10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

Effective Parameters in the Response of SDOF RC Frames Under Consecutive Seismic Excitations

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Abstract

Strength and stiffness degradation are important phenomena which affect the behavior of RC frames under seismic actions more specifically in the case of consecutive earthquakes. This paper study the effects of consecutive earthquakes on one story RC frames considering various dynamic properties and hysteresis behaviors. To allow for inherent uncertainties in earthquake and frame characteristics Incremental Dynamic Analysis (IDA) is utilized. The value of structural transient and residual drift ratios are evaluated as indicators of critical structural performance. It is concluded that consecutive excitations may result in an unacceptable lateral displacements as compared to individual earthquakes, which depends on the characteristics of the structure and the size of the earthquakes. Further studies are required on the different seismic excitations intensity and multi-story RC frames to better understanding repeated earthquake effects on structural response and mean annual frequency of exceedance.

Keywords: Incremental Dynamic Analysis, Consecutive earthquakes, Degrading Behavior

1. INTRODUCTION

The key objective in earthquake engineering is to control the damage and/or to prevent the collapse of the structures so that to reduce economic and life losses from severe earthquakes. Seismic resistant design traditionally has focused on structures under single isolated design earthquake. In fact they do not consider the effects of damage accumulation during possible previous events. This was to some extent due to the complexity of seismic behavior and the limitations in technical and computational knowledge to understand and deal with the considerable uncertainties in structural behavior under even one single seismic event. On the other hand lack of sufficient actual data was led to accept the assumption that there would be sufficient time to assess and upgrade the structure before the next significant event. However current advances in earthquake engineering concepts and tools have paved the way to consider more complex circumstances. Moreover with the growing number of recorded and reported actual events and experiences it may be seen that the multiple seismic events are no longer remote incidents. It has been observed that the buildings may stay apparently intact during a main seismic event but collapse in a subsequent event.

Occasionally multiple earthquakes occur in regions where complex fault systems exist. It is usually hard to define the earthquake sequence as fore-, main- and after-shocks or earthquakes from proximate fault segments. An aftershock is a smaller earthquake that occurs after a previous large earthquake, within the same area of the main shock, Figure 1. However based on recent experiences (Chile (2010), Christchurch (2011), Tohoku (2011), Van (2011), Ahar-Varzeghan (2012)) there are sufficient evidences that the issue of a structure to be subjected to two or even more consecutive earthquakes is real and therefore requires attention.

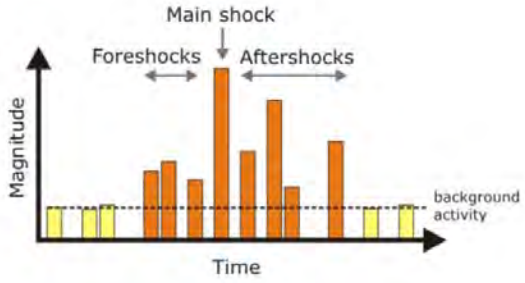

Figure 1 Illustration of fore-, main-, and aftershocks definition is an earthquake sequence