INFLUENCE OF REPEATED EARTHQUAKES ON THE DUCTILITY DEMAND OF INELASTIC RC BUILDINGS

ABSTRACT

Current design practice considers the use of single event of earthquake. In fact, seismic hazard is a multi events earthquake or the so-called repeated earthquakes. Consequently, the structural behavior under repeated earthquakes is not clearly understood. Since seismic codes have no clause for this issue, the designed drift could be underestimated and hence could propagate the collapse of building when subjected to repeated earthquakes. Therefore, the present study focused on the evaluation of influence of repeated far-field earthquake (FFE) and earthquake with forward directivity effect (FDE) on the ductility demands of reinforced concrete (RC) buildings. A comprehensive assessment was conducted using 3D generic frames with 4 types of fundamental period representing 3-, 6-, 12-, and 18-story models, respectively. A model having behavior factor of 1.5, 2, 4, and 6.0, and plastic hinge at member ends with 3 types of plastic rotation capacity was assumed. The buildings were assumed to be situated on a stiff soil in the high seismic zone in Europe. This study shows that repeated earthquakes significantly increase the roof ductility and maximum story ductility demands of RC buildings. On average, amplification ratio of roof ductility demand due to repeated earthquakes reached to 1.5 and 1.7 for double and triple events of repeated earthquakes, respectively, regardless of the type of ground motion. Amplification ratio of 1.6, in average, is found on the roof ductility demands of RC buildings having medium class (DCM) and high class (DCH) of behavior factors when subjected to repeated earthquakes,

regardless of the type of ground motion. The study has found that the effect of earthquake type viz. FFE and FDE in repeated earthquakes on the roof ductility demand can be neglected. For maximum story ductility demand, the RC buildings experienced amplification ratio of 1.4 and 1.3 times under the double and triple events of repeated earthquakes, respectively. The difference in maximum story ductility demands of RC buildings having DCM and DCH is not significant. The present study has also established the empirical relationships of ductility demands of RC building with the fundamental period, behavior factor, ratio of global post-yield stiffness to elastic stiffness, and ratio of story ductility to global ductility capacities to predict the amplification ratios of ductility demand due to repeated earthquakes. Using the established relationships, the required behavior factor for regular RC frame buildings was found to be increased up to 1.8 times higher than DCM in Eurocode 8.