Earthquake duration effect on the nonlinear response of MDOF system using a new version of Incremental Dynamic Analysis (IDA)

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Abstract

In this article we introduce a new version of Incremental Dynamic Analysis (IDA) by which the effect of earthquake duration on the nonlinear dynamic response of the structure seems to be more obvious. We believe that the input energy of earthquakes is a better Intensity Measure (IM) than the spectral acceleration in first mode of the structure vibration (Sa(T1,5%)) for the study of duration effects. We used artificial acceleration time-histories simulated by the specific barrier model modified slightly for this study as well as real records apropriately selcted. Results confirm our proposed aproach.

Keywords: strong motion duration, incremental dynamic analysis, artificial earthquakes.

1. INTRODUCTION

The emergence of computers with high computing power, speed and accuracy on the one hand and the need to design irregular, uncommon and important structures on the other hand, leads the engineers to perform the nonlinear analysis such as the well known Incremental Dynamic Analysis approach (IDA). In this method the nonlinear dynamic analysis for the structure is performed using the acceleration time histories which are scaled appropriately and the maximum interstory drift ratio is plotted versus the Intensity Measure, thus the linear and nonlinear responses of the structure and structural collapse are evaluated [1].

One of the important parameters in the study of earthquake records is the strong motion duration. In this study the effects of the earthquake duration on the damage measure (DM) for the MDOF system is calculated and assessed. Since it is not always likely to find enough real earthquake records satisfying the conditions needed for this study, analysis is performed using the generated records compatible to the source, path and site soil condition as well as real records selected appropriately.

For our purpose, primarily some earthquakes (acceleration time histories) having certain durations, the same site soil type which the structure is designed for, and a variety of the magnitudes and distances are simulated, then the a 9story SMRF structure is modeled using the DRAIN-2DX code and the IDA analysis is performed. It seems that, the dependence of the damage measure on earthquakes' durations is more cleared if the input energy of the earthquakes is selected as the intensity measure in IDA procedure.

2. STRONG MOTION DURATION

Empirical observations and analytical studies show how cyclic structural damage is related to energy released during ground shaking. More than 30 definitions of seismic duration are available in literature [2] trying to measure such damage potential [3–5]. Trifunac and Brady [6] define the effective duration t_D as the time interval between the 5 and 95% of the root mean square acceleration (RMSA).