Design Spectrum for Near Fault Ground Motions Considering Frequency-Dependence of CH/SC Material Behavior Regarding Laboratory and Field Shear Wave Velocity (Vs)

Ata Aghaei Araei[1], Nahid Attarchian[*1], Ahmadreza Ghodrati Ghazaani[1], Hossein Haddad[2], Amir Saeid Salamat[1], Hossein Hasani[1]

1. Road, Housing and Urban Development Research Center (BHRC), Tehran, Iran
2. Ph.D. student, University of Technology Sydney (UTS), Sydney, Australia

Extended Abstract

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Introduction

One-dimensional site response analysis is widely performed to account for local site effects during an earthquake. Most of these approaches assume that dynamic soil properties are frequency independent. Laboratory test results as well as in-situ testing show that shear modulus and damping ratio are dependent on the frequency of loading. Although the amplification factor at ground surface with respect to frequency dependent dynamic properties of mixed alluvium materials under different near-fault motions with various velocity period is recognized, it is not well characterized and quantified.

Material and analysis methods

In this study, the tests results of samples which obtained from the drilling borehole (BH14) form Pardis city in Iran, are used. The soil is classified as clayey of high plasticity/clayey sand (CH/SC) and almost uniform and similar in the whole log profile.

Shear modulus and damping ratios versus shear strain curves (ASTM D3999) of CH/SC natural materials at effective confining pressures of 1, 2

and 5 kg/cm^2 with frequency of 0.5, 2, 5, and 10 Hz were used in one dimension response analyses using EERA Code.

Generally the damping ratio versus shear strain of the studied materials under low loading frequency (i.e. 0.5 Hz) almost falls in the range identified in literature. However, at higher loading frequencies (5 and 10 Hz) the damping ratios completely fall above the known upper bound trend. It is observed that, in general, the G and D values increase as loading frequency increases. Moreover, at certain strain G/G_{max} ratio decreases as loading frequency is increased.

Different dynamics behavio~~u~~r curves were used in analyses, in isotropic consolidation conditions. In order to assess the amplification, acceleration spectra, acceleration spectra ratio, coefficient of B, at ground surface under eight well-known near-fault ground motions, 1728 one dimensional analyses were carried out with EERA code. The analyses have been performed for three base acceleration levels, namely, 0.1 g, 0.35 g and 1 g, using the simple time history scaling method. Field and laboratory test results of shear wave velocity were used in the analyses.

In this study, several well-known near-fault motion records are utilized for ground response analyses. Near-fault earthquakes records were selected from the strong motion database of the Pacific Earthquake Engineering Research Center (PEER) and Iran Strong Motion Network (ISMN) for specific reasons of location of the near fault~~s~~ sites.

In current building codes, the upper 30 m soil deposits overlying the higher impedance earth crust are regarded as the most relevant and significant in characterizing the seismic behavior of a site. Therefore, it is useful to accomplish investigations for obtaining their amplification and spectral acceleration for 30 m and even thicker (e.g. 60 m, for usual deep excavation in Iran), in order to have economical and safe design~~s~~ and construction~~s~~.

Results and discussion

Figure 1 presents a comparison of normalized spectral acceleration (B factor) versus period for 30 m and 60 m thick profiles and Vs testing for frequencies dependent and independent analyses under input base acceleration of 0.35g for longitudinal component of used earthquakes. B

factor of Iranian Standard 2800 and UBC97 also has been presented in the figure. The spectral acceleration at short period for frequency dependent analysis is higher than that of the frequency independent analysis. The T_s increases in frequency dependent analysis and higher thick profile (i.e. 60 m).

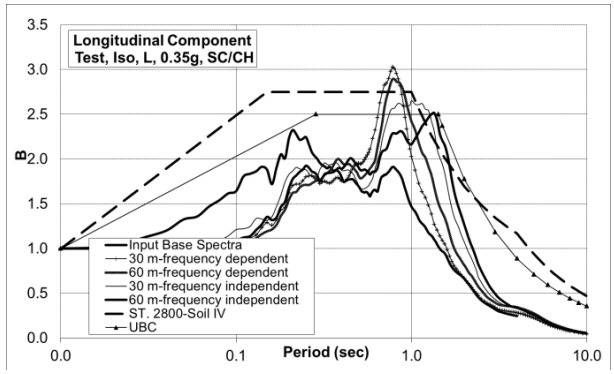

Figure 1. Comparison of normalized spectral acceleration (B factor) versus period for 30 m and 60 m thick profiles and V_s testing for frequencies dependent and independent analysis under input base acceleration of 0.35g for longitudinal component of used earthquakes with B factor of Iranian Standard 2800 and UBC97

Conclusion

Results show that the effect of loading frequency has a considerable influence on the acceleration response at the ground surface. For both 30 m and 60 m soil columns, the increase of the loading frequency, decreases the amplification factor especially in the short period zone of the spectra. Based on the acceleration response spectra of near field strong motions derived for soils types of I and IV in this study, the period corresponding to T_s in the design spectrum of Iranian Standard 2800 should increase to 0.5 and 1.4, respectively. Therefore, selection of the appropriate *G* and *D* curves measured at frequency similar to those of the anticipated cyclic loading (e.g. seismic) has a paramount importance.

Keywords: acceleration response spectrum, near fault, damping ratio, shear modulus, loading frequency, triaxial apparatus.

*Corresponding Author: n.attarchian@bhrc.ac.ir