5th National Congress on Civil Engineering,
May 4-6, 2010, Ferdowsi University of Mashhad, Mashhad, Iran

An Efficient Method of Earthquake Ground Motion Selection for Performing Reliable Nonlinear Dynamic Analyses

A. A. Golafshani[1], H. Ebrahimian[2], S. A. Tabandeh[3]

1 – Associate Professor, Sharif University of Technology, Tehran, Iran
2 – PhD candidate, Sharif University of Technology, Tehran, Iran
3 – M.Sc. student, Sharif University of Technology, Tehran, Iran

golafshani@sharif.edu
ebrahimian@civil.sharif.edu
a_tabandeh@mehr.sharif.edu

Abstract

Selection of recorded ground motions is an important consideration. Most of the current building codes enforce the requirements to match the event characteristics, as well as ensuring that the median spectrum exceeds the target Uniform Hazard Spectrum (UHS) ranging from $0.2T_1$ to $1.5T_1$. Performing the analysis with respect to the same code's criteria and with different sets of selected ground motions, will result in responses with considerable variability. These facts show the significance of considering a proxy for spectral shape. Indeed, there is no single earthquake that is likely to produce a spectrum as high as UHS over all periods. So, the Conditional Mean Spectrum (CMS) is proposed as a substitution which considers the spectral shape through an indicator named "epsilon". In this paper, the advantages of CMS over UHS are investigated for a hypothetical site.

Keywords: UHS, Spectral Shape, CMS, Epsilon.

1. INTRODUCTION

Selection of recorded ground motions as inputs for dynamic analysis is an important consideration when assessment of structures is based on nonlinear dynamic analysis. Nonlinear response of multi-degree-of-freedom (MDOF) structures is affected mainly by spectral shape. Considering the spectral shape in record selection process will be done through defining an indicator of spectral shape named epsilon which will be discussed in the following section.

The intensity measure $S_a(T_1)$ as a value that quantifies the effect of a record on a structure provides the response of a linear single-degree-of-freedom (SDOF) structure with a period of vibration approximately equal to the first-mode period of the MDOF structure under consideration. For a given $S_a(T_1)$, the shape of the response spectra is known to be a significant factor in the response of nonlinear MDOF structures [1]. This is owing to the fact that the response of an MDOF structure is affected by excitation of higher modes of the structure at periods shorter than T_1. In addition, when the structure starts behaving nonlinearly, the effective period of its first mode increases and spectral values at periods longer than T_1 affects the nonlinear structure.

2. EPSILON AND SPECTRAL SHAPE

Given two records with the same $S_a(T_1)$ value, the record with higher spectral values at periods other than T_1 will tend to cause larger responses in a nonlinear MDOF structure. To know about spectral values at other periods, we will see that ε is an expedient implicit measure of spectral shape. Parameter epsilon (ε) is defined as the number of standard deviations by which a given $\ln S_a(T)$ value differs from the predicted mean value, $\mu_{\ln S_a}(M,R,T,\varphi)$, for a given magnitude, M and distance, R, fault rupture mechanism and site condition which are generally designated by the parameter φ. Parameter epsilon (ε) can be computed by employing an appropriate ground motion prediction model and using the following mathematical relationship: