A Site Specific Study on Evaluation of Design Ground Motion Parameters

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ABSTRACT

Design ground motions are usually developed by one of the two approaches: site-specific analyses or from provisions of building codes. Although contemporary codes do consider approximately the site effects, they provide more conservative estimates. Hence it is preferred to carry out site specific analysis which involves both the seismic hazard analysis and ground response analysis. This article presents a site specific analysis for a seismically vulnerable site near Ahmedabad, Gujarat. The seismic hazard analysis was carried out by DSHA approach considering seismicity and seismotectonics within 250km radius. The site is predominantly characterized by deep stiff sandy clay deposits. Extensive shear wave velocity measurement by cross hole test is used for site classification and ground response analysis. The ground response analysis was carried out by equivalent linear approach using SHAKE2000. It is found that the deep stiff soil site considered is found to amplify the ground motion. The site specific response spectra obtained from RRS analysis is compared with the codal provision which reveals high spectral acceleration in site specific spectra for mid period range.

Keywords: Deep Stiff Soil Site, Design Spectra, DSHA, Ground Response PGA, Site Specific Study

INTRODUCTION

Earthquakes are one of the most devastating natural hazards that cause great loss of life and livelihood. Seismic waves generated at the earthquake source propagate through different geological formation until they reach the surface at a specific site. The path of the seismic waves in the upper geological formation strongly influences their characteristics producing varying effect on the ground surface motion. Thus the ground motion parameters at a particular site are influenced by the source, travel path and site characteristics. The influence of local soil conditions on the ground response has been recognized for many years and its significance was felt during 1985 Mexican earthquake. There can be significant differences in local site conditions such as variations in geological formations, thickness and properties of soil and rock layers, depth of bedrock and water table, surface and underground topography. These variations would have significant effects on the characteristics: amplitude, frequency

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content and duration of strong ground motion at the surface (Carlos et al., 2006). The extent of the influence depends on the geometry and material properties of the subsurface materials, site topography and on the characteristics of the input motion. The significance of the local site effect on the earthquake-resistant design must be accounted for by the development of site specific design ground motions i.e. motions that reflect the levels of strong motion amplitude, frequency content and duration of a structure or facility at a particular site. Hence site specific design ground motion estimation shall include both seismic hazard analysis and ground response analysis. Seismic hazard analysis can be carried out by deterministic or probabilistic based methods considering the seismicity and seismotectonics of the region. Ground response analyses are commonly carried out by equivalent linear approach to predict the design ground motion parameters including PGA and design response spectra at the surface level. This article presents evaluation of site specific design ground motion parameters for a seismically vulnerable site near Ahmedabad, Gujarat by conducting a detailed seismic hazard analysis and ground response analysis.

SIGNSIFICANCE OF SITE-SPECIFIC ANALYSIS

The characteristics of the design ground motion at a particular site are influenced by the location of the site relative to potential seismic sources, the seismicity of those sources, and nature of rupture at the source, travel path effects, and the importance of the structure or facility for which the ground motion is to be used. Design ground motions are usually developed in one of two approaches: from site-specific analyses or from the provisions of building codes and standards. Although contemporary codes do consider site effects, they usually do so by lumping groups of similar soil profiles together so that their provisions apply to broad ranges of soil conditions within which the local conditions of a particular site are expected to fall. Because of this, the design ground motions developed from code provisions are usually more conservative (i.e. correspond to stronger levels of shaking) than those developed from site-specific analyses. The UBC adopts two basic approaches: static approach which considers the effects of ground motions represented by static lateral forces and dynamic approach in which ground motion is characterized by a design response spectrum. These approaches are based on developed hazard maps and provide zone factors that reflect to an extent the local site conditions. However these maps do not consider local variations at the site in developing the ground motion parameters, deeming it necessary to perform site specific ground response analysis for vulnerable sites and critical structures.

Site specific design ground motions reflect the detailed effects of the subsurface conditions at the sites of interest. The process involves development of site-specific ground motions by seismic hazard analysis and ground response analysis. The seismic hazard analysis will produce a set of ground motion parameters that may or may not correspond to the conditions at the site of interest. Seismic hazard analyses are based on a set of attenuation equations which usually correspond to a fairly narrow range of subsurface conditions. If the site of interest is located on a similar profile the parameters developed shall be taken as ground motion parameter. If not, the parameters developed should be suitably modified for the effects of local site conditions. The parameters can be modified by analytical or empirical approach. The former involves deconvolution and conventional ground response analysis (Kramer, 1996).

A site specific analysis for evaluation of design ground motion parameters of a particular site comprises of the following aspects

1. Site characterization based on geological, geophysical and geotechnical investigation
2. Site classification using the shear wave velocity profile

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