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Research Article**Data visualization utilizing 3D technique at roof characterization in tunneling****Cihan Dogruoz^a , Eren Yurdakul^{b,*} , Mehmet Emin Ozdemir^c** *a,b,c Cankiri Karatekin University, Faculty of Engineering, Civil Engineering, Cankiri, Turkey***ARTICLE INFO****ABSTRACT***Article history:*

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Rock characterization visualization technique is used for determining the rock mass prediction in underground tunneling. Drilling the boreholes in tunnels to identify and figure out the roof rock specifications is indispensable to create 3D maps and also designing the 3D rock layers. After gathering the information of borehole coordinates, designing, modeling and investigation of the boreholes in roof of tunnels needs to be well organized. The inaccurate estimation of rock mass layers at the roof of tunnels can cause needing more time to schedule and affect economical costs in time. In contradistinction of gathering data of boreholes on the top of tunnels, data belonging to the boreholes is obtained by using rock bolters in roof characterization. Generally, the lengths, diameter and spacing between boreholes are standard and easy to get the information about rock masses in 3D. Mapping and designing the 3D model of boreholes and rock structures together help us to see the cracks and also gives us the dispersion of different zones in roof. In this study, 3D rock characterization of visualization for underground tunnels was modeled based on possible dataset.

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1. Introduction

Rock characterization and rock mass imaging processes have gained importance in the tunneling industry in recent years. This has led to an increase in three-dimensional imaging processes in tunneling. In many studies, three-dimensional imaging processes are performed by different software. However, all software programs depend on same basic dataset creation technique. For that reason, it is very important to prepare the data set correctly and regularly.

There are several research based on 3D visualization to evaluate the underground tunnels and the rock formations. Not only the tunneling but also the petrological, geochemical, geochronological, and structural studies can also be applied in underground. In this study, possible 3D visualization modeling technique for tunnels are shown. The main focus of this study is that if any results related to rock parameters and results exist, it can be very easy to forecast and model the tunnels in 3D visualization [1,2,3].

2. Tunneling**2.1. Data Visualization in Tunneling**

In tunnel projects, determination of tunnel coordinating plays an important role during the scheduling. This impacts the economical parameters in tunneling. Some researchers developed performance prediction models for horizontal tunnels [4]. In tunnel construction, maintaining a safe work environment often involves installation of suitable rock characterization. It is very common to use rock bolts in tunneling projects with simple installation.

Moreover, support capacity and low costs are also significant in these projects. Selection of rock bolts depends on correct form of the identification of geological conditions. In short distances, these conditions can be changed based on rock characterizations [5].

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Figure 1. Flow sheet of designing 3D visualization in tunnels

However, it is not easy to get more information about the rock formation and borehole measurement scales. For that reason, finding out the real coordinates of rocks are necessary to forecast and determine the future steps of tunnel modeling. Ground support for roof characterization has been attracted by some researchers due to the operational interruptions in short time in order to get the geological information. Such maps will in turn allow for development of hazard-maps and 3D data visualization of the ground. Furthermore, for ground supporting, the information can be applied to focus on the availability of the ground characterization. Available and applicable borehole logging systems including rock parameters can easily be designed and created using specific software. Figure 1 shows the preparatory process of 3D data visualization using in tunneling.

2.2. Borehole Logging

Logging of boreholes is highly impressive alternative to show the predictive situation for some physical properties of rocks. The bore hole is continuously recorded and later would be related to rock type, rock mass and some physical properties. Since the tunnels involve dealing with a small amount of data, there is a need to be able to visualize the recorded data from various boreholes in a 3D so that it could be interpreted and presented easier [6]. Initial efforts in developing a 3D visualization of the borehole roof characterization data have been done by using software packages in this study.

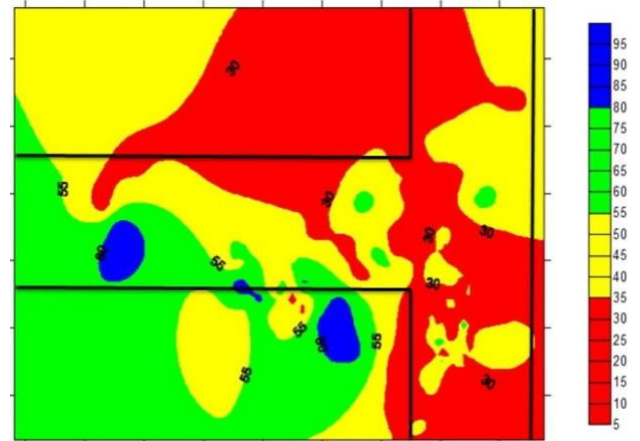


Figure 2. Determining the Tunnel section on roof characteristic using mapping

The objective of this exercise was to illustrate the encountered rocks and possibly rock mass specifications in a borehole around the tunnel opening in 3D modeling. By detecting the position, distance, and frequency of the discontinuities in boreholes using the instrumented roof bolter, it is possible to calculate the rock parameters of each borehole based on getting samples and further plots in different sections. Additional efforts are underway to work with other visualization software to select a platform for future developments and to enable the programs to show the stratification around the opening and to develop an algorithm for ground support evaluation and mapping of the failure risks.

Geologic structures, borehole and borehole database can be modeled and be integrated with the other models for purposes of scientific visualization. Data descriptions, coordinate information procedures and modeling techniques are investigated as the best visualization method in tunneling. Examining the boreholes and mapping, these boreholes are very important to forecast in roof characterization technique and underground works [7]. Data collection, data loading into the special software program and creating the 3-D visualization should be coordinated via true actual database. During the data processing, although the data are provided with spatial coordinates in terms of the local surface grid, it is felt that three-dimensional modeling and visualization of the subsurface data will be most useful if rendered in terms of the tunnel coordinates. Figure 2 shows the mapping of rock characterization of the boreholes at the top of a tunnel. As it can be seen on the map, there is the plan view of the tunnel section. Using these rock mass layers, 3D rock layer models can be visualized and drawn by software shown in Figure 2.

Figure 3 shows the roof part of tunnel design using roof characteristics and layer formations. Initially, the top of the tunnel design is applied while visualizing and then the bottom of the tunnel is designed.

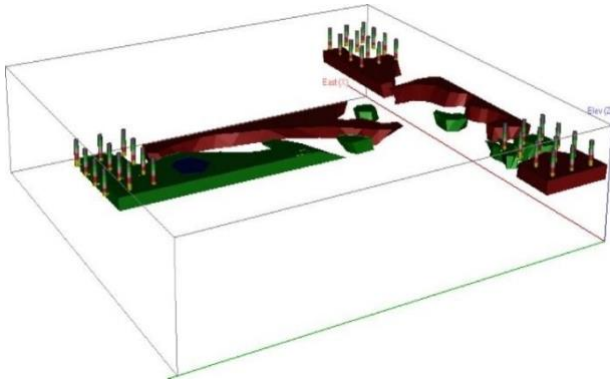


Figure 3. Determining the Tunnel section on roof characteristic using mapping

Creating the tunnels with rock layers and boreholes help us to forecast the strength of roof and also let us know which part of the roof is available to drill rock bolts. In figure 4, horseshoe shaped tunnel and boreholes are modeled with 3D rock layers through the holes. In 3-D modeling of the borehole and borehole data, it is necessary to calculate the coordinates of each of the observation locations in 3-D space. By incorporating core logs and assay data with the drill-hole paths, the software calculates the 3-D coordinates of each data point. The result is a file of data with associated borehole identifiers, 3-D coordinates, and associated software modeling calculation. Figure 4 shows the possible scenario of roof rock layers using rock parameters and specific energy results as well.

3. Conclusions

This study describes a possible scenario of roof rock characterization in tunneling. The use of data obtained from the formation to characterize the ground around an opening can be a substantial resource in understanding the models without interruption of the tunneling operations and related activities. Moreover, in this study, the modeling efforts have been carried out in producing reasonable three-dimensional renderings of the rock parameters information included in the borehole data. The 3D visualization borehole data technique is better solution to represent the ground conditions in underground working. It also generates the 3D data visualization value and shows the integration by comparing the original database with arranged ones. Ultimately, the generated information can be utilized to develop a 3D view of the geology of the ground for the roof using a software program for data visualization.

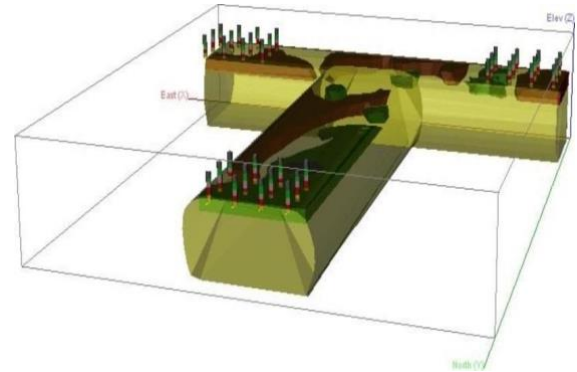


Figure 4. 3D data visualization of roof rock characterization in tunnels

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