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Linear modelling of seismic site effects in Bucharest City, Romania

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Bucharest, the capital of Romania, with more than 2 million inhabitants, is considered one of the most earthquake-endangered cities in Europe. Four major earthquakes with moment-magnitudes between 6.9 and 7.7 hit Bucharest in the last 65 years. The most recent destructive earthquake of 4th March 1977, with a moment magnitude of 7.4, caused about 1.500 casualties in the capital alone. All disastrous earthquakes are generated within a small epicentral area –the Vrancea region- about 150 km north-east of Bucharest at a hypocentral depth 60 km to 180 km. Two other strong earthquakes occurred in 1986 and 1990 in the same area and affected Bucharest City, but fortunately without victims.

Thick unconsolidated sedimentary layers in the area of Bucharest amplify the arriving seismic shear-waves causing severe destruction. Thus, disaster prevention and mitigation of earthquake effects is an issue of highest priority for Bucharest and its population.

Within the NATO-funded Science for Peace Project 981882 “Site-effect analyses for the earthquake-endangered metropolis Bucharest, Romania” we obtain a unique, homogeneous dataset of soil-mechanic and elasto-dynamic parameters. Ten 50 m deep new boreholes were drilled in the metropolitan area of Bucharest in order to obtain

the necessary data (dynamic tests at cores and vertical seismic profiles) for a new and modern map with site effects related to earthquake wave amplification. The boreholes are placed near URS stations (URban Seismology project 2003/2004, Ritter et al., SRL, 2005) or K2 stations (a strong-motion recording network) of the National Institute for Earth Physics, Bucharest (NIEP) to allow a direct comparison and calibration of the borehole data with actual seismic measurements.

The drilling and the Vp and Vs (seismic longitudinal and shear-wave velocities) measurements in the boreholes were done by the Technical University of Civil Engineering Bucharest (UTCB) in cooperation with the National Institute for Earth Physics, Bucharest (NIEP) in the years 2006-2007 (Bala et al., 2007). Rock samples were taken from each borehole at different depths for laboratory tests to determine the geotechnical parameters of each sedimentary rock type at the sites. Thus a valuable data base is assembled which contains: Vp and Vs values for each sedimentary layer, density and geologic characteristics of each layer, which are the basic data for equivalent linear modelling of the site; other geotechnical parameters measured in the laboratory on the rock samples will permit the nonlinear modelling of the site using Osinov's approach and the possibility of soil liquefaction during strong earthquake shaking.

Using the program SHAKE2000 we compute spectral acceleration functions at specific depths and transfer functions for the 1D models obtained from the in situ measurements. The acceleration response spectra correspond to the wave amplifications due to the package of sedimentary layers from 50 m depth (maximum depth) up to the surface, that are expected for a moderate real earthquake motion incident at the bottom of each 1D model. Because of the lack of outcropping bedrock in the Bucharest area, a seismic signal recorded in a borehole (BBI station, horizontal component) is used as input, and it is considered to be the same for the entire study area.