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Effects of local geology: evaluation of ground motion characteristics and liquefaction susceptibility at Itea site, Corinth Gulf (Greece)

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The evaluation of ground response at sites with complex geological conditions, especially in regions with liquefaction susceptibility, is one of the most important problems in geotechnical earthquake engineering. As regards seismic hazard assessment it is very important to describe beforehand possible geotechnical factors that may cause in relation to earthquake activity. Therefore, it is highly desirable to apply numerical tools with the purpose to estimate seismic ground displacement especially in areas where strong motion records do not exist and/or will not be available at least in the near future.

In Greece, a highly seismogenic region, a long number of liquefaction cases due to strong earthquakes have been documented (Papadopoulos and Lefkopoulos, 1993). In the Corinth Gulf, one of the seismically most active segments of Greece, several regions are quite susceptible to liquefaction due to alluvial fan deposits along its coastal zone. In the present paper we focus our research in the Itea region with the purpose mainly to evaluate the effects of local geology, through numerical calculation of the ground motion characteristics based on the effective (ES) and total stress (TS) methods, and to estimate simply the liquefaction susceptibility. According to the historical and geological criteria of liquefaction susceptibility the Itea site is quite suitable for the application of our numerical experiment.

Data from seismic refraction experiment and CPT N-values as well as the selected records of ground motion in nearby areas were combined for the construction of the input files for the numerical model. Through dynamic analysis, such as characteristics of ground motion as acceleration time histories, response spectra and amplification function, were evaluated and 1-D soil amplification effect was clearly shown. The liquefaction probability at Itea site was predicted on the basis of the factor of safety and the calculation of the induced settlement at the test site completed further analysis. Based on the results of the modeling two main conclusions have been made: (i) the presence of soft soil at Itea caused significant amplification (almost 2.5 times) of the underlying bedrock motion and, therefore, can contribute further to damage. Thus, it is strongly desirable for the engineers to include such an effect in code-documents for seismic-resistant constructions; (ii) Itea is highly susceptible to liquefaction due to presence of silty sand deposits at depth between 2.48 m (the position of water table) and 12 m, which show the rapid growth of EPWP ratio with the increase of PGA values.

Hopefully the conclusions, resolved from our modeling, will be helpful in modifications of criteria determination for the liquefaction hazard assessment and mitigation not only in the Corinth Gulf region but also to other liquefaction-prone regions.