EVALUATION OF RANDOM SEISMIC RESPONSE OF MID-RISE BUILDINGS WITH MASS IRREGULARITY CONSIDERING SOIL-STRUCTURE INTERACTION EFFECTS

f. Homaei
Ph D. student, School of Civil and Environmental Engineering Tarbiat Modares University, Tehran, Iran
f.homaei@modares.ac.ir

h. Shakib
Professor, School of Civil and Environmental Engineering Tarbiat Modares University, Tehran, Iran
shakib@modares.ac.ir

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ABSTRACT

Seismic response of non-geometric vertically irregular steel buildings with non-uniform distribution of mass along the height is investigated in the framework of random analysis. As foundation flexibility influences structural responses, soil-structure interaction effects are also considered. A 10 story elastic shear steel building with fully restrained moment connections was considered as the superstructure. For the interaction forces at foundation level, frequency-independent springs and dashpots set in parallel were used and equations of motion of the superstructure resting on an elastic homogeneous half-space were established. Since in many engineering cases, the applied loads are random, in this study, structural response is evaluated in the framework of non-stationary random excitation.

According to the curves of mean square value of structural response, it is observed that in spite of the same specifications of structures, non-uniform distribution of mass through the structure height influences displacement demands. It is shown that regardless to the position of irregularity, a large portion of displacement demands have been concentrated on the lower stories. Meanwhile, depending on the position of the heavier floors through the structure height, demand distribution would be affected. As the heavier story moves to the upper floors, demand concentration reduces in the lower stories. Placement of the heavier stories at the upper half floors or through the bottom half ones has the maximum demand variations (up to 28%), compre to the regular structure.

INTRODUCTION

Uncertainty extensively exists as external actions to a system in nature and engineering area that forms random excitation. One of the most disastrous natural events that threats the human life and property is earthquake. It is a random phenomenon that widely affects structures and facilities. Therefore evaluation of structures and buildings response to the earthquake loading has been widely investigated (Romão, Costa et al. 2004; Jangid 2005; Tremblay and Poncet 2005; Adhikary, Singh et al. 2014; Fragiadakis, Vamvatsikos et al. 2015). Vertically irregular buildings have been reported to have different performance compare to the regular ones (Karavasilis, Bazeos et al. 2008; Pirizadeh and Shakib 2013). Constructions of mid to high-rise buildings, with different story usage, impose mass irregularity to the structures. In spite of the random nature of seismic events, the majority of seismic assessments of this type of structures belongs to the time history analysis with recorded earthquakes. Due to the variability of earthquake records, this procedure can't fully