Abstract

The present dissertation deals with the evaluation of seismic loads of the subway of Thessaloniki. This effort falls within the scope of Thessaloniki's microzonation study and is located along the axis of the subway. At the same time with the seismic loads, we attempt to make a preliminary estimation of traverse and longitudinal (axial and bending) deformations, that are developed, as well as a preliminary estimation of seismic vulnerability of tunnels, for both bored/drilled and cut and cover tunnels. The study was based on elements from the preliminary study, which was carried out by the companies GEOGNOSI, GEOTECHNOLOGIKI and ATTIKO METRO, and on elements from the existing Thessaloniki's microzonation study.

The objective of this work was, in the first phase, the research of local soil conditions along the axis of the subway. For this reason a simplified geological – geotechnical profile, which was drawn by the above companies, was used. Furthermore, the survey was enriched by information resulting from numerous casual drillings and classical geotechnical tests CPT tests and cyclic triaxial tests, that took place in the nearby area. Afterwards, we dealt with the definition of the soil properties of each formation and the subsoil geometry. Then a site response study was performed, by means of one – dimensional (1-D) equivalent linear analysis program (EERA software). A variation of time histories (past earthquakes), that represent, as possible, the seismicity, the geological and morphological settings and generally the local conditions of the region of the project and a synthetic accelogram were used as input motion. A crucial point was the choice of the proper G – γ – D curves that would be representative of each soil formation. Finally, we used those of the microzonation study.

The work out of the results consisted of three stages. In the first one, we emphasized on the results of the site response analysis. Specifically, we dealt with the evaluation of an average response spectrum for acceleration, velocity and displacement and also the limits: average plus standard deviation and average minus standard deviation. The classification of the subsoil classes was made according to Euro code 8 and EAK2000. Besides, we estimated the variation, along the axis of the tunnel, of the maximum ground acceleration (PGA), maximum ground velocity (PGV) and maximum ground displacement (PGD), as well as the average expected price, for each one of the mentioned before magnititudes, in each site. At the same time, we estimated the variation, along the axis of the tunnel, of the fundamental period (resonant frequency), the amplification factor and the maximum shear strain.

The next stage includes the preliminary estimation of deformations. In chapter 2 we made a detailed description of deformities that are developed because of an earthquake in tunnels. We also gave equations of estimating transverse and longitudinal (axial and bending) deformations and a comparison between them took place. Finally, in the last stage, we made an effort to evaluate the seismic vulnerability of the tunnel, based on the fragility curves that are proposed by Hazus' 99.

For reasons of completeness, in the first two chapters a brief but concise report about the Anti – seismic Design of Tunnels and the expected seismic damage was presented that is accompanied by a rich photographic documentation of recorded damage in tunnels, from previous earthquakes.