PalArch's Journal of Archaeology of Egypt / Egyptology

SUSTAINABILITY STUDIES OF THE EYVAN TUNNEL AND ITS ROADS IN ORDER TO IMPROVE THE ROAD

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Zabihollah Tajbakhsh, Mostafa Sharif Zadeh: Sustainability studies of the Eyvan tunnel and other road in order to improve the Ilam-Chawar- Eyvan -- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(9). ISSN 1567-214x

Keywords: Sustainability Analysis, Tunnel, FLAC3D, Road Improvement

ABSTRACT

The Ilam-Eyvan road is currently most important connection route of Ilam province with the central regions and other neighboring provinces. The purpose of this paper is to study the stability of the Eyvan tunnel. Sustainability and instability assessment of underground Drillings and tunnels are the most important parameters in designing this structure. There are various methods for analyzing the sustainability of underground spaces that can be used to analyze the stability of underground spaces and determine their storage system. The most reliable way to analyze the stability of these spaces is to use a number of different methods for analysis so that these methods complement each other, deliver more reliable and optimal results. In the most general case, the tunnel is evaluated using empirical methods and also primary preservatives are predicted based on the initial analysis, and then analyzes are performed more accurately using analytical or numerical methods. In this study, FLAC3D software was used for modeling and analysis of the Eyvan tunnel. The results and diagrams with the software included changes in shape, principal tension and shear stresses in different sections of the drilled tunnel. On average, the result of calculations showed a concrete cover across the tunnel.

INTRODUCTION

The basic axis in designing any underground space should be based on the use of the stone itself as the main fabric of the instrument. In designing the drilling process, as much as possible, the amount of fracture and loose stone around the tunnel may be minimized to decrease the need for a maintenance system. Usually the "master rock" in primed state and before exposure to stress is much stronger than concrete, and many of them are in the same resistance to steel. As a result, it's not an economy that has changed materials such as rock that might be resistant enough to other materials that are known to be better than rocks. The extent and scope of the use of the rock as a protector and maintainer depends on the geological conditions that prevail in the tunnel site and depends on the extent to which the designer is sensitive to these conditions and how much he wants them to be in the design. Underground structures are extremely complex buildings, and the only theoretical tools that the designer has available and can help with, are a number of simplified and incomplete models of some processes that interfere with the control of underground structures. Therefore, in order to solve the design problem, the designer is faced with the requirement to make a decision to solve the design problem and get result in which his engineering judgment plays an important role. In designing and calculating such buildings, it is always necessary to consider the implementation method, since different execution methods require different design and calculation methods. There are various methods for analyzing the sustainability of underground spaces that can be used to analyze the stability of underground spaces and determine their storage system. The most reliable way to analyze the stability of these spaces is to use several different methods for analysis so that these methods complement each other, deliver more reliable and desirable results.

AN OVERVIEW OF LITERATURE

Sustainability and instability assessment of underground caves and tunnels is one of the most important parameters in designing this structure. In different stages of stability analysis and design of tunnel storage system, in addition to geological factors, the use of a rock mass classification method is very useful. By relying on a classification system, one can obtain a general idea of the status of the rock and, as a result, its stability. The tunnel analysis allows us to examine how the tunnel engineering behaves in different conditions. In brief, several studies have been conducted on the study of tunnels whose stability has been investigated by empirical and analytical methods.

A Resalat tunnel with a length of 1900 meters passes through dual tunnels from below the residential area of which the land consists of alluvial deposits, often sandy and gravel, with a low throughput of 7 to 33 meters. The stability of this tunnel is based on numerical analysis using FLAC, NISA software. The results of this analysis show that the construction of dual mission tunnels leads to stress concentration in the final cover of the tunnel, which may threaten the stability of the tunnel. By modifying the geometry and the method of construction, this concentration can significantly reduce the inducing stresses.

Safa Dam is located in Kerman province, and in 30 km northeast of Baft city. In this study, the stability of the tunnel in the related formation (marl and Lichen alternation) has been investigated for the stability analysis required by existing experimental methods such as Q, RMR. FLAC software has been used to analyze the stability of this tunnel. In general, all calculations were carried out in three stages before and immediately after the drilling tunnel and also after installation of the maintenance system. At each stage, all tensions and displacements were calculated around the tunnel. Finally, for controlling the displacements around the tunnel, by comparing the results of the experimental and numerical methods, the best maintenance system is technically determined for the tunnel.

The Lavasan Water Transfer Tunnel is located in 30 kilometers north-east of Tehran, and the stability analysis and maintenance of the tunnel have been carried out based on Q, RMR and numerical methods. The results of the research show that, considering the specific condition of the tunnel, its diameter and thickness vary for maintenance The tunnels should be used with different diameters and diffusion and different thicknesses of concrete. Due to the specific geometry of the space and the complexity of the topography of the area and the loose rock mass around the tunnel, the instrument system is installed in the tunnel. At first, data from the installed instrument was processed and then the return analysis was performed using the FLAC direct analysis program to find geomechanical parameters and horizontal stresses.

The 6-kilometer Boston tunnel in the United States, the Transcula tunnel in Hawaii, in 1069 meters in length, the Northbridge Bridge tunnel in Austria, 1600 meters in length, the Süssberg tunnel in 9.2 kilometers in Switzerland, which has been run twin, a tunnel Mont Blanc spans 11.6 kilometers across the Alps.

TUNNEL SUSTAINABILITY ANALYSIS METHODS

In the most general case, the tunnel is evaluated using empirical methods, and primary preservatives are predicted based on the initial analysis, and then analytical or numerical analysis is done more accurately.

Analysis of the Eyvan tunnel stability using empirical method

Geomechanical classification of rocks (RMR)

In the RMR classification, six parameters are used to classify the rocks, that each of them according to the existing tables adds points. Finally, the total of these points determines the amount of RMR of the rock. In this classification, the quality of rock masses is determined by examining a number of physical factors affecting its mechanical and strength characteristics. According to geological evidence, the tunnel range is divided into eight structural zones. Generally, the classification of these zones is within the range of medium rock, but at the entrance to the tunnel in the area of approximately 500 meters, the tunnel section is located in a good rock area. In the same area, the parking is predicted. Predicted kilometer for tunnel is approximately 350 + 2 km to 393 + 2 km. Also, the existence of a fault in an approximate 510 + 2 to 540 + 2 km from the tunnel leads to the requirment for stronger retainers in these sections, which have been analyzed, and also the prediction of the required preservatives in the geological table is obvious. Of course, that these ranges are not completely accurate and only obtained on the basis of the evidence that the geologist has taken from the field survey from the surface of the earth. Therefore, there is a permanent geologist in the workshop and a continuous examination of the rocks in the drilling site.

Classification based on Tunneling Quality Index (Q)

This classification is used to examine the stability of tunnels and design their storage system. In this classification, six parameters are considered, that each of them for given stone, a concession is granted according to the tables, an award, and finally, by placing them in the proposed Barton relations, the numerical value Q is obtained.

Analysis of the stability of the tunnel in a numerical way

Now numerical methods are the most comprehensive calculation methods for various engineering issues. Considering the problems encountered in numerical simulation of these structures in terms of complex soil or rock behaviors and their various behavioral models, the presence of water in the soil or the presence of the crucible in the rock, and the interaction of soil and structure, which continues to the world, in this relation has been developed and prepared for specific geotechnical and geomechanical issues. The FLAC3D software has many abilities, including calculation of large shapes, various soil behavioral models, step-by-step drilling capabilities in 3D space, and more. Therefore, FLAC3D software is suitable for studying the stability of the tunnel. The general stages of modeling in the FLAC3D include the selection of a suitable range of rock or soil and the design of the geometry of the model, selecting the appropriate behavioral model and determining its parameters, applying boundary conditions and initial stresses, changing the model, solving the model.

MODELING THE TUNNEL EYVAN

For drilling operations to be simulated in a numerical model step-by-step, and the stability analysis to the extent possible is similar to the real state, we will model the Eyvan tunnel in a three-dimensional. In modeling the tunnels at first, the environment of the area is considered without any drilling and the environment is analyzed based on the mechanical properties of the rock in order to obtain the initial tension in the environment. Then, in the next step, the obtained displacements in the previous step be zero and then drilling is done step-by-step for the problem. This capability is available in the program after completion of each stage of drilling and achieving equilibrium, displacements, normal stresses, shear tension, volume strains, and shear strains and so on.

In the modeling of the tunnel output, in order to simulate the drilling as close as possible to the actual state, it has been attempted, in the subsidary fault zone where the characteristics of the rock are weak, as it can possible, the length of the element is small (2 meters is selected) and in each stage of drilling is considered as the length of an element from a drilled tunnel of the primary retainer and then framed if necessary. From the spatial point of view, the progressive drilling fronts and the performance of the primary holders differ in such a way, depending on the rock material, the holders may have three or four stages of delay compared to the drilling face.

THE RESULTS OF TUNNEL INPUT ANALYSIS

Figure 1 shows the elementalization of rock mass in the tunnel section. Figure 2 shows the cross section of the excavated tunnel in the arch area. Figure 3 Show the modeling environment (tunnel outlet part) as a zoned three dimensional. The tunnel has been analyzed in two stages. In the first stage, at each stage, the half-section of the arc is drilled, and then the primary covering is executed until reach to the end of the model portion step-by-step, and the results of this analysis are presented below. The use of the primary coating in the section after the drilling at that time was carried out immediately in areas where the stone is weaker, and in areas where the rock type is average, between the working surface and the preliminary coverage of the distance up to 20 meters,

In the second step, drilling is done step by step in that section, and then the initial cover for that wall is defined in each step.

The results in this section are more focused on the main tension, displacement, shear and strain in the transverse section in the analytical zones 1 (450 + 2 km), 2 (sub fault per km 525 + 2), 4 (Kilometers 700 + 2), 7 (km 100 + 3) and 8 (km 218 + 3).

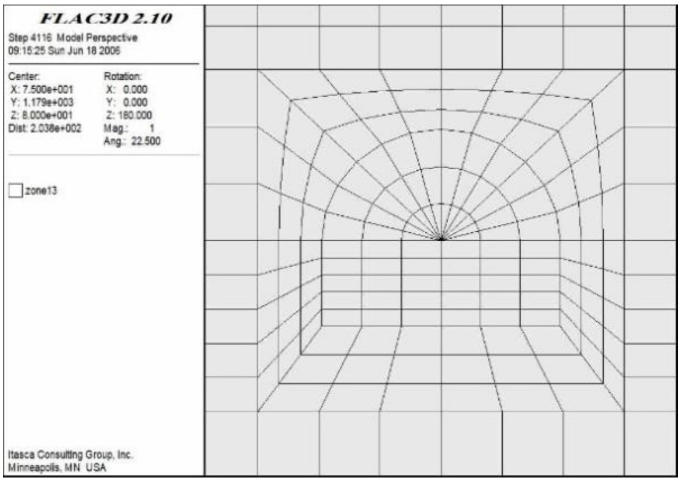

Figure 1. Transverse section of the model (Eyvan Tunnel Enviroment) at the entrance part.

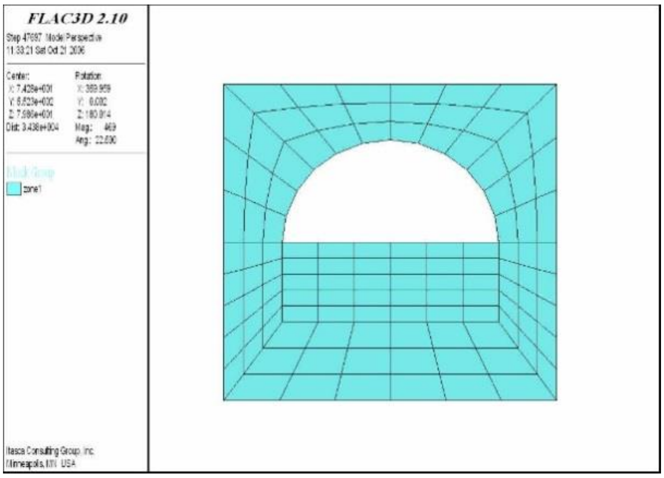

Figure 2. Elementalized transverse section of entrance of the Eyvan Tunnel after drilling the top half.

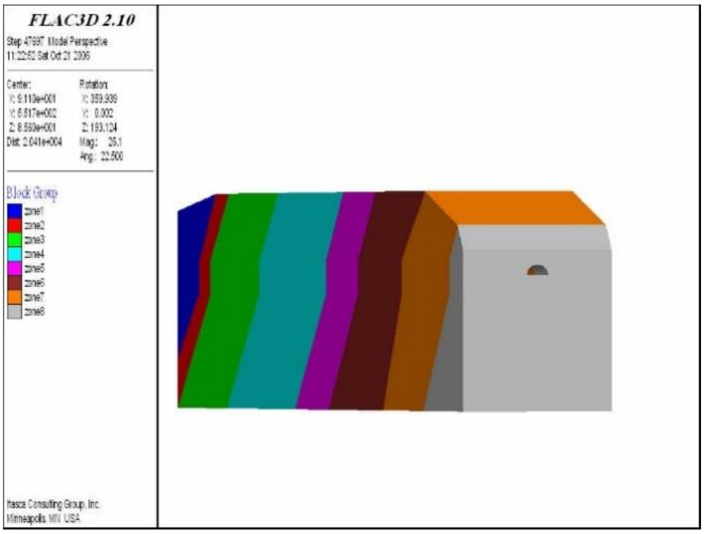

Figure 3. Zone longitudinal section of the entrance of the Eyvan tunnel.

Figure 4 shows the tunnel under conditions where its cross-sectional length has been completely removed in the tunnel. The color difference seen inside the tunnel is due to the various rock types along the tunnel. Figure 5 shows the vertical displacement transducer at the tunnel section in km218 + 3. The maximum displacement of the tunnel crown is 3 mm downward. The bottom of the tunnel is up to 17 mm in height. Figure 6 shows the main tension tunnel at least at the entrance of the tunnel. We have the highest level of tension in the wells of the drilled area, which is in the range of 1250-1000 kPa. The tensile strength of the tunnel is 500-550 kPa. Figure 7 shows the volume strain contour at the entrance to the tunnel. The maximum amount of strain on the tunnel section is at the bottom of the tunnel, but in the tunnel body, the maximum amount of strain in the tunnel. Figure 8 shows the shear strain conic at the entrance to the tunnel. The maximum amount of shear strain of the tunnel section is at the bottom of the tunnel, but in the tunnel body, the greatest amount of shear strain is in the tunnel.

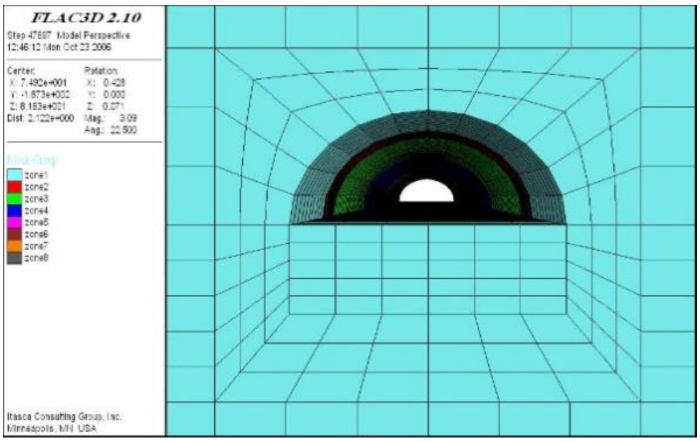

Figure 4. The half-section drilling performed during the tunnel.

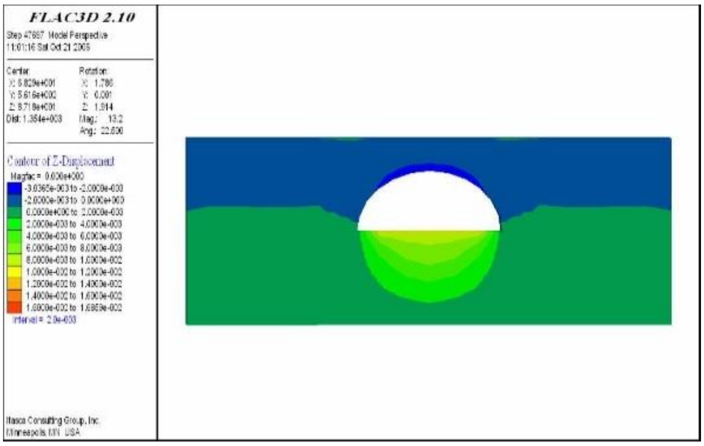

Figure 5. Vertical displacement contour at the Transverse section in 218 + 3 km.

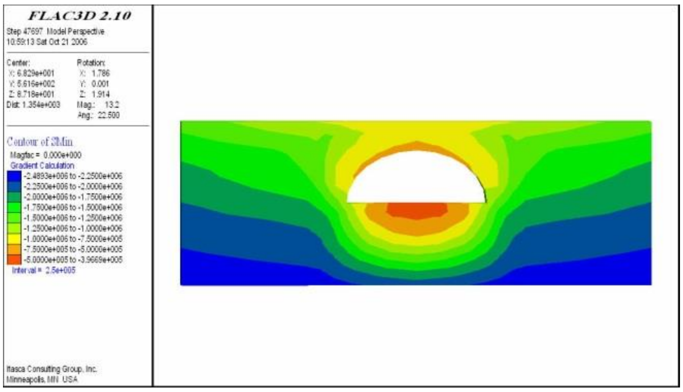

Figure 6. Main stressor contour at a cross-sectional area of 218+3 km.

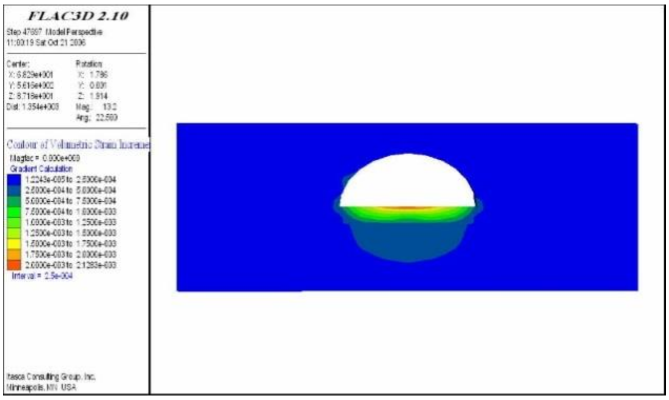

Figure 7. Volume strain contour around the drilled section in kilometer in 218 + 3km.

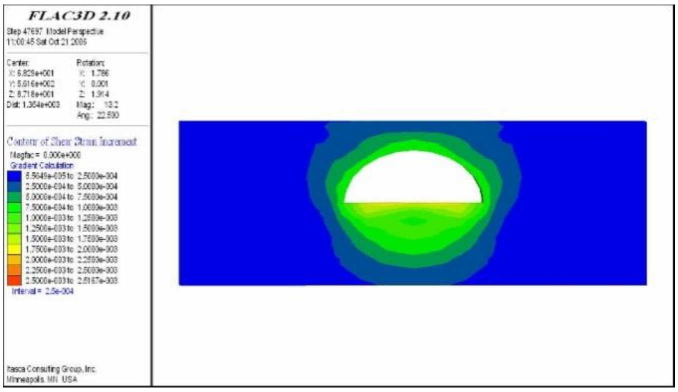

Figure 8. Shear strain contour around the drilled section in km 218 + 3.

After finishing the upper half of the tunnel drilling, drilling starts in the lower area. To simulate the drill more, the initial maintenance execution has distance 10 to 20 meters away from the front. The input file is defined in sequence. After each 4 to 5 drilling stages, that are saved the outputs of the program.

Figure 9 shows the vertical displacement contour at the entrance to the tunnel at km 218 + 3 after complete drilling. The maximum displacement of the tunnel crown is 6 mm downwards. The bottom of the tunnel is up to 10 mm in height. Figure 10 shows the main tension tunnel at least at the entrance to the tunnel. We have the highest tension level in the drilling tunnel, which is at 1000 kPa. In the crown of the tunnel, the pressure tensile strength is 800-600 kPa. Figure 11 shows the volumetric strain rate at the 218 + 3 tunnel. The maximum amount of strain on the tunnel floor is 7.03e-4, but in the tunnel body, the maximum amount of strain in the tunnel crown is4e-4. Figurre 12 shows the shear strain rate at 218 + km. The maximum amount of shear strain of the tunnel section is at the bottom of the tunnel, but in the tunnel body, the greatest amount of shear strain is in the tunnel bore. Figure 13 shows the rotation of the main tension around the tunnel section. As you can see in the figure, tension concentrations arise at the angle of inclination. In the tunnel arch, maximum tensions are tangentially formed on the drilling depth.

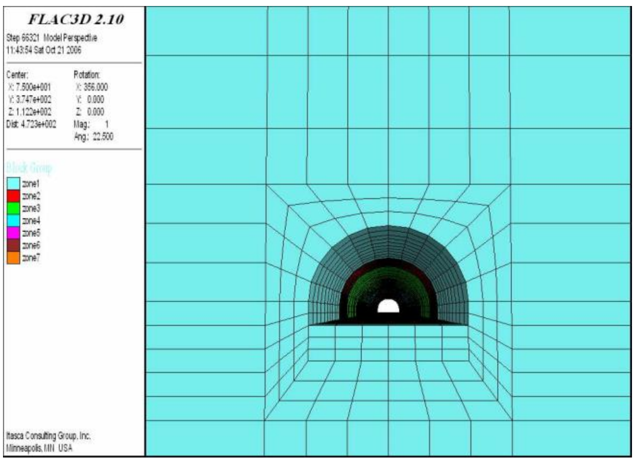

Figure 9. Drilling all sections of the tunnel in the total length of the outlet.

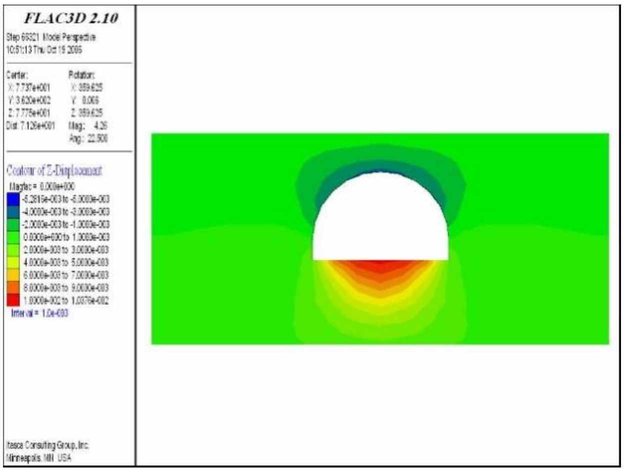

Figure 10. Vertical displacement cantactor, in cross section, km 218 + 3 for complete drilling.

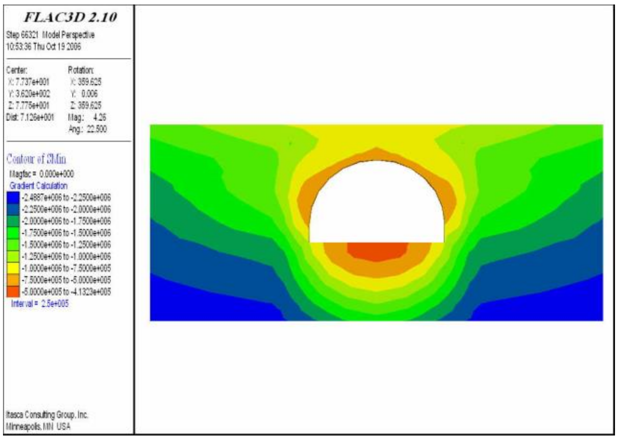

Figure 11. Main tension connector at least in cross-section 218 + 3 for complete drilling.

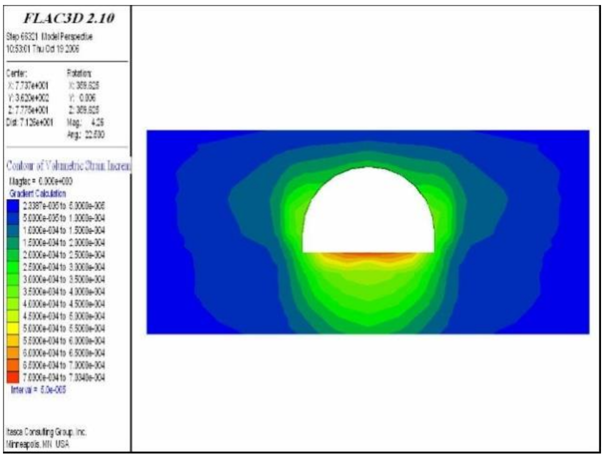

Figure 12. Volumetric strain contactor of cross section 218 + 3.

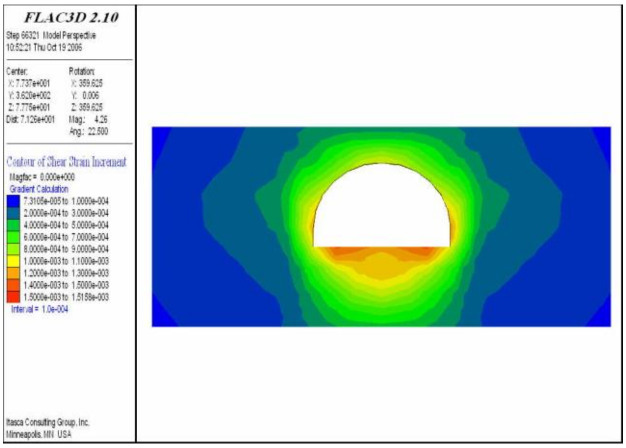

Figure 13. Shear strain in cross section 218 + 3.

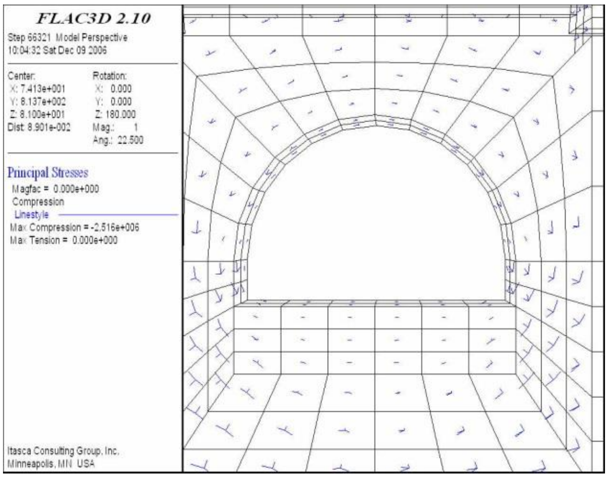

Figure 14. Rotation for the main tension of the cross section 218 + 3.

CONCLUSSION

Based on studies done in simplistic studies and without drilling exploratory wells, the tunnel area has a relatively good stability. Therefore, tunnel drilling with two-stage explosion method and the implementation of primary protective coating is recommended in the tunnel arch and the final coating is applied on the entire length of the axis. It should be noted that during the drilling in the tunnel there are cases that may have been hidden or unplanned at the initial stage of geological studies, so it is sometimes necessary to be later designed by observational methods. The design of underground spaces by observation methods involves interpreting the behavioral information during construction. Therefore, basically, "an observational design method is a kind of method with advance. The wall of the tunnels, under the influence of changing the stresses of the earth, shows a reaction around them that the displacement of the walls and the cross section of the tunnels is the most obvious of these phenomena. Information about the displacement or convergence of the tunnel wall, which is measured continuously through a specific timing program by installing precision tools around the tunnel, can be used to estimate the tension, strain, or behavior of the rock around the tunnel. Information about the distribution of tension around the tunnel can be great help in analyzing the stability and adopting methods for preventing the probability of tunneling. According to the geological evidence, the tunnel range of the Eyvans was divided into eight structural zones.

Generally, the classification of these zones was in the middle range, but at the entrance of the tunnel in the area of approximately 500 meters, the tunnel section is located in the appropriate rock area. In the same area, preparation of parking is predicted. The kilometer for the tunnel is predicted about 350 + 2 to 393 + 2. Also, the existence of a fault in an approximate 510 + 2 to 540 + 2 km from the tunnel caused the reinforced holders in these sections to be embedded in the analyzes carried out, and also the prediction of the required preservers in the geology table, is clear that these ranges are not completely accurate and only obtained on the basis of the evidence that the geologist has taken from the field survey from the surface of the earth. Therefore, there is a permanent geologist in the workshop and a continuous examination of the rocks in the drilling site.

The FLAC3D software used for modeling and analyzing tunnel in the Eyvan tunnel studies report. The results and diagrams obtained with the above software, including deformations, tensions and shear tension at different sections of the drilling tunnel, which are in the third chapter. It is explained in detail. The results of the calculations are based on a stone's thickness of 70 centimeters in the arch and 100 centimeters in the cushion.

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