COMPARISON OF DUAL SCALING WITH AMPLITUDE SCALING OF EARTHQUAKE RECORDS FOR TIME HISTORY ANALYSIS

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Recently, time-history analysis is becoming more common in seismic analysis and design of structures. An important issue of such analysis is the selection of acceleration time histories to satisfy design code requirements and soil type at a specific site.

The dynamic analysis of structures according to seismic code regulations requires the selection and scaling of sets of accelerograms complying with certain relevance criteria. Iranian code for seismic design of structures (2800 ver3) requires that for recorded accelerograms, selection criteria concern the adequacy to the seismologic features of the sources. Tectonically and geotechnical aspects and specially the soil conditions must be match the site. Real records must also consider the magnitude, distance and earthquake mechanism. Selected records must have strong ground motion duration at least 10 seconds or three times the fundamental period of the structure in consideration.

The first step to scale the records is scaling of their values to their peak ground acceleration, so all the records have a peak ground acceleration equal to “g”. In this process there is no role for duration of strong motions and the scaling is based on intensity scaling. At least three pair of recorded accelerograms must be used. For each pair the values of response spectra must be combined by SRSS method to give the combined spectra. Then these three combined spectra must be averaged.

There are requirements concerning the maximum allowed differences between the standard spectra provided by the code and the mean spectrum calculated for all accelerograms in the set. For example, Iranian code (2800 ver3) requires that in the range of periods between 0.2T1 and 1.5T1, where T1 is the fundamental period of the structure in the direction where the accelerogram will be applied; no value of the mean 5% damping elastic spectrum, calculated from all time histories, should be less than 1.4 times the corresponding value of the 5% damping standard spectrum.

In this study, a proposed method (Martinez Rueda, 2006) for scaling real accelerograms to obtain sets of code-compliant records is assessed. The method, which uses combined time and amplitude scaling, corroborated with an imposed value of Housner intensity.

The main objective of this paper is to compare the response spectra estimated when using simple amplitude and dual scaling criteria. Three steel structures are considered for representing the effect of different fundamental periods. These structures are considered on soil type II, medium soil, and the selection of records is based on a region with very high seismic risk. The methodology for selecting the real time histories is applied to find ten pairs of horizontal component of real earthquake records.

In dual scaling method we need to find a combination of a time-scaling factor SFt and an amplitude-scaling factor SFa that modifies the real selected records to estimate an accelerogram on medium soil. In this article an accelerogram under scaling is visualized as a time-series in which each term of the series consists of a point with time and amplitude coordinates (t, $\ddot{u}_g(t)$), Where t = time and $\ddot{u}_g(t)$= ground acceleration. Accordingly, each point of the accelerogram subjected to dual scaling has as modified coordinates ($SF_t.t, SF_a.\ddot{u}_g(t)$); where SFt is the time-scaling factor and SFa is the amplitude-scaling factor.

The relationship between SFt and SIH may be approximated by a truncated polynomial of second degree which predicts a null intensity when SFt = 0 (i.e. for no ground motion);

$$SI_H = A.SF_t^2 + B.SF_t \quad (1)$$

Where SIH is the Housner intensity affected by time scaling; A & B are fitting constants.

Based on the results of the evaluations performed on these structural systems, it is concluded that the use of the considered set of accelerograms leads to a rather good estimation of the seismic action specified by the code.

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