Evaluation Site Effects On Ground Motion By Elasto-Plastic Model and Numerical Approach

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Abstract

Seismic response of a site depends on geological and specifically on geotechnical properties of the soil. In this paper, nonlinear dynamic analyses of 4 different sites, selected based on soil types in the Iranian Earthquake Code (2800), have been carried out. The FLAC software, one of the powerful packages in modeling the soil media, has been used. The analyses have been performed in time-domain with elasto-plastic model and results are presented as normalized acceleration spectra. Comparing the obtained spectra using nonlinear approach with those obtained from Iranian Code, the reliability and accuracy of the equivalent linear method are investigated and discussed. Also the effects of some main geotechnical parameters of the site such as soil cohesion and angle of internal friction on the amplification factor of the site are evaluated.

Keywords: Local site effect, equivalent linear analysis, nonlinear analysis, numerical model, FALC

1. INTRODUCTION

There are different types of analytical and experimental approaches for investigating site effects on seismic waves, whose efficiencies in various situations have been examined and compared with each other in various studies.

For dynamic analysis of ground response, different theories as linear, equivalent linear and nonlinear have been put forward, which have their especial advantages and limitations. The importance of site specific design spectra in seismic design of structures and earthquake engineering, clarifies the necessity of more precise study of these theories. The “equivalent-linear” method is common in earthquake engineering for modeling wave transmission in layered sites and dynamic soil-structure interaction. Since this method is widely used, and the fully nonlinear method embodied in FLAC is not utilized extensively in this regard, it is worth investigating some differences between the two methods.

In the Iranian Earthquake Code (2800), design spectra for consideration of site effects are presented by classifying soils on the basis of shear wave velocity. The common approach used in engineering of earthquake for modeling the transition of wave in soil media is one dimensional equivalent linear method which uses linear traits for each element, constant during seismic provocations. Meanwhile in equivalent linear method the incidence of combined phenomena between components of different frequencies, which happen in nonlinear materials, can not be possible. On the other hand this theory relates strain tensor with stress tensor by means of elasticity theory. In contrast in real plastic flow, tensor of strain increments is related to stress tensor by functions which conduct flow rule in plasticity theory. According to these deficiencies, plastic yielding can not be modeled in equivalent linear method properly, while in fully nonlinear method, elastic-plastic model is employed to relates plastic strain increments to stresses.[1],[2]

Regarding to extensive use of equivalent linear method and all of its defects pointed out above, in this paper a comparison has been made between responses of this approach and fully nonlinear which models soil behavior more realistically. Effects of some impressive factors such as soil cohesion and angle of internal friction on dynamic behavior have been evaluated as well.