Nonlinear Behavior of Tall Buildings with Foundation Uplift under Earthquake Excitation

Mehrdad Lotfollahi[1], Mir Ali Asghar Sajedi[2] and Massood Mofid[3]

1. Corresponding author. PhD Student, Department of Civil Engineering, Sharif University of Technology, Azadi Avenue, Tehran, P.O. Box: 11365-9313, Iran.
Email: lotfollahi_m@alum.sharif.edu

2. Engineering and Construction Manager, National Iranian Oil Engineering and Construction Company (N.I.O.E.C.), No. 263, Ostad-Nejatollahi Avenue, Tehran, P.O. BOX: 11365-6714, Iran.

3. Full Professor of Civil Engineering, Department of Civil Engineering, Sharif University of Technology, Azadi Avenue, Tehran, P.O. Box: 11365-9313, Iran.

Abstract

The earthquake response of structures is usually analysed under the assumption that the foundation is firmly bonded to the soil. Such analyses often predict a base overturning moment that exceeds the available overturning resistance due to gravity loads, which implies that a portion of the foundation mat or some of the individual column footings, as the case may be, would intermittently uplift during the earthquake. Therefore it is essential to know the effects of uplift on earthquake response of structures, especially tall buildings. In this paper, the influences of uplift on earthquake response of tall buildings via consideration both horizontal and vertical earthquake accelerations has been studied, using new finite element modeling method called *direct modeling* approach. We compared the response of tall buildings in two phases: *1*-with foundation uplift, and *2*-without foundation uplift. Also, some parametric studies have been conducted such as: slenderness of structure, elastic modulus of soil, cohesion coefficient of soil and the results on foundation uplift are evaluated. Finally, earthquake response of the models mentioned above, assuming linear behavior was compared to the response in nonlinear behavior. Considering soil-structure interaction is perceived to be an effective means to reduce base shear, stories shear and also members' forces in uplift system. However, it is imperative to demonstrate the beneficial effects of foundation uplift in computing the earthquake response of structures while the effects of horizontal and vertical components of the earthquake excitation are considered.

Keywords: uplift, parametric study, nonlinear finite element analysis, dynamic analysis, soil-structure interaction, tall buildings, direct method.