem. Consequently, comparing the results with and without inclusion of SSI effects reveals that both II and KI play an important role in analyses or design procedures and ignoring them may cause un-conservative results in cases of deep embedded foundation and slender structures.

INTRODUCTION

The flexibility of structure's underlying soil affects the response of the structure due to SSI. This phenomenon has two main effects. The difference between stiffness of the foundation and the surrounding soil induces the difference between the motion experienced by the essentially rigid foundation that is the foundation input motion (FIM) and the free-field motion (FFM). This effect is called the KI effect and happens even if the foundation has no mass. In other words, the FIM is the result of geometric averaging of the seismic input motion in the free field (Meek and Wolf, 1994). The flexibility of soil affects the response of the structure subjected to FIM. In fact, the soil-structure system behaves as a new system with different dynamic properties (longer natural period and usually higher damping). This effect is called II effect. Numerous researches have been done on the effects of SSI over the past few decades. Veletsos and Meek (1974) recognized that the effects of inertial interaction on elastic structures could be approximated by modifying the fundamental period and the damping ratio of the fixed base replacement oscillator. The variations of the equivalent natural period and damping ratio have been studied by Wolf (1985) and Aviles and Perez-Rocha (1999). But the inelastic behavior of structures has recently been given more attention by some researchers. Bielak (1978) first studied this matter by investigating the harmonic response of a bilinear structure supported on a visco-elastic half-space and found that the resonant structural deformation could be