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Geophysical/Geotechnical Applications to Urban Transformation: Example of District of Yildirim of Bursa City

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The city of Bursa, which is located near to the North Anatolian Fault Zone has a very active tectonic regime. The city has a local site effect problem, which is the subject of many studies for this region due to take place in the middle of the basin of the city center. However, in line with the law of new urban transformation, Turkey has started renovation of damaged old buildings and sub-urban buildings. The first example of study has been conducted in Bursa City Center in the district of Yıldırım and that has covered a big area. We used Turkish/Eurocode-8 Standard and Microzonation Criteria for all of this study. The study area covered 7 sub-district areas in particular the southern part of the conservancy district of the plains and northern part of the Uludag slope. We carried out geophysical (microtremors, seismic refraction method, surface wave analysis methods (MASW-MAM) and vertical electrical sounding) and geotechnical (boring up to 20 m and laboratory testing) studies at 75 sites to estimate elastical parameters, soil group, soil classification, and geological cross-sections. The study area was divided into two sub-areas as slope rubble (in the southern part) and alluvial deposits by using borehole data. Standard penetration tests were applied for each 1.5 m to all the boreholes and to estimate mechanical and index properties of soils, several laboratory test were applied to soil/rock specimens. Several soil problems such as soil bearing capacity, soil liquefaction potential, soil settlement analysis, soil amplification, soil expansion analysis were solved by using the results of geophysical, geotechnical and laboratory data.

For the study area, deterministic and probabilistic earthquake hazard analysis was performed and ground motion level (magnitude and accelaration of design earthquake) was estimated as Mw:7.4 and a: 0.41 g for exceedence rate of 30% in 50 years. These values guided the solution of soil dynamic analysis. Vs30 map of soils for the study region were obtained by MASW-MAM measurements. According to Eurocode-8 study area was classified as C type of soil (near to Ankara motorway, Uludag slope and Sirinevler district) and D type of soil (Northern part of study area: Ulus, Mevlana, Yavuz Selim distict etc.). According to soil amplification values, the study area was classified two sub-hazard region as lower hazard (from 0.0 to 2.5) and middle hazard (from 2.5 to 4.0). By using the Turkish Earthquake desing code, while the southern part of the study area is represented by Z3 type of soils, and the northern part of that is represented by Z4 type of soils.

By using the plastisity values and granulometry curves of soils, the properties of soil expansion were plotted. Generally, there are middle and lower expansion levels for clays in this area. There are also some areas which have high expansion levels/potentials (Arabayatağı, Hacivat, Mevlana, Ulus ve Cinaronu disticts). Plasticity limits were calculated by using the plasticity index, and non-plastic materials are a big part of the field.

Finally, we calculated the liquefaction potential of soil and analyzed soil settlement connected to it. Looking at the general geological characteristics of the study area by using results of the borehole data and laboratory analysis, we determined that fines content is low, sand content is high and underground water level is very close to the surface, and laboratory experiments were conducted with drilling operations. At this point, important knowledge for engineering structures is the amount of settlements due to liquefaction not liquefaction possibility itself. According to the analysis results we calculated settlement due to liquefaction over 10 cm and in the 1.5 km2 of the study.

Key Words: Yildirim District of Bursa, Urban Transformation, Soil Settlement, Geophysics, Liquefaction.