ABSTRACT

This dissertation initially describes the analysis and the design of a bridge of ‘Egnatia Odos’ for earthquake loads. Then, its inelastic behaviour under seismic loads is examined and finally a seismic assessment of the bridge is made.

The bridge is designed according to the Greek code ‘EAK2000’ and the circular ‘E39/99’. SAP2000 V.10.0.7 is used for the analysis of the structure. The results of the analyses of some initial models of the bridge, that were made in order to investigate its behaviour under lateral loads, pinpointed the great contribution of the abutments in the resistance of seismic loads due to the existence of ‘Stoppers’ between the abutments and the deck. Dynamic modal response spectrum analysis is used for the design of the bridge.

In the second part of this project the structure is assessed under seismic loads using the non-linear static (pushover) analysis in SAP2000 V.10.0.7. The inelastic behaviour of the ground is modelled through P - y curves in the nodes of the foundation piles. Two groups of P - y are calculated which correspond in the maximum and the minimum limits of dissemination of the mechanic parameters of the foundation soil (layers of clay) and the inelastic analyses are then run for each of the two cases of ground (stiff and soft). The inelastic behaviours of the critical cross-sections of the piers and piles are estimated with the ‘RCCOLA’ software and thus the M - θ_{pl} curves are calculated. After that, for all the critical elements, the shear resistance in relation with the ductility is calculated and the shear failure is modelled in the elements where it occurs before the ultimate bending failure M_u - θ_u. Finally the stiffness and inelastic behaviour of the embankment is estimated in the longitudinal direction, so that the activation of the system embankment - abutment is modelled when the displacement of the deck reaches the joint length. Resistance curves of the structure are produced in the longitudinal and transverse direction and a seismic assessment follows for the displacement that corresponds to the design earthquake as well as twice the values of the previous displacement.

The results show a very good behaviour of the bridge for the design earthquake. For twice the displacement of the design earthquake the closure of the joint is expected and the activation of the system embankment - abutment which drastically increases the resistance of the whole structure and the safety factor against collapse remains high. In the transverse direction and for the case of soft soil some damage is expected in the piers and the abutment piles but the safety factor against collapse is still high. On the contrary, for the case of stiff soil shear failure is expected at the abutment piles and therefore the degree of damage at these places is significant. Stability issues also arise because the abutments are no longer able to withstand the permanent pressures of the embankment at the longitudinal direction.