

Seismic Microzonation and Vulnerability Assessment of Buildings and Lifelines Using Detailed Site Information: Case Study for European Part of Istanbul

A. Ansal, A. Kurtuluş, G. Tönük

Boğaziçi University, Kandilli Observatory and Earthquake Research Institute

Abstract

A major earthquake is expected to occur within the next 30 years that could cause significant damage in Istanbul. A number of studies were carried out in the past to estimate the damage distribution for building stock and infrastructure system in the city. However, all of these studies lacked detailed assessment of site effects on the expected damage since limited information on local soil conditions were not available.

Recently an extensive site investigation study was carried out on the European side of Istanbul as part of a large-scale microzonation project financed by Istanbul Metropolitan Municipality. 2912 borings (mostly down to 30m depth with approximately 250m spacing) were conducted within an area of about 182 km² to investigate local soil conditions. Standard Penetration Test (SPT), Cone Penetration Test (CPT), PS-Logging, Refraction Microtremor (ReMi), seismic reflection, refraction and resistivity measurements were carried out at each borehole location. Samples collected in the field were tested in the laboratory to determine index and engineering properties of local soil within the investigated area.

In this study, a detailed microzonation of the area with respect to earthquake ground shaking parameters and liquefaction potential was carried out using the recently compiled soil data. Probabilistic and deterministic seismic hazard scenarios evaluated by Kandilli Observatory and Earthquake Research Institute (KOERI) and INGV (Istituto Nazionale di Geofisica e Vulcanologia) as part of an EU FP6 Project (“LessLoss - Risk Mitigation for Earthquakes and Landslides”) was used to conduct 1-D site response analyses to generate microzonation maps for ground shaking and liquefaction potential. Site-specific ground motion parameters were employed to evaluate vulnerability of building stock and natural gas pipeline system in the area. A building inventory composed of 24 building classes and region-specific vulnerability relationships that were proposed by KOERI were used to estimate damage distribution in the

building stock. Natural gas pipeline inventory provided by İGDAŞ (Istanbul Gas Distribution Industry and Trade Co. Inc.) and empirical correlations proposed in literature were used to assess expected damage in the pipeline system due to wave propagation and liquefaction induced settlements.

The resulting damage scenarios are compared to those performed earlier where NEHRP site amplification factors were used to take into account site effects as opposed to 1D site-specific response analyses carried out in this study. The comparison provided evidence that there are significant variations in the ground motion parameters within the investigated region which cannot be detected when the site conditions and their effects are evaluated using NEHRP site classification and related amplification coefficients. Therefore it appears essential to perform site response analyses to have more accurate information on ground shaking characteristics for estimation of seismic damage in buildings and lifeline systems.