

Support system analysis in building diversion tunnel ST1-ST4 of Leuwikeris dam construction at West Java Province

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Abstract. Construction activities in diversion tunnel of dam need to consider the stability of the tunnel which is very important factor for its continuity. In order to become a safe mining method, it is necessary to analyze the tunnel stability and excavation method using drill and blast method. This analysis is based on empirical method, which is approach using rock mass classification and analytical method based on stresses and deformation of rocks. Based on the analysis, there are three types of rocks passed by the diversion tunnel, i.e breccia, sandstone and claystone, with RMR value ranged from 36 to 51, poor rock class to fair rock class, 2,5 – 3 meters span, top heading bench excavation method, rockbolt, and shotcrete support system with thickness between 256 to 334 mm and steel support.

Keywords: diversion tunnel, RMR, support system, excavation method

1. Introduction

The tunnel is a copy below ground or mountain. Tunnels are generally covered on all sides except at both ends that are open to the outside environment. Some civil engineers define tunnels as a below-ground surface that has a minimum length of 0.1 miles (0.1609 km), and a shorter one of them is better called an underpass. For example, underpass under Yahata Station in Kitakyushu, Japan with a length of 0.130 km (0.081 miles) and so it is unlikely to be considered a tunnel. Tunnels are made by keeping their stability safe for workers and mining equipment. This will affect production because of avoidance of losses, such as the occurrence of collapse. One way of prevention, namely by providing rock mass strengthening movement, thus increasing the value of safety factors for tunnel stability.

In the construction process, tunnel excavation causes deformation and redistribution of the initial stresses on rock mass. In some cases, the voltage generated by the excavation of the tunnel increases beyond the strength of the soil and / or rock around the tunnel. In this condition there will be collapse on the surface of the tunnel excavation. The above should be recognized by the engineering geologists, because it plays an important role in the making of the tunnel from planning, determining the method of work and determining the system penyanggaan in accordance with conditions in the field. So it can be planned a tunnel structure strong enough to withstand the load around it.

2. Research Method

The research method used in this research are:



1. Study of Literature

The study of literature is done by looking for materials that support the library. Determining the point and boundary of the observation location so that the research is not widespread, not out of the existing problems, and the data taken can be utilized effectively, that is the research conducted along the tunnel path. It then refers to the supporting standards used on the recommendation by Bieniawski (1984), and the calculation of buffer loads according to Unal (1983).

2. Data Retrieval

Secondary Data:

The data used is the data from the observation of the tunnel that refers to the observation of Prakoso (2018). The data are:

- 1) Uniaxial Compressive Strength (UCS)
- 2) *Rock Quality Designation* (RQD)
- 3) Joint Spacing
- 4) Joint Condition
- 5) Groundwater Condition
- 6) Joint Orientation
- 7) Geological Data (Rocks, stratigraphy and geology structure)

3. Results and Discussion

Based on the rock class there can be a buffer design that will be used in the research location so that the condition of the stability of the tunnel based on the calculation of load collapse, buffer load, shotcrete thickness and maximum shotcrete pressure.

3.1. *Rock Mass Rating (RMR)*

Rock mass classification (Rock Mass Rating) was developed to solve problems that arise in the field quickly and is not intended to replace analytical studies, field observation, measurement, and engineering judgment. Bieniawski's Geomechanic Classification provides rock mass rating based on its quality (Bieniawski, 1989). The geomechanical classification is based on six parameters, namely rock compression strength, Rock Quality Designation (RQD), space discontinuity, discontinuity field conditions, groundwater conditions and discontinuity field orientation (Bieniawski, 1989). The obtained RMR value is then classified by rock mass by obtaining the following rock class (Tabel 1).

Tabel 1. *Rock Mass Rating (RMR) Value.*

Station	RMR	Rock Mass Class
1	36	Poor (IV)
2	46	Fair (III)
3	41	Fair (III)
4	51	Fair (III)

Supporting Recommendations Based on RMR Value:

a. Station 1

From the data analysis above, on station 1 with rock class IV (Poor Rock), generally the proposal for the appropriate method of excavation is by the method of Top Heading and Bench Method. This method is carried out with advances of about 1 - 1.5 meters and supporting begins after blasting as far as 20 meters from the face. With this method the method of excavation where the top section of the tunnel was dug first before the bottom of the cross section. After top heading reaches 1-1.5 meters long, bench cuts are worked up to form the desired tunnel sections and supporting begins every 10-meters from face excavation. Supporting proposals using rockbolts on roofs and walls 4 to 5 meters

long, spacing between rockbolts 1 - 1.5meter, occasionally using wire mesh on roofs and tunnel walls and using 334 mm thick shotcrete on the roof and wall of the tunnel, and recommended using light sets of medium-light ribs with 1.5 m spacing capable of being initial buffers, with an acceptable maximum pressure of 26.888 ton / m².

b. Station 2

From the data analysis above, at station 2 with rock class III (Fair Rock), generally the proposal for the appropriate method of digging is by the method of Top Heading and Bench Method. With this method the method of excavation where the top section of the tunnel was dug first before the bottom of the cross section. After the top heading reaches 1.5 - 3 meters, bench cuts are worked on to form the desired tunnel sections and the buffer begins every 10-meters from the excavation of the face. The proposed rockbolt buffer with a length of 3 meters, spacing between using rockbolt on the roof and walls with a length of 4 meters, spaced between rockbolts along the 1.5 - 2meter, sometimes using wire mesh on the roof of the tunnel and using shotcrete thickness of 282 mm on the roof and walls the tunnel can be an initial buffer, with an acceptable maximum pressure of 22.872 ton / m².

c. Station 3

From the data analysis above, at station 3 with rock class III (Fair Rock), in general the proposal for the appropriate method of excavation is by Top Heading and Bench method. With this method the method of excavation where the top section of the tunnel was dug first before the bottom of the cross section. After the top heading reaches 1.5 - 3 meters, bench cuts are worked on to form the desired tunnel sections and the buffer begins every 10-meters from the excavation of the face. The buffer proposal using rockbolts on roofs and walls with a length of 4 meters, spacing between rockbolts along the 1.5 - 2meter, sometimes using wire mesh on the roof of the tunnel and using shotcrete thickness of 308 mm at the roof and the tunnel wall can be an initial buffer, with pressure an acceptable maximum of 28,888 ton / m².

d. Station 4

From the data analysis above, on claystone with rock class III (Fair Rock), in general the proposal for the appropriate method of excavation is by Top Heading and Bench method. With this method the method of excavation where the top section of the tunnel was dug first before the bottom of the cross section. After the top heading reaches 1.5 - 3 meters, bench cuts are worked up to form the desired tunnel sections and the buffer starts every 10-meters from the face excavation. The buffer proposal using rockbolts on roofs and walls with a length of 4 meters, spaced between 1.5 - 2meter rockbolts, sometimes using wire mesh on the roof of the tunnel and using shotcrete as thick as 256 mm on the roof and the tunnel wall can be an initial buffer, with pressure an acceptable maximum of 20.841 ton / m².

4. Conclusion

From the research that has been done on duck tunnel in Leuwikeris Dam, it can be concluded that:

1. Technical geological investigation is a very important thing in conducting the construction of tunneling dam tunnel. Given the existing geological data, can be determined rock class. From the rock class can be determined the initial design of the tunnel in accordance with the conditions in the field and the most enabling methods of implementation and preparation of all aspects as well as possible, especially on the security aspects of the construction of the tunnel construction
2. Based on the calculation, the study area has two classes of rocks, namely Class III (Fair Rocks) and Class IV (Bad Rocks) with RMR values ranging from 36 to 51
3. Method of excavation of research area with top heading and bench method and initial buffer system using rockbolt and shotcrete and sometimes using steel support according to Bieniawski (1989).

4. Calculation of high load burden, buffer load, shotcrete thickness and maximum shotcrete pressure is necessary, because each station passes through different lithology and RMR value.
5. In the research that has been done, very high accuracy in analyzing the existing data, especially geological data of the research area, because of the geological data we can know the basic information of the existing rock conditions in general.

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