Damage Design Acceleration Spectrum Including Soil-Structure Interaction

Abstract

Design spectra of earthquakes are important tools that play the main role in investigation of structural behavior. These are usually presented for structures resting on rigid bases. This is while the underlying soil is often flexible and this soil flexibility affects the structure's response. After a comprehensive survey on the spectrum analysis and the analysis methods of the systems with non-classical damping, this study continues to investigate the soil-structure interaction in its course. The model presented in this research has three degrees of freedom, one of them relates to structure and the other two to the foundation. Determination of foundation dynamic stiffness is one of the main steps in analysis of soil-structure systems. The dynamic analysis of the systems with dynamic characteristics dependent on frequency is possible, but also lumped parameter models (LPM) are available to be used to obtain the impedance functions. In lumped parameter models the soil is replaced by a series of springs, dampers and masses with constant coefficients that are frequency independent. Hence, the presented equation in time domain can be used for the mentioned model. The direct integration method with the Newmark operators can be used for the solution of soil-structure system. Accordingly, a computer programs was written for the calculation of the structure responses on flexible support in the form of acceleration spectra. A suite of ground motions recorded on D and E soils of ASCE7-10 was selected. Also, the calculated spectra are compared with the design spectrum. Some dimensionless parameters are used for calculation of the response spectra including soil-structure interaction corresponding to cases that are examples of real structures. Finally, a parametric study is implemented to investigate the effects of each dimensionless parameter on the response spectra.

Keywords: design spectrum, soil-structure interaction, dimensionless parameter, time domain equations, Newmark numerical method, non-classical damping.