

ASSESSMENT OF SOIL-STRUCTURE-INTERACTION EFFECTS ON THE DYNAMIC RESPONSE OF STEEL HIGH-RISE MOMENT RESISTING BUILDINGS

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ABSTRACT

The dynamic response of structural systems under earthquake ground motions is significantly affected by the flexibility and damping of the soil-foundation system, either for shallow (rafts) or deep (pile) foundations. Recent numerical and experimental tests carried out world-wide have shown that high-rise buildings, which are most commonly built employing as steel lateral resisting systems, e.g. perimeter moment resisting frames (MRFs) and concentrically (CBFs) or eccentrically (EBFs) braced frames, may also be influenced by soil-foundation-structure interaction (SFSI) under specific design scenarios. Nevertheless, few studies address the seismic performance of steel high-rise buildings including SFSI. The present analytical work focuses on the earthquake response of a steel framed structure designed in the framework of the SAC Steel Project. The twenty-storey MRF was selected and assessed with and without considering the role of SFSI. The foundation of the sample frame was designed for various conditions of soil flexibility; the design was performed in compliance with European and international seismic standards. An extensive parametric analysis was carried out and the variations of the fundamental periods of vibrations along with higher modes participation were assessed. It was found that the dynamic response of the sample building is indeed affected by the design of the foundation, the relative flexibility of the foundation-soil system as well as the structural modelling employed. The proposed case study is intentionally examined on the basis of simple dynamic characteristics (i.e. modal contribution parameters) in order to highlight their dependency on easy-to-derive foundation-soil properties. Although the approach is inevitably case-dependent and as such, the fundamental conclusions drawn cannot be easily generalized, it is a practical attempt to quantify in a simplified manner the effects of SFSI on the seismic response of tall buildings.

Keywords: high-rise buildings, steel buildings, soil-structure interaction

INTRODUCTION

Tall buildings are being built in densely populated areas world-wide. Such buildings are often located in regions with high seismic and/or wind hazards. For instance, several high-rise structures exist in the California, in Japan, and many others are under construction especially in China, Taiwan and in several cities in the Middle East. Nevertheless, tall buildings are still one of the few constructed facilities which exhibit complex dynamic response that often requires the implementation of expensive scaled model testing or advanced health monitoring techniques.

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