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Overview of the studies on bedrock depth distribution beneath Istanbul, Turkey by microtremor measurements

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On August 17, 1999, a devastating earthquake with a moment magnitude of Mw=7.4 struck the Kocaeli and Sakarya (Adapazari) provinces, and part of suburbs of Istanbul in the northwestern of Turkey, a very densely populated region in the industrial heartland of Turkey. This earthquake is considered to be the largest event to have devastated a modern, industrialized area since the 1923 Great Kanto earthquake. This earthquake caused about 30.000 losses of life and collapsed thousands of buildings. Thus, total loss figure amounted to about $16 Billion. Following the losses during this large earthquake, there has been a broad recognition among Turkey governmental, non-governmental and academic organizations of the need for extensive response planning based on detailed risk analysis of likely seismic hazard, microzonation studies and ground-motion researches in Turkey, in general, and Istanbul particular. In this frame, several studies are performed to map the bedrock depth distribution in the west part of Istanbul. Local S-wave velocity-depth profiles and bedrock depth distribution are key factors in assessing seismic hazard and earthquake ground motion characteristics since they allow determination of the amplification potential of geological formations overlying bedrock. In a project supported by Istanbul University, S-wave velocity structure beneath the European side of Istanbul is determined. One of the aims of the project is to improve the knowledge about the influence of local geology on the expected earthquake ground motion. In this project, both array measurements and single station microtremor measurements at 40 sites are conducted. In another study by Birgoren etal. 2009, an empirical relationship between the thickness of Tertiary?Quaternary sediments overlying Palaeozoic bedrock and their resonance frequencies is calculated for the ?stanbul region and the bedrock depth distribution beneath the city is presented. The bedrock distribution beneath populated areas of ?stanbul is obtained by applying the derived relationship from this study to 86 strong-motion sites, where the resonance frequencies are known. Picozzi etal. 2008, have investigated the site characterization by seismic noise in Istanbul. Single station seismic noise measurements were carried out at 192 sites in the western part of Istanbul, Turkey. This extensive survey allowed the fundamental resonance frequency of the sedimentary cover to be mapped, and identify areas prone to site amplification. There sults obtained by this study are in good agreement with the geological distribution of sedimentary units, indicating a progressive decrease of the fundamental resonance frequencies from the northeastern part, where the bedrock outcrops, towards the southwestern side, where a thickness of some hundreds meters for the sedimentary cover is estimated. From these studies and the other studies, not mentioned here, the conclusion is that the bedrock dips towards SW from NE and S-wave velocity structure shows the presence of strong impedance contrast being responsible of seismic ground motion amplification. On the other hand, the particular distribution of fundamental resonance frequencies indicates that local amplification of the ground motion might play a significant role in explaining the anomalous damage distribution in the west part of Istanbul after the 17 August 1999 Kocaeli Earthquake.

Keywords: Earhquake disaster, Microtremor, Dominant frequency, Istanbul