

Effects Of Urban Tunnel Excavation In Tehran In Response To Existing Static And Dynamic Structures In Terms Of Soil And Structure Interaction.

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ABSTRACT

Excavation of tunnels can cause the earth to move, which is significant in the static and dynamic response of structures. In this study, the effect of a tunnel excavation in Tehran city on the dynamic and static response of structures in three section has been investigated. In the first part, PLAXIS software calculates the following two step session before and after excavating. The second part of PLAXIS also performs dynamic analysis for both stages and the following acceleration response is calculated. The purpose of the second part is to investigate the impact of excavating on acceleration response and its use in SAP 2000 software as input for structural analysis. In the third part, structure in modeled in SAP 2000 software and the results of the first part of the displacements of footing are applied and by using accelerating response, the structure's nonlinear dynamic analysis is performed in two stages (PLAXIS output). The results of the analysis show that the tunnel excavation has increased the subsidence of foundation subsurface and the highest subsidence is in 6th model (Operation stage), which is 1.2 times the average of the previous one. The excavation has increased and the impact of the supporting structures during the execution phase compared to the operation stage where the concrete side walls are executed, has been effective in reducing the subsidence by 4% and maximizing the acceleration below 1.5 times and also in the structures the displacement increased by 1.25 times compared to the pre excavation phase response.

KEYWORDS

Urban Tunnel, Excavation, supporting structures, Dynamic Analysis, Subsidence

1-Introduction

Due to the increasing population, the need to build underground structures and Drilling urban transport tunnels has become inevitable to provide infrastructure [1]. In general Drilling of tunnels and other underground structures results in removal of Piles of soil and rock at the site and significant changes in environmental stress conditions and dynamic and static response of adjacent structures. Tunneling causes a change in the dynamic and static response of existing buildings. Therefore, Investigation and estimation of tunneling drilling effect on adjacent structures is of particular importance and it is necessary for tunnel design and construction engineers estimate the extent of drilling response to structures and determine whether or not these structures will be affected by drilling [2, 3]. he activities carried out in this area are related to Dimok research, which has done a lot of

studies on tunneling in urban environments and its contributing factors [4]. In 1993, Wang presented equations to determine the forces generated by tunnel cover during an earthquake [5]. Hashash in 2001, by completing Wang's equation to soil and structure interaction, has proposed an applied method for seismic analysis and design of tunnels and underground structures [6] Marinella et al., 2019 did Reinforcement a case Tunnel with concrete cover that reinforced in two layers of 30 and 40 mm, the first layer having no significant impact on the load but the second layer being effective in reinforcement [7]. Martino Gatia et al. In 2019 used a case tunnel with reinforced rou-plastic mortar and a layer of galvanized steel, which was used in the retrofitting of created cracks [8]. In this research also In order to evaluate the impact of urban tunnel drilling on the dynamic and static response of

existing structures, the necessary analyzes were performed in three parts using two PLAXIS and SAP 2000 software.. PLAXIS software was used for nonlinear dynamic soil analysis due to its inability to perform nonlinear dynamic structural analysis using SAP 2000 for nonlinear dynamic analysis which was a step-by-step task.

2-Methodology

According to the modeling, to determine the effect of tunnel drilling on existing buildings, an applied tunneling method has been applied. In this way, first, in PLAXIS software, By performing a static analysis The subsidence of the existing building under dead and live load is calculated in two steps before and after tunnel excavation. In the later stage of drilling, the calculation of the subsidence due to drilling is investigated in two parts. In the first part, which consists of 6 operating phases, in all phases the building assembly is calculated. In the first and second phase, the building is activated and in the third phase excavation and pile execution and Concreting around drilling is done. In the fourth phase drilling was carried out up to -22 m and the tunnel retaining structure was activated and Concreting around drilling is done. In the fifth phase drilling was carried out to a height of -28 m and the tunnel retaining structure was activated and Concreting around drilling is done. In the sixth Drilling of side platforms and implementation of the Anchor Element and the seventh phase, which is the post-implementation phase (operation phase) Guard structures are removed and the subsidence of structure is calculated. In the second part, the PLAXIS software also performs dynamic analysis for both stages using the desired record and the acceleration response under the existing building is calculated. The purpose of this section is to investigate the effect of tunnel drilling on acceleration response and use in SAP 2000 as input for structural analysis. In the third part, structure is modeled in APSAP 2000 software and the results of the first part of the displacements are applied to the foundation and the using the acceleration response (PLAXIS output Dynamic Nonlinear Dynamic Analysis of Structures is performed in two stages.

3-Analysis

3-1 Calculate the Building foundation subsidence.

For the pre-drilling phase, using the PLAXIS software, the soil and the existing building frame without drilling were modeled considering soil and structure interactions as shown in Fig. (1) and by performing static analysis the horizontal and vertical sub-basement displacements Calculated under dead and live load.

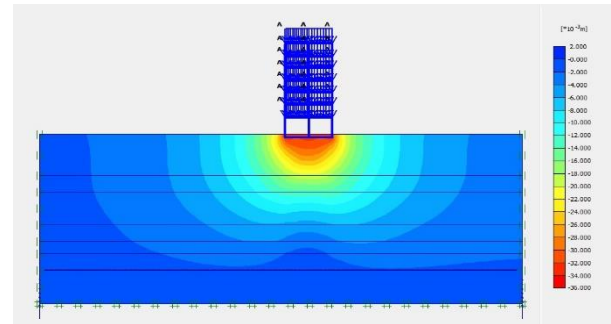


Fig 1. Structure foundation displacement, before excavation

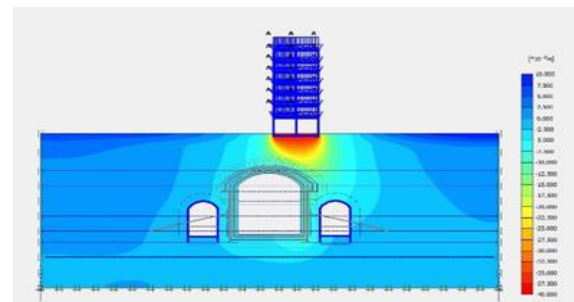


Figure 2. post-drilling step (model six)

In the post-drilling step, Fig. (2) calculation of the subsidence under the foundation due to drilling investigated in two parts. In the first part, Simultaneously with the drilling implementation which consists of 6 operating phases that In all phases the subsidence of the building is calculated.

3-2- Nonlinear Dynamic Analysis of Soil

In PLAXIS software, dynamic analysis with Irpinia record and considering soil-structure interaction were performed in two separate stages before and after drilling and the acceleration response under foundation was calculated. The purpose of this section is investigation effect of drilling on acceleration response and use in SAP 2000 as input for structural analysis.

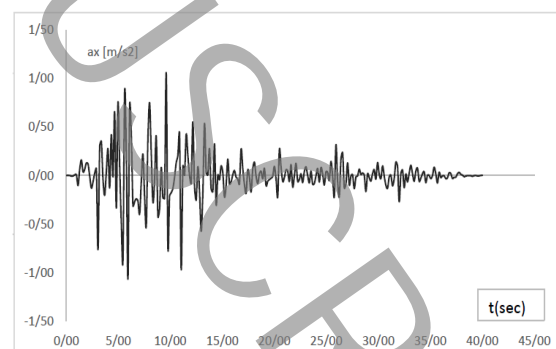


Fig 3. Acceleration response under foundation before excavation

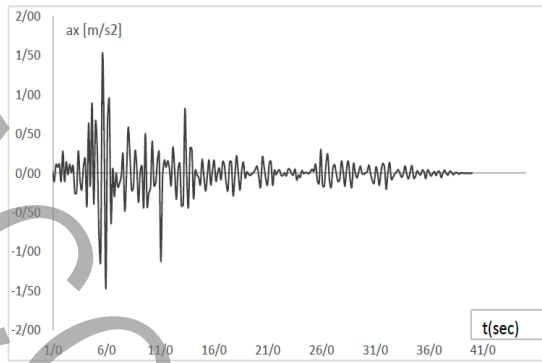


Fig 4. Acceleration response under foundation after Excavation

3-3- Nonlinear Dynamic Analysis of Structures

In this section, the structure is modeled in SAP2000 software and the results of the static analysis displacements are applied to the foundations of the structure and using the acceleration response (PLAXIS output) nonlinear dynamic analysis of the structure is performed in two-stage. Finally, the changes of the structural response due to drilling have been investigated and the results of the analyzes are presented in Fig. (5). Due to the figure, the impact of drilling on the seventh floor displacement response, the maximum displacement of the structure increased by 1.15 times compared to the pre-drilling phase.

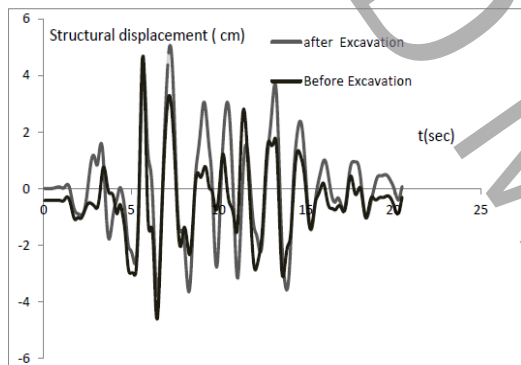


Fig 5 .omparison of Structural Change

4- Conclusion

In this research, first, to Verification the softwares, used the model of Castaldo et al that they had done the impact of drilling on the Italian Naples station adjacent to the Ferrari building in 2014, all stages of his research were modeled and analyzed. After validation, the present study was conducted in a case tunnel located in Tehran using PLAXIS and SAP 2000 software. PLAXIS software was used for dynamic nonlinear soil analysis and the because of its inability to perform nonlinear structural analysis, SAP 2000 software was used for nonlinear dynamic analysis of structures. In the first part, PLAXIS software calculates the subsidence of below the foundation in two-step session before and after drilling. In the second part in PLAXIS software dynamic analysis done for both stages and the acceleration response is calculated below the foundation. The second part aims to

investigate the impact of drilling on acceleration response and its use in SAP 2000 software as input for structural analysis. In the third part, the structure is modeled in APSAP 2000 software and the results of the first part of displacements are applied on foundation and the using of the acceleration response (PLAXIS output) the nonlinear dynamic analysis of the structure is performed in two stages. The main purpose of this study was to investigate the effect of tunnel drilling on the static and dynamic response of adjacent structures in which the rate of subsidence changes under the foundation and the role of guard structures as well as the rate of acceleration changes and displacement of existing structures due to drilling The tunnel has been calculated. The results of the analysis show that due to tunnel drilling, the subsidence of under the foudation is increased and the highest subsidence due to excavation is in Model 6 (operation stage) which average 1.2 times is Increased towards the pre-drilling stage and the impact of guard structures at the implementation stage compared to the operation stage where the Side concrete walls is made effective in reducing the 4% subsidence and the maximum acceleration below the foundation 1.5 times increased, and in the structure, the displacement 1.25 times is higher than the pre-drilling response. The usage of this research can be useful in identifying structural vulnerabilities before and after construction.

5- References

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