ABSTRACT

Title
Seismic design of Metro's underground structures. Practise on metro's station of Venizelos in Thessaloniki

Surname Name
Matsoukas Paraskevas
Flentzouris Vasilakis

Text

The purpose of this thesis is to study the behavior of large underground structures such as multi-storey metro stations under **static and seismic loading**.

In the first chapters of this thesis, validation of **ADINA** software was attempted by comparing the free-field ground response of a soil profile computed with ADINA with the corresponding results of **Cyberquake** software. The next stage consisted in performing a complete dynamic analysis of a **simple box - model**, using the validated ADINA software. The response results of this analysis were used for a comparison with the provisions of the **Greek seismic code,** as far as the seismic earth pressures of the vertical diaphragms of the structure are concerned.

The main part of this work was focused in the study of the behavior of **4 variations** of Venizelou metro station in Thessaloniki. These 4 variations differ in the type of their foundation. The 4 variations that were examined are the following:

i. Box - model with a 2.5m thick foundation slab.
ii. Box - model with a stiff 4m thick foundation slab.
iii. Box - model with a 2.5m thick foundation slab and extension of the vertical diaphragms under the foundation level.
iv. Box - model with a 1.5m thick foundation slab, extension of the vertical diaphragms and construction of a pile set under the foundation level.

The dynamic part of this analysis was conducted using the **complete dynamic time history analysis** in ADINA software. The structure was modeled in the 2D level. The ground was modeled with **plane strain finite elements** and the structure with **beam elements.**

SAP2000 software was used for the static analysis procedure, in which appropriate **springs** were attached to the structure to simulate the soil-structure interaction and beam elements were used to simulate the structure.

The piles' model, which demonstrated the best behavior under seismic and static loading, was used for a further **parametric analysis** concerning the assessment of the **best combination** between the **slab thickness and piles' arrangement**. The **uplift** had the most critical role in this assessment. The model which was qualified from this parametric analysis was analyzed with two methods in order to compare their results; the complete dynamic analysis and the **equivalent static analysis.**

RESULTS:

1. The validation of the soil profile's simulation demonstrated a very satisfactory correlation between the ADINA and Cyberquake software response results.
2. The resulting from the ADINA software seismic earth pressures acting on the external surface of the diaphragm are smaller than these of the provisions of the Greek seismic code concerning rigid walls and similar to these concerning yielding walls (Mononobe–Okabe).
3. The variation of the foundation system affects only the response of the part of the structure which is in the vicinity of the foundation.
4. The best behavior was demonstrated by the model with a 1.5m thick foundation slab, extension of the vertical diaphragms and construction of a pile set under the foundation level (model iv).
5. Based on the parametric analysis, the model with a 1.5m thick foundation slab and a 3x12 piles set was qualified.
6. The complete dynamic analysis leads to smaller response results and therefore to an inexpensive and reasonable structure while the equivalent static analysis leads to higher response results and therefore to a safer structure.