# Abstract

Current seismic codes require from the seismically designed structures to be able to withstand inelastic deformation. Many studies dealt with the development of different inelastic spectra with the aim to simplify the evaluation of inelastic deformation and performance of structures. Recently, the concept of inelastic spectra has been adopted in the global scheme of the performance-based seismic design through capacity-spectrum methods. In this thesis, following the earlier work of inelastic response spectra has been developed which is called "Ductility Demand Response Spectrum", and a new feature is introduced in the first place, where the ductility demand is correlated with period and some parameters. The median of the ductility demand ratio for 80 ground motions are presented for different levels of normalized yield strength, defined as the yield strength coefficient divided by the peak ground acceleration (PGA). The influence of the post-to-preyield stiffness ratio on the ductility demand is investigated. For fixed levels of normalized yield strength, the median ductility versus period plots demonstrated that they are independent of the earthquake magnitude and epicentral distance. Determined by regression analysis of the data, two design equations have been developed; one for the ductility demand as function of period, post-to-preyield stiffness ratio, and normalized yield strength, and the other for the inelastic deformation as function of period and peak ground acceleration valid for periods longer than 0.6 seconds. The equations are useful in estimating the ductility and inelastic deformation demands for structures in the preliminary design. It was found that the post-to-preyield stiffness has a negligible effect on the ductility factor if the yield strength coefficient is greater than the PGA of the design ground motion normalized by gravity. Based on the inaccuracy of ATC-40 procedures and the need of a direct approach for the seismic design of structures, an improved procedure was proposed and investigated in this thesis. It is proved that ATC-40 procedures are deficient for structure shaving long first period. The method uses the ductility demand response spectrum and is suitable for seismic design of structures.

**Keywords:** Nonlinear, ductility, inelastic, seismic demand, response spectra.