Determination of Maximum Unsupported Span and Stand Up Time Value using Q-System Method (Case Study: Pongkor Area, Nanggung Subdistrict, Bogor District, West Java Province)

Alisah*[1], Irvan Sophian**[2], Zufialdy Zakaria**[3],
Ryan Pratama**[4], Yusi Firmansyah**[5,]
*Geological Engineering Faculty, University of Padjadjaran, Indonesia
[1]Email : alisah12001@gmail.com
** Postgraduate Program of Geology, University of Padjadjaran, Indonesia
[2]Email : irvan.sophian23@gmail.com
[3]Email : zufialdy_z@unpad.ac.id
[4]Email : ryan.pratama@antam.com
[5]Email : yusi.firmansyah@unpad.ac.id

ABSTRACT

Epithermal deposit might be a potential economic mining source. One kind of this deposit is the low-sulphidation epithermal with the quartz vein which can be found in the study area. However, the high intensity number of the alteration process will affect the rock mass quality in the area of interest which also will influence the safety of underground mining process, ecspecially while the tunnel reinforcement is being set. Therefore, maximum unsupported span and stand up time value need to be determined.

Study area is Nanggung Subdistrict, Bogor District, West Java Province. This study is conducted at some fronts in Ciguha tunnel, using the Q system methode. After the rock mass has been classified, the maximum unsupported span and stand up time value can be calculated.

The result shows that maximum unsupported span value has a variety number from 8 hours to 1 year extend. At the other side, stand up time value also has a variety number from 1 to 4 meters span. Both shows a value depends on their own rock mass quality.

Keyword: *Q- System, Stand up time, Maximum unsupported span*

I. Introduction

Mining activities highly need a safe working environment. In order for underground mining operations run smoothly and safely, security and stability of underground tunnels where the mining process takes places need to be considered. Geotechnic plays an important role in building a mining design that takes mine safety, stability, and effectiveness factors into account.

PT. Aneka Tambang Tbk. UBPE Pongkor is a company that processes gold ore epithermal deposit with the low-sulphidation type and quartz vein extends form following the direction of geological structure.

Application of rock mass class for the tunnels reinforcement is vary based on the character of rocks at each location. According Lauffer (1995) (Hoek & Kaiser, 1993), Stand Up Time value in a tunnel greatly affected by the characteristics of the rock mass itself. Therefore, before recommending any tunnel reinforcement system, there should be a geomechanics study of the rock mass at the area of interest

to obtain the stability of the rock mass in a tunnel. It was only after the rock mass classification known, the value of the maximum span and stand up time can then be determined.

II. Methodes

This research can be divided into several stages: preparation, field work, studio work, and report. Through these stages, it is expected to achieve the research goal is to find the condition of the rock mass geomechanics using Q-System which would then be used to perform data processing in order to know the value of standup time and the optimum span.

1. Field Work

Data is collected from Ciguha tunnel, 500 meters above sea level and the results obtained in the form of field description and sampling. Field description is a general description of field engineering geology characteristic including the geometry of the tunnel and its constituent materials, also the orientation and dimensions of the tunnel, the character rock lithological, the effect of alteration and weathering, rock strength, dimensions and condition of discontinuities (RQD, Jn, Jr, Ja), groundwater conditions (Jw), as well as other factors that affect the stability of the tunnel as a weak zone (SRF) (NGI, 2013).

2. Laboratory Testing

Rock compressive strength testing is done using a Point Load Test. Based on this test the Point Load Index can be determined. After that, this result can be converted to maintain the actual compressive strength.

3. Data Processing

Data processing is conducted by weighting the parameters of the data obtained in the field. These weights is adjusted with the provisions of the rock mass classification using Q-System methode. Furthermore, the calculation to determine the unsupported value of maximum span is conducted which corresponds to its own rock mass class (Barton, 1974).

Maximum unsupported span is the maximum length of a tunnel openings that were suggested and considered quite stable to possibility of debris.

$$MUS\ (meter) = 2\ Q^{0,4} \quad \textbf{.....(1)}$$

As for maintaining the value of stand-up time, it is necessary to do the conversion of the Q-System rock mass classification value to the Rock Mass Rating (RMR) classification value. The calculation is done based on formula proposed by Bieniawski (1976).

$$RMR = 9 \ln Q + 44 \quad \textbf{.....(2)}$$

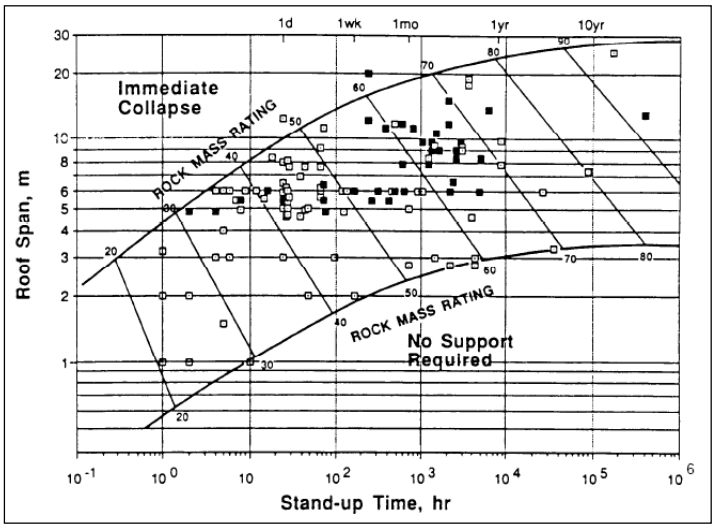

Figure 1. Stand-up time interpolation chart (Beniawaski, 1976)

Stand-up time is the range of the length of time a rock mass that can still maintain its own strength to prevent the roof or wall collapse (openings remain stable), both without the installation of reinforcement, after reinforcement, as well as installation time (Singh & Goel, 2006)

III. Study Area

This research is located in the gold underground mining PT. Antam in Pongkor, Bantar Karet Village, Nanggung, Bogor, West Java Province. The study was conducted on the some fronts at tunnel Ciguha.

IV. Result and Discussion

After determining the weight of each parameter, rock mass classification could be known and displayed in the following table.

Table 1. Rock mass character in Ciguha tunnel

Tunnel		RQD	Jn	Jr	Ja	Jw	SRF	Q- System	
Name	Location							Results	Value
Ciguha	A	63,60	9	3	2	1	10	1,06	Poor
		53,20	15	2	2	1		0,35	Very Poor
		55,83	12	2	2	1		0,47	Very Poor
		51,45	6	2	4	1	10	0,43	Very Poor
		72,97	6	2	4	1		0,61	Very Poor
Ciguha	B	65,15	9	2	3	1	5	0,97	Very Poor
		59,87	15	2	3	1		0,53	Very Poor
		57,82	6	2	4	1	7,5	0,64	Very Poor
		67,36	3	2	4	1		1,50	Poor
Ciguha	C	58,75	6	3	3	0,66	5	1,29	Poor
		60,10	6	3	3	0,66		1,32	Poor
		61,06	4	2	3	0,66	-	6,72	Fair
		55,95	15	2	3	0,66		1,64	Poor
Ciguha	D	69,85	6	2	3	1	2,5	3,10	Poor
		61,43	4	2	3	1		4,10	Fair
		36,94	12	2	2	1	10	3,08	Poor
		57,28	12	2	2	1		4,77	Fair

Based on these data it is known that the location of the A and B location have the worse rock mass characteristics compared to the rock mass characteristics at locations C and D. This is because at locations A and B, there has been some weak zones encountered that do not support the safety of the tunnel. This condition is weighed to the value of Safety reduction Factor (SRF).

Once the value of the rock mass classification has been known, the value of Maximum Unsupported Span (MUS) can be determined by performing data processing based on the formula **(1)**. The results are shown in **Table 2**.

Stand Up Time value determined by interpolating the graph shown in figure **1**. However, before the rock mass classes can be used, its value need to be converted first into the rock mass class RMR using the calculation **(2)**. The results are shown in Table 3.

Table 2. *Maximum Unsupported Span* in Ciguha tunnel

Tunnel		*Excavation Support Ratio (ESR)*	*Q - System*	*Max Unsupported Span* (m)
Name	Location			
Ciguha	A	1,60	1,06	3,28
		1,60	0,43	1,43
Ciguha	B	1,60	0,97	1,97
		1,60	0,64	1,68
Ciguha	C	1,60	1,29	2,22
		1,60	6,72	4,28
Ciguha	D	1,60	3,10	3,15
		1,60	3,08	3,14

The values shown by MUS calculation varies between 1.4 and 4.2 meters. This value is also highly dependent on the rock mass classification. The smaller the rock mass quality will made a shorter span of the tunnel openings that can be recommended because of the reinforcement capacity of the rock is also shown a lesser value.

The results of these calculations show that the value of the stand-up time is greatly influenced by the rock mass class. At locations A and B which have a very poor rock mass class has value only stand up time of 8 to 80 hours, while the location C and D have a much longer time that reached up to 1.24 years.

Table 3. Stand Up Time value Ciguha tunnel

Tunnel		Roof Span (m)	RMR Value	*Stand Up Time*			
Name	Location			Hour	Sunday	month	year
Ciguha	A	3,40	34,67	8,00	0,05	0,01	0,00
		1,00	36,38	80,00	0,48	0,12	0,01
Ciguha	B	4,90	38,32	9,00	0,05	0,01	0,00
		2,40	40,02	80,00	0,48	0,12	0,01
Ciguha	C	2,60	46,31	200,00	1,19	0,30	0,02
		4,70	48,46	100,00	0,60	0,15	0,01
Ciguha	D	1,00	54,20	10000,00	59,52	14,88	1,24
		1,00	54,12	10000,00	59,52	14,88	1,24

V. Conclusion

- The research location of Ciguha tunnel have conditions between **very poor** to **fair** for the classification of Q-System and **poor** to **fair** for RMR classification. Both classification RMR or Q-System show the value that isn't much different. A and B location show the rock mass conditions were worse than the condition of the rock mass at locations C and D

- The results at research sites show that the data of MUS values is varied between 1.4 and 4.2 meters, while the value of the stand-up time varied between 8 hours to 1.2 years. Both show similar comparisons with the class of the rock mass. The smaller the class of the rock mass, the smaller the value of standup time and maximum unsupported spam.

VI. References

Barton, N. R. (1974). *Engineering classification of rock masses* . Canada: Springer.

Hoek, E., & Kaiser, P. (1993). *Support of Underground Excavation in Hard Rock.* Toronto: Toronto University.

NGI. (2013). *Rock Mass Classification and Support Design.* Oslo: Allkopi As.

Singh, B., & Goel, R. K. (2006). *Tunneling in Weak Rocks.* UK: Elsevier.