ABSTRACT

This diploma thesis was worked out in the laboratory of Soil Mechanics and Foundations at the Department of Civil Engineers of the Aristotelian University of Thessaloniki. The main object of this project was to investigate the possibility to control the seismic response of R/C buildings through the intervention in the foundation soil, as well as to pinpoint those parameters that differentiate the behaviour of the soil-structure system after the intervention.

In the last four decades there has been a steady trend towards the use of ground improvement as a measure for the reduction of seismic consequences for the structured environment. Considering the observed behaviour of improved soils during seismic excitations on one hand, and the experimental results based on the soil improvement on the other hand, it becomes obvious that soil intervention results in more favourable seismic response of the improved ground against the neighbouring not improved one. These observations are developed extensively in the second chapter of this project. Already existing data have shown that the main parameter of the problem is the correlation of choice and design of the method of improvement with the final purpose of ground intervention, which is the reduction of ground deformations and therefore avoidance of unwanted consequences of the liquefaction phenomenon in the majority of already examined cases. The methods that have been developed include a wide variety of interventions, which can be categorized depending on the special site-conditions (type of soil profile, type of structure, ability of access and application, restrictions of level of improvement, pre-existing experience). Extensive report on subjects of choice, limits of application and design are reviewed in the 3rd chapter, which initially includes the general characteristics for every method of ground improvement. Furthermore, the specific aspects and design guidelines for three methods of intervention, namely grouting, micropiles and diaphragm walls, are more extensively presented.

The main perspective of the analysis part of this project was the attempt to investigate the influence of the ground improvement in the seismic response of the structure. Using the finite element program code ANSYS, a first set of analyses, as included in the 4th chapter, was obtained in order to examine the seismic response of soil profile and superstructure as independent systems. The comparison between the obtained analysis results and the theoretical or the existing ones, using a different code (MSC/NASTRAN), showed convergence in almost absolute degree

The 5th chapter of this project includes a series of parametric analyses of the soil – structure system as a whole, aiming at the investigation of how the intervention in the foundation soil alters the seismic response of the structure. The results that were obtained from this soil-structure seismic analysis show the comparison between the ground deformations inside and outside the improved area, as well as the differentiation that the intervention had on the base moment of the wall and on the top translation of the R/C dual structure that was examined. Thus the method of grouting was examined for a certain soil profile, for a certain structure (six floor dual system) and by using a real recording of seismic excitation as the loading condition. This method led into significant reduction of the base moment of the wall, thus resulting to the fundamental role that the geometry of the improved area plays in the final response.

The main part of the parametric analyses studies the method of diaphragm walls. As a first analysis stage, the inner distance of the diaphragm walls remained fixed in order to examine the influence of the soil type on the seismic response of the structure. Three dual systems (4, 6 and 8floor) founded on six different soil profiles, were seismically excited with three different seismic events. The obtained results showed that the effectiveness of diaphragm walls seems to be more sensitive to the type of soil profile than the fundamental period of the structure. Critical parameter in the seismic response of the structure is the shear wave velocity contrast of the 2layer soil profiles, especially when it equals the value of 2, since in that case the structure performed seismically favourable for all seismic events (the base moment of the wall and the top displacement reduced significantly).

Finally, a third set of parametric analyses was obtained, in which the inner distance of the diaphragm walls was changed respectively. While the ground displacement inside the area of intervention was decreased by the presence of walls, it was not significantly influenced by the change of distance between the walls. Furthermore, the response of the dual system remained favourable for every case of walls distance. The reduction of the inner distance of the diaphragm walls presupposes the ability of access and consequently it is applicable only in new structures. The addition of new elements in order to reduce the distance, leads to an important increase in the cost of intervention, parameters that should also be taken into consideration.