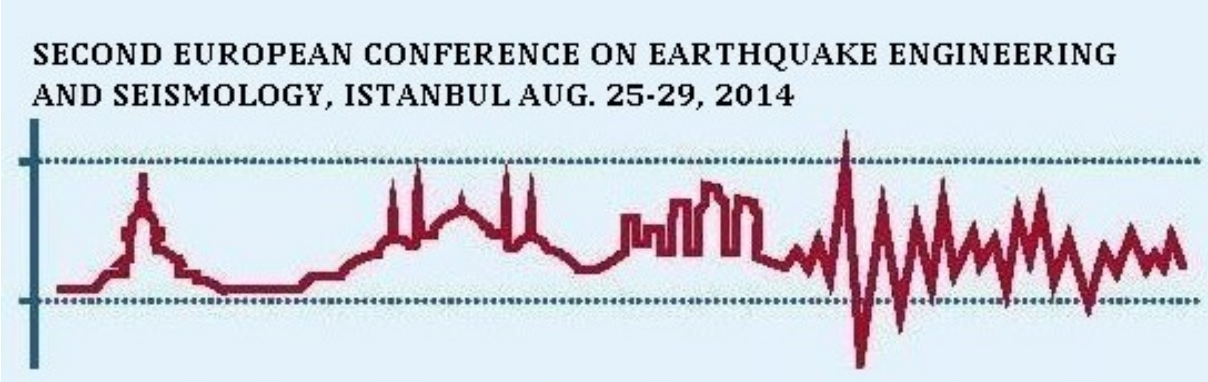

SCALING OF ENERGY SPECTRA

Ahmet Anıl DİNDAR[1], Cem YALÇIN[2], Ercan YÜKSEL[3], Hasan ÖZKAYNAK[4] and Oral BÜYÜKÖZTÜRK[5]

The seismic design codes use the relation between demand of the earthquakes and capacity of the structures. Such relations have been described in terms of strength and lately deformation in the current codes. In either relationship, the earthquake demand has been obtained from acceleration response spectrum those constructed for linear Single Degree of Freedom Systems (SDOF) with usually 5% viscous damping ratio. Even if the acceleration response spectrum has been widely used in practise, the spectral values are the largest absolute responses in the linear time-history analysis. For that reason, the entire duration and accordingly the frequency content of the earthquake record is not included into the response spectra (Chopra 2001). On the other hand, an unconventional relationship between demand and the capacity may bring an alternative solution in the current sesimic design procedures. The energy concept, which was introduced by Housner (1956), has been part of the many numerical and experimental research studies (Akiyama, 1985,Bertero and Uang, 1991, Fajfar et al, 1994, Akbaş, 1996, Kunnath et al, 1998, Decanini and Mollailoi, 2001, Erberik and Sucuoğlu, 2004, Benavent et al., 2010, Dindar et al., 2013). These research studies have examined the representation of the earthquake demand and capacity of the structural systems in terms of energy. Among these studies, a special care is given to the definition of earthquake demand in order to overcome the shortcomings of the current design practices. The energy-based design formulation or energy-balance equation derived from equation of motion includes all the components of the structural response, Fig. 1. Among these components, the Input Energy (E_I) and Plastic Energy (E_p) play important role in seismic design since they represent the earthquake demand in general and particular to element level, respectively.

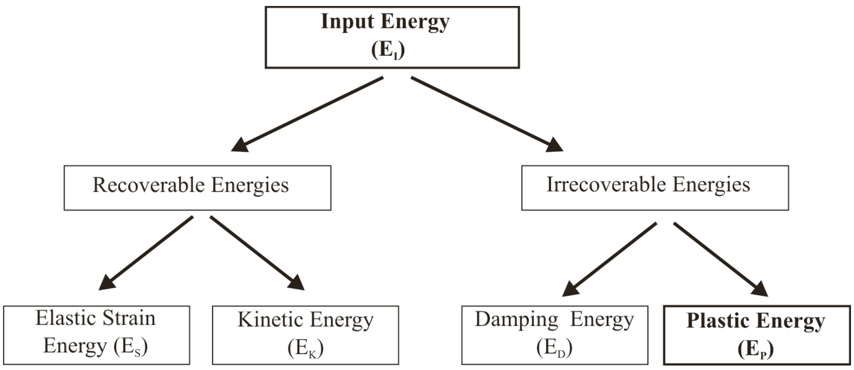

Figure 1. Energy components in Energy-Balance Equation

This study aims to give a better understanding in the direct derivation of Input Energy (E_I) and Plastic Energy (E_p) terms using spectra concept with the parameters of structural behaviour, soil types for both linear and nonlinear response under near and far field earthquake excitations. Since the both

[1] Assist. Prof. Dr., Istanbul Kultur University, Istanbul-TR, adindar@iku.edu.tr
[2] Assoc. Prof. Dr., Bogazici University, Istanbul-TR, cem_yalcin@yahoo.com
[3] Assoc. Prof. Dr., Istanbul Technical University, Istanbul-TR, yukselerc@itu.edu.tr
[4] Assist. Prof. Dr., Beykent University, Istanbul-TR, hasanozkaynak@beykent.edu.tr
[5] Prof. Dr., Massachusetts Institute of Technology, MA-USA, obuyuk@mit.edu

energy spectra are derived independent from each other, the Input Energy (E_I) represent the total energy imparted to the entire structure while the Plastic Energy (E_P) is directly related to the damage occurred in the form the plastic rotations at the end of the structural members. The spectra given here are obtained from extensive computations for SDOF systems but they can be easily applied to Multi Degree of Freedom Sysyem (MDOF).

The use of the derived spectra for regions having different seismic intensities, a scaling procedure has been recommended as a part of the current study. Much different seismic intensity measures are used in the literature, whereas Peak Ground Acceleration (PGA) of the earthquake record is generally most respected parameter. Hence, the spectral values for the derived Input Energy (E_I) and Plastic Energy (E_P) are found in the quadratic relation with the reference level seismic intensity of PGA=0.1g. The formulation of the scaling procedure is also incorporated into the both smoothed energy demand spectra (Dindar et al 2013). The recommended scaling procedure is also proven for a real case avaiable in literature.

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