ABSTRACT

Structural response of ordinary 5-storey R/C buildings induced by both real and artificial accelerograms

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Text

The objective of the current project is to compare the response from 3D models of two common buildings, computed by dynamic analyses (linear and non-linear) and induced by both real and artificial accelerograms of the same intensity level. The real accelerograms come from records of seismic excitations in the greek region (Thessaloniki, Athens, Leykada, Egio, Kalamata), while the artificial accelerograms were determined by a proper software, that figures this kind of accelerograms (http://infoseismo.civil.auth.gr). The input of this software consists of a number of parameters (like magnitude, duration, frequency content, damping of the motion and local site conditions) which are necessary to produce the design earthquake scenario.

The research of the accelerograms effect on the structural response was implemented by the analysis of two buildings, which constitute two variants of an ordinary 5-storey R/C building, characterized by the same properties except the stiffness of the models.

The analyses were carried out for five real and five artificial accelerograms, with the application of SAP2000 (v.9). The same accelerogram was applied along both two horizontal and orthogonal directions of the input motion while the vertical component of the excitation was neglected. For the linear analyses, the maximum values of the response quantities were compared, computed for the critical angle of seismic incidence for each parameter of interest. This estimation is achieved by the implementation of two bi-directional time history analysis cases, the first one with angle of seismic incidence $\theta=0^o$ and the second one $\theta=90^o$. For the non-linear analyses, an additional seismic incidence angle $\theta=45°$ was examined.

The accelerograms were normalized to a value of the peak ground acceleration equal to 0.24g, in order to compare the results of the linear time-history analyses

with the results, determined by the modal analysis, which was carried out using the elastic response spectrum, proposed by the Greek Aseismic Code (E.A.K. 2003), for the 2nd zone of hazard level (A=0,24g) and for the soil category indicated as B (stiff soil).

In the framework of the linear analyses, both the response values, obtained by the two types of accelerograms (real and artificial accelerograms), and the results of the dynamic modal analysis, were compared. The following response quantities were checked: the axial force N and the bending moments M_x and M_y, developed at the base of the most stressed external vertical element (column or wall) and also the displacements along the x-x and y-y directions of the same structural element at the level of the first (UX1,UY1) and the last (UX5, UY5) floor.

The results produced by the linear analyses, which are represented through comprehensive figures demonstrate that the largest scatter among the values of the response quantities, caused by real and artificial accelerograms, is observed between the records of ''Athens'' (the record with the lowest magnitude M=5,9) and ''M720'' (the record with the highest magnitude M=7,0). Scattering among the values of the response quantities between the records which are defined by the same magnitude and duration may be explained by the differences between the frequency contents of the records. Finally, comparing the response values, obtained by the two types of accelerograms (real and artificial accelerograms), with the results of the dynamic modal analysis, it is obvious that linear time history analysis leads to larger values of the response quantities than dynamic modal analysis does.

In the framework of non-linear response history analyses, which were implemented by using the non-linear finite elements (NLLinks) of SAP2000, the number of the plastic hinges, developed at the various structural elements of the models, was compared. The results of this kind of analysis confirm the fact that due to the discrepancy in the frequency content between the real and the artificial accelerograms, a large amount of scatter in the number of the plastic hinges was noted. Finally, plastic hinges' scattering between the analysis cases obtained by artificial accelerograms is smaller than the scattering between the cases obtained by real records.