Overcoming on Geotechnical Problems in Imamzade Hashem Tunnel by Using Innovative Rock Support System

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Abstract: Imamzadeh Hashem's neck variant with 25 Km long, forms the important and impassable part of Haraz road. This part of the path has been ascending and descending (slopes up to 9%), with large and small arc radius up to 35m. Apart from safety issues, cold, ice and avalanche problems, this part of Haraz road had very low geometric features and about 40 percent of Amol - Tehran road problems, and 70 percent of winter problems related to this part. So to lessen the problems Imamzadeh Hashem's tunnel with 3189 m had been excavated. During tunnel construction, engineers are faced with many problems. In this paper, the analysis of geotechnical problems and deal with it will be discussed.

Key words: Tunnel, Geotechnical Problem, Road.

INTRODUCTION

Imamzadeh Hashem's tunnel is a road tunnel under Ozaneh mount, which located in 52° 2' 35" longitude and 35° 50' 40" latitude and at a distance of 95 km of Amol. This tunnel with a length of 3185 m, gradient 2.5%, extends from north to south, has a horseshoe-shaped section with 9.5 meters wide, 7.2 m high and 97 m2 cross-sections. Maximum of overburden in this tunnel is about 450 m (Giovanni Barla, 2000).

All the construction operations on part 1 Imamzadeh Hashem's variant with a length of 5.4 Km from 0 Km to 5+400 Km include construction operations, technical buildings and construction a tunnel with a length of 3189 m.

This variant start from 1+107 km of Amol-Tehran road and about 4.5 Km from south of Plour then in 1+448 km inter the tunnel and after passing the tunnel it extended to 5+400 km in Mosha valley. According to administrative divisions, it starts within Mazandaran province (Plour) and ends within Tehran province (Mosha-Damavand) (figure 1)(Giovanni Barla, 2000).

Fig. 1: Project location.
Squeezing stands for large time-dependent convergence during tunnel excavation. It takes place when a particular combination of induced stresses and material properties push some zones around the tunnel beyond the limiting shear stress at which creep starts. Deformation may terminate during construction or continue over a long period of time (Barla, 1995) (Iran Oston Consulting Engineering, 2008).

In the landmark paper on tunnelling by Karl Terzaghi (1946), “Rock defects and loads on tunnel supports”, the following definition of squeezing rock is given: “Squeezing rock is merely rock which contains a considerable amount of clay. The clay may have been present originally, as in some shales, or it may be an alteration product. The rock may be mechanically intact, jointed, or crushed. The clay fraction of the rock may be dominated by the inoffensive members of the Kaolinite group or it may have the vicious properties of the Montmorillonites. Therefore the properties of squeezing rock may vary within as wide a range as those of clay”. When proceeding a little further, with the purpose to “inform the tunnel builder on the steps required to get a conception of the pressure and working conditions which have to be anticipated in the construction of a proposed tunnel at a given site”, Terzaghi gives a behavioural description of squeezing rock as follows: “Squeezing rock slowly advances into the tunnel without perceptible volume increase. Prerequisite of squeeze is a high percentage of microscopic and sub-microscopic particles of micaceous minerals or of clay minerals with a low swelling capacity”.

This creep behavior of rock mass should be eliminated during the excavation but particular conditions, especially the type of excavation and support schedule can be caused very serious consequences and even increase creep behavior of rock mass through opening.

**General Geology of the Tunnel:**

The tunnel with a length of 3189 m starts from Seyah Chal valley and extended to Mosha valley under Ozaneh mount. Geological map (figure2) shows that tectonic structure is simple. This tunnel located in Alborz central zone. Based on the main fault's function and resulted in-situ stresses, many local faults located along it so some of these faults smashed down rock mass and reduced its strength and quality. Twelve main faults have been identified in the tunnel that crossed it axis perpendicular. In addition, two major faults have been detected in the north and south of the tunnel.

![Fig. 2: Geology map of tunnel (Iran Oston Consulting Engineering, 2008).](image)

**Problems Occurred During The Tunnel Construction:**

Due to lack of adequate research and required maps, before starting excavation, there is no-good understanding of the specific condition of this project. In addition, several layers with different slopes, unusual fractures and the existence of high underground water flows, has been created unimaginable roof caves. Not having enough knowledge of the advancing conditions and the lack of preparedness in dealing with the faced problems has created long delays in the project. Lack of appropriate facilities and equipment related to specific working conditions constantly has been changed the support-excavation methods. Unforeseen and rare events such as mod flow and its tolls have been brought consequence psychological problems. Given the current problems and inefficiency of traditional method's new method was proposed to deal with current conditions. In these conditions, the use of shotcrete and mesh due to the high- water pressure and roof cave was impossible. For installation of the rock bolts, holes should be drilled at the proper depth while the existence of loose layers and weak inter-beds, fractures will be started from holes and extends linearly to other holes. After installing the rock bolts tunnel roof will be collapsed due to occurred large fractures so that no bolt will be remained on the
tunnel roof. Installation of steel sets required drilling of cotter pin holes in roof and walls. After installation of cotter pin steel sets will be connected together and between them should be filled with shotcrete, which is impossible with these conditions.

**Innovative Rock Support System:**

In this method, new machine is designed, which can install tunnel support in collapsing condition. In this method gallery has excavated with 4*4 m cross section.

**Segment Preparation:**

First, the beam will be cut to desired size, considering the excavation method and change of cross section, and the remaining part is divided into two equal parts (each of them 3.8 m). Because if every beam is bent due to the pressure beam will be crumpled two roof beams coupled to each other and are ready to be bent. According to the required shape and size of the arc prepared beam will be bent. While piles should be welded to the roof, and it is arch-shaped junction of them will be welded. The roof had been cut, and plate is installed and welded. Two plates have been temporarily welded together and drilled with drill to be ready for installation. After installation and welding, two sides of each plate, beams are numbered to solve the coupling problem in the workplace during the Installation.

Based on the number, made steel sets are ordered and five numbers of them with 35 cm intervals should be welded which overall length is 1.8m. The following piece will covered with mesh and rabits and is ready for concrete (figures 3,4 ). Care needs to be taken, to achieve best strength and hardness. This happens after the concrete has been placed. Cement requires a moist, controlled environment to gain strength and harden fully. After reaching a seven-day strength of concrete segments is ready to be shipped and installed in place.

![Fig. 3: Based on the number, made steel sets are ordered and five numbers of them with 35 cm intervals should be welded which overall length is 1.8m. The following piece will covered with mesh and rabits and is ready for concrete.](image)

![Fig. 4: Each segment, according to the number of it, loaded and carried to installation place.](image)
Segment Installation:

After each blasting sequence with regard to working conditions and status of the layers support operation are carried, drilled locations controlled by the surveyor and are ready to install the segment. Each segment, according to the number of it, loaded and carried to installation place. Segment placed in its original position and piles attached to the tunnel roof by workers. Piles should be concreted and after 12 hours the truck will collect the jacks.

![Segment Installation](image)

Fig. 5: Segment placed in its original position and piles attached to the tunnel roof by workers. Piles should be concreted and after 12 hours the truck will collect the jacks.

Conclusion:

By using this method workers are safe from water rash and roof caving also will have better performance due to psychological comfort so the loss of labor and time will reach to minimum. Support installation is fast and first support opportunities are not lost. In this method tunnel excavation advanced rapidly also the installation rate of support and steel sets is four times than before.

REFERENCES

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