Determination of temporary support for squeezing zone underground mine PT. Cibaliung Sumberdaya

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Determination of temporary support for squeezing zone underground mine PT. Cibaliung Sumberdaya

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Abstract. Underground Mining activity will always face deformation and instability of the rock mass around the underground openings. A large deformation was reported to occur on decline tunnel of PT. Cibaliung Sumberdaya (PT. CSD). Prior to this event, the same tunnel, which the tunnel wall had been refurbished into the proposed original shape. This implies that the squeezing zone had developed around the tunnel and the same support system couldn't resist the increasing load. Therefore, an analysis of squeezing zone around the excavation should be carried out. Conducted analysis started by the modelling the excavation should be carried out. Conducted analysis started by modelling the excavation the tunnel to get causing the cross cut failure. Then, back analysis was carried out to estimate the decreasing strength of the rock mass inside the squeezing. After that, squeezing zone can be determine the support systems to prevent the failure of rocks. The strain from back analysis results showing that similarity compared to the monitoring result when the modulus deformation E and the strength parameter mb and s of Hoek-Brown Failure criteria of the materials in the squeezing zone is 40 % peak strength. Analysis for temporary support shows that need 250 mm thick shotcrete, 1 m of spacing rock bolting, and 0.5 spacing reinforcement beam. Although, the floor of tunnel should be given extra consideration because could given high load, so must be installing rock bolt to helping stabilization.

1. Introduction

Cibaliung Sumberdaya (PT CSD) is an underground gold mining company in Indonesia. Mining is only viable in the Cikoneng vein area through decline. Ore is mined by hand using a crosscut method, then stope mining with infill material from tailings and waste rock—inter-level mining using reinforced concrete sill pillars. Suppose rock bolt is installed in rock mass. Under the action of some load, either external or deadweight, strata separation can occur. As the rock bolt is embedded in the strata, it tends to resist the movement or displacement between strata due to its higher stiffness or modulus of elasticity and a load is induced in the rockbolt through shear action in the grout along the contact surfaces at the point of strata separation. On the left wall (west side), fan access, N 225 E / 50, N 225 E / 80, N 350 E / 32, and Bending at CKN Acc 1129 were found. In terms of the movement, PT. CSD feels that tunnel stability should be assessed by an outside expert.

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2. Method

2.1 Study Area

Cibaliung Sumberdaya is a subsidiary of PT. Aneka Tambang. Tbk. Cibaliung Sumberdaya is a subsidiary of PT. Aneka Tambang. Tbk. Cibaliung Sumberdaya is a gold mining company that operates underground. The gold ore deposit is a low-sulfidation epithermal vein that extends north to south from Cikoneng to Cibitung (Figure 1)

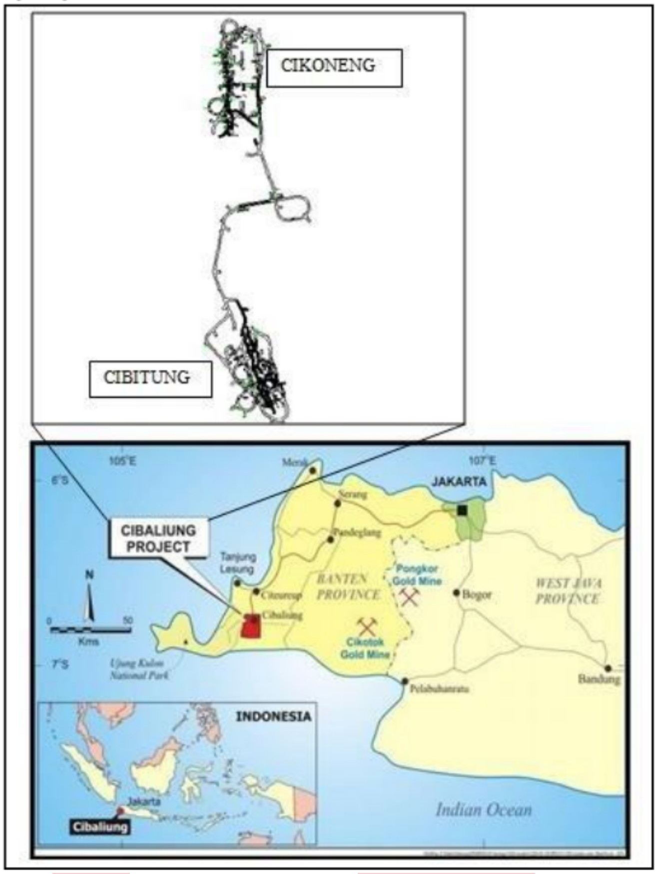

Figure 1 PT. Cibaliung Resources Regional Landscape Map

Cibaliung Sumberdaya is administratively located in Mangku Alam Village - Padasuka District Cimanggu Pandeglang Regency, Banten Province, and geographically located at coordinate position 105038'05,5 "E and 6045'04,8 "S, bordering on the north: Tanjung Lesung and Citeureup; Cibaliung and Cimanggu districts in the east; Cikaung District in the south; and Ujung Kulon.

2.2 Analysis Tool

Geoteknik studies

• Basic Criteria

Several parameters are utilized in the analysis for the stability of openings:

a. Safety Factor

By comparing the rock strength to the stress acting on it, the safety factor is derived. In this investigation, the safety factor value of FK> 1.30 was employed to assess if the apertures were safe. Using the Mohr-Coulomb criterion, the safety factor may be calculated using the formula below.

$$FK = \frac{\frac{\sigma_1 + \sigma_3}{2} sin\emptyset + C.cos\emptyset}{\frac{\sigma_1 - \sigma_3}{2}} \quad (1)$$

b. Massive displacement

Rock conditions become unstable when observed displacement exceeds the expected displacement predicted by elastic theory. Based on observations in 13 huge underground aperture openings, Cording (1974) claims that displacements and loosening along weak spheres begin when the measured displacement is three times more than the elastic displacement. To prevent additional movement, the excavation and buffer approach should be altered if the displacement is five to ten times more than the estimated elastic displacement.

• Elastic Displacement is a term used to describe how something moves when it is

a. Rock Mass Characteristics

It is necessary to conduct analyses for geotechnical rock qualities. The complete rock qualities collected from Cibaliung may be found in Table 1 for rocks in Cibaliung.

Table 1 Rock Properties

Material	**g (MN/m3)**	**sc (MPa)**	**V**	**mi**	**D**	**GSI**	**E (MPa)**
Filling	0.026	0.6	0.25	25	0.8	9	400
FW	0.027	75	0.25	25	0.8	40	1100
HW	0.0271	51.07	0.14	19	0.8	40	985.6
Vein (ore)	0.0231	61.32	0.06	20	0.8	50	10703

Because the qualities listed above are still present in intact rock, they must first be transformed into rock mass (rock mass) using the roclab program, which yields the following findings.

Table 2 Rock Mass Properties

scm (MPa)	**Em** (MPa)	**F** (°)	**c** (MPa)
4.711	2104.5	44.11	0.246
8.106	5126	51.97	0.33
7.955	1302.9	49.3	0.304
0.014	5.27	6.61	0.012

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a. Method of Calculation

Elastic displacement is calculated using the parameters listed in Table 2 above. Inelastic theory for computations calculating the magnitude of displacements. σcm is used to calculate the stress in the rock mass in the vertical direction (σv).

The first step is to figure out how much vertical tension there is. Knowing the value of the modulus deformation mass of rock (Em), the strain caused by stress may be determined using the equation:

$$\varepsilon_v = \sigma_v / E_m \qquad (2)$$

The strain obtained from equation (2) is a strain in the vertical direction as a result of the vertical stress (σv) .Vertical strain is calculated using the vertical stress approach divided by modulus deformation mass of rock, whereas a horizontal strain is calculated using the vertical strain approach multiplied by Poisson's ratio.

$$\varepsilon_h = \varepsilon_v \; x \; v \qquad (3)$$

Assume the beginning distance is equal to the span of the opening's roof or wall. Based on elastic theory, the elastic displacement (d) that happens as a result of stress may be computed as follows.

$$\delta = \; \varepsilon \; x \; span \; wide \qquad (4)$$

Other than elastic, another assumption of rock mass conditions is homogeneous and isotropic. Table 3 shows the total elastic displacement calculation results.

Table 3 Elastic Calculation

Parameter	ε_v	ε_h	δ_v *(mm)*	δ_h *(mm)*	δ_v *max(mm)*	$\delta_h max$ *(mm)*
Span = 3 m	0.0044	0.000975	8.87	1.95	44.34	9.75
υ = 0.22						
E_m = 5.12GPa						
σ_{cm}= 8.1 MPa						
Material = Vein						

δ max = 5 x δ (criteria of displacement by Cording 1974)

3. Results

Support for CKN Decline is available for a limited time. As a result of empirical and computational modelling, Cikoneng with Rock Mass Rating was identified (RMR). CKN Decline, which is the major access point for moving ore from the stop area to the ROM pad, showed rock mass deformation during the first and second supervisions. The shortening of the tunnel's left and right walls, as well as the increase of rock mass, which generates shotcrete cracks, are early warning indicators. As a result, determining the rate of deformation necessitates the use of a convergence meter.

Examine the state of the rock samples in the core box to check whether they've been tampered with or if their geological strength index has shifted (GSI). Collect rocks and soil samples from the observation area for laboratory tests on their physical and mechanical properties. Rocscience also provides numerical modelling services based on the finite element method (Phase2). All of the experiments listed above are intended to assess how rock mass properties or stress redistribution affect convergence behaviour.

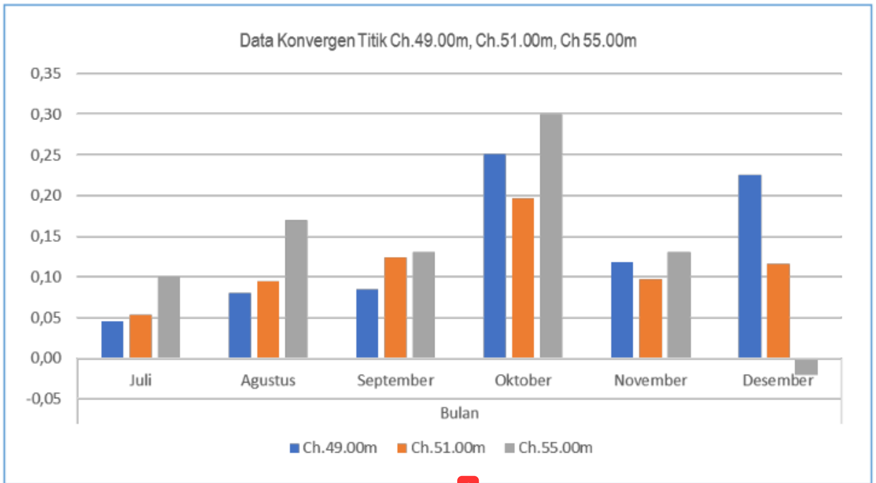

Figure 2. Convergence Data in the Decline Cikoneng

The displacement value chart illustrates that from July to December 2017, the displacement value grew. In October 2017, the maximum movement of 0.25mm was recorded at Ch.49.00m. 50.00m (0.20mm) and 55.00m (0.20mm) (0.30mm). The value is in the 0.2 to 3 range, indicating that it is quite stable. The bending, on the other hand, was discovered. The 1129 Cikoneng access fan accepts a crack and has failed.

A bending hole on the right roof, as well as a fracture on the left wall and a failure on the right wall, can be found in the entry hole Acc Fan Shaft 1129 Cikoneng Block.

Numerical geotechnical modelling is done with the tool Phase2 v 8.0. The model's features are based on the rock and buffer qualities of PT CibaliungSumberdaya.

4. Discussion

Rock bolt is reinforcement which increases the structural integrity of rock mass. For good bolting designing it is very important to understand the performance of rock bolt in rock mass. The analytical models (In situ and pull out) give about performance of rock bolt. In situ rock bolt has anchor length and pick up length while in pull out rock bolt only has anchor length. By instrumented rock bolt it is found that anchor length varies from 200mm to 500mm and this length is used in short encapsulation pull out test for determining the load capacity of rock bolt. Further factors which affect the performance of rock bolt carefully understood. For spinning time & hold time the recommendation of manufactures of resin is used. To avoid finer gloving the resin wrapping should be break throughout the surface of bolt. The load transfer capacity of rock bolt is also increase by the rib surface of rock bolt.

There were three stages of the study. In the first step, field stresses were applied to the rock mass. Boundary restrictions were employed to limit the wall softening model, and external field loads were used to simulate distant field stresses. In the second phase, the face progress was simulated using the core replacement technique to determine tunnel reaction during construction (short term). The third phase looks into the long-term deterioration of the rock mass. This is accomplished by reducing the GSI in the short-term plastic zone by a factor RMR, so reducing the stiffness and strength of the rock bulk.

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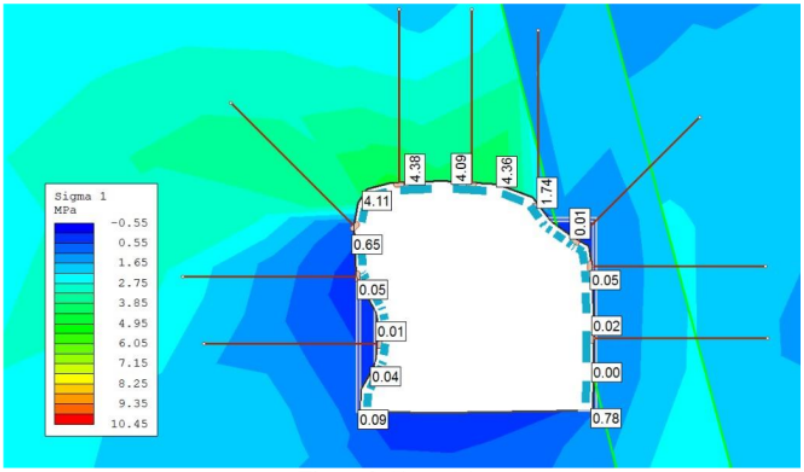

Figure 3. Sigma 1 / σ_1

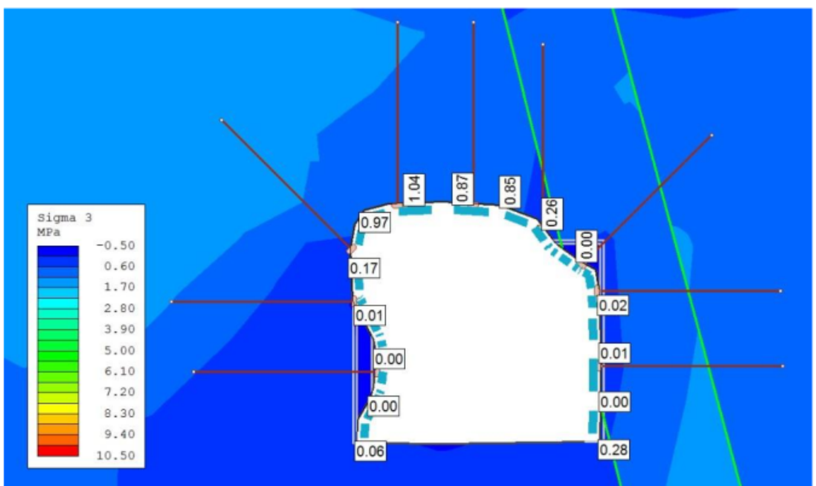

Figure 4. Sigma 3 / σ_3

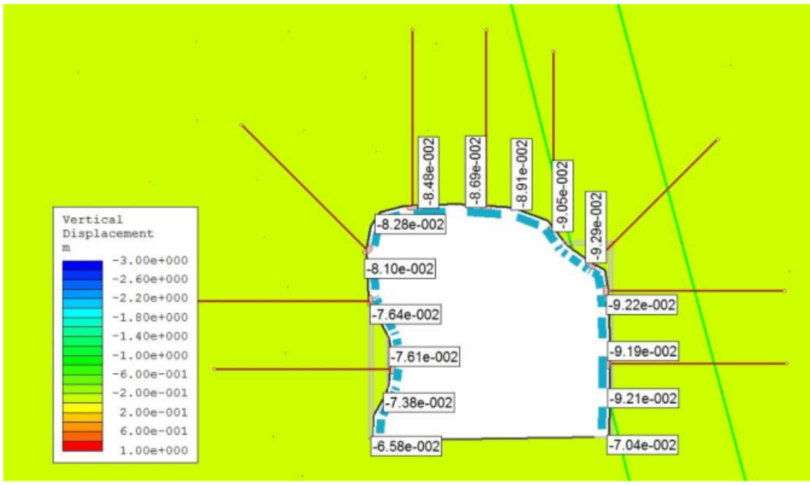

Figure 5.*Vertical Displacement* / ε_v

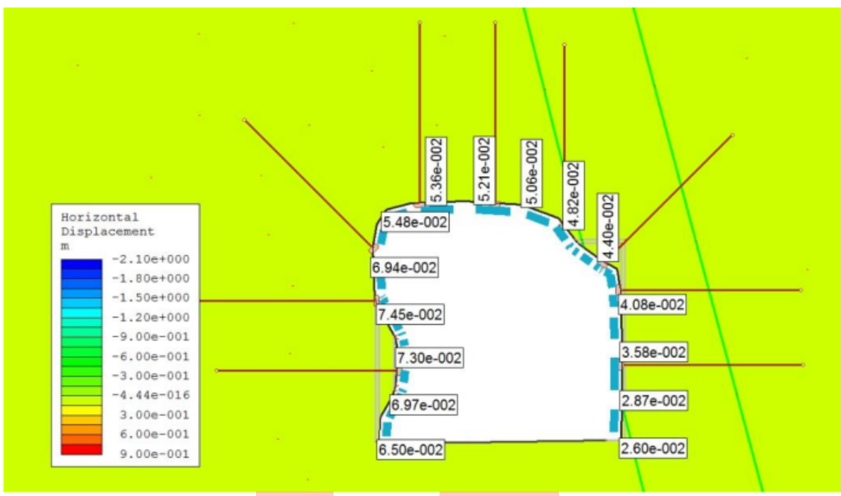

Figure 6.*Horizontal Displacement* / ε_h

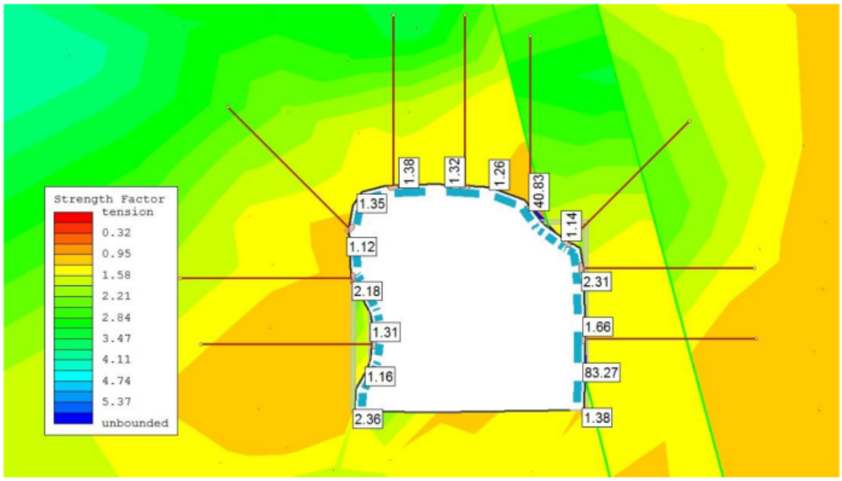

Figure 7.*Strength Factor*

5. Conclusion

Field trips and convergence data have led to the following conclusions:

1. Convergence measurement data on the Cikoneng drop along the observation path (Ch.49.00m, Ch.51.00m, Ch.55.00m) from July to December reveal the largest deformation in October: At Ch.49.00m, the maximum deformation measured 0.25 mm. Ch.51.00m, 0.20 mm, and Ch.55.00m, 0.30 mm
2. According to a temporary support study, 250 mm thick shotcrete is needed. 1 m spacing rock bolting and 0.5 m spacing reinforcing beam Although. Because it may be subjected to tremendous weights, the tunnel's floor requires careful attention. As a result, rock bolts must be used to help stabilize the structure.
3. 3. A detached block of rock from the parent rock due to a strong structure that separates the rock into blocks may be the cause of roof bending and failure. An indicator of the problem is water seepage on the roof.

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References

[1] Alejano. L. A.-D.-M. (2010). Application of the convergence-confinement method to tunnels in rock masses exhibiting Hoek-Brown strain-softening behaviour. *International Journal of Rock Mechanics & Mining Sciences*. 150-160.

[2] Bienawski. Z.T.. *Engineering Rock Mass Classification*. John Wiley & Sons. Inc. New York. halaman 7. 1989

[3] Bieniawski. Z.T.. *Rock Mechanics Design in Mining and Tunneling*. AA. Balkema. Rotterdam. halaman 79-84. 169. (1984)

[4] Brady. B.H.G dan Brown. E.T.. *Rock Mechanics for Underground Minings*. George Allen &Unwin. London. halaman 151 – 164. 464 .1985

[5] Bickel. J.O.. et al. *Tunnel Engineering Handbook*. Springer.1996

[6] Bowen Du. Y. D. (2018). Conception and Exploration of Using Data as a Service in Tunnel Construction with the NATM . *Engineering*. 278-291.

[7] Cording J. Edward. Mahar W. James. dan Brierley S. Gray.. *Observations for Shallow Chamber in Rock*. Proceedings of The International Symposium Field Measurements in Rock Mechanics. Volume II. Zurich. 4-6 April 1977. AA. Balkema. Rotterdam. halaman 485-508 (1979).

[8] Cozar. *Application of Rock Mass Classification System for Future Support Design of The Dim Tunnel Near Alanya*. Master Thesis. Departement of Mining Engineering. Middle East Technical University. 2004

[9] Ghosh. C.N. Ghose. A.K.. *Prediction of Ground Stability Through Convergence Velocity*. Proceedings of 35th US Symposium on Rock Mechanics. AA. Balkema. Rotterdam. Halaman 411-416 (1995).

[10] Goodman. Richard E.. *Introduction to Rock Mechanics*. John Wiley and Sons. USA. 1989

[11] Hoek. E.. Kaiser. PK.. Bawden. W.F. *Support of Underground Excavation in Hard Rock*. *1998*.

[12] Kolymbas. D.. *Tunnelling and Tunnel Mechanics*. Springer. Austria. 2008

[13] Li. P. Z. (2016). Displacement characteristics of high-speed railway tunnel construction in loess ground by using multi-step excavation method. *Tunnelling and Underground Space Technology*. 41-55.

[14] Mahtab. Grasso. *Geomechanics Principles in the Design of Tunnel Caverns in Rock*. Elsevier Science Publisher. 1992.

[15] N. Vlachopoulos. M. D. (2009). Improved Longitudinal Displacement Profiles for Convergence Confinement Analysis of Deep Tunnels. *Rock Mechanics and Rock Engineering*. 131-146.

[16] Oreste. P. (2014). A Numerical Approach for Evaluating the Convergence-Confinement Curve of a Rock Tunnel Considering Hoek-Brown Strength Criterion. *American Journal of Applied Sciences*. 2021-2030.

[17] Pan. Y.W dan Dong. J.J.. *Time Dependent Tunnel Convergence-I Formulation of the Model*. Journal of Rock Mechanics and Mining Science. Volume 28 No.6 halaman 469-475 (1991)

[18] Rai. Made. A.. Saptono. S.. "Pemantauan*Convergence* Untuk Menentukan Kestabilan Penggalian Bawah Tanah". Kumpulan Makalah Pertemuan Ilmiah Tahunan – III Himpunan Ahli Teknik Tanah Indonesia. Jakarta. 1996.

[19] Sakurai. Shunsuke. *Back Analysis in Rock Engineering*. ISRM. CRC Press. 2017.

[20] Saptono. S.. *AnalisisKemantapanLombongpadaSistemPenambangan Cut and Fill di Unit PertambanganEmasPongkor PT Aneka Tambang*. Tesis Magister (tidakdipublikasikan). Program StudiRekayasaPertambanganBidangKhususGeomekanika. ITB (1997)

[21] Sullem. J. Panet. M danGuenot. A.. *A New Aspect in Tunnel Closure Interpretations*. 26-th US Symposium on Rock Mechanics. South Dakota Scool of Mines and Technology. Rapid City. AD. 26-28 June 1985. halaman : 455-460

[22] Sullem. J. Panet. M danGuenot. A.. *A Closure Analysis in Deep Tunnels*. International Jurnal of Rock Mechanics and Mining Science. Volume 24 No.3 June 1987. halaman 145-154 (1987.a)

[23] Sullem. J. Panet. M danGuenot. A.. *An Analytical Solution for Time Dependent Displacement in a Circular Tunnel*. International Journal of Rock Mechanics and Mining Science. Volume 24 No.3 June 1987. halaman 155-164 (1987.b)

[24] Yanbin Luo. J. C. (2018). Longitudinal Deformation Profile of a Tunnel in Weak Rock Mass by using the back analysis method. *Tunnelling and Underground Space Technology*. 478-493.

[25] Zhenxiang. X. A.. *Tunnel Design Method Using Field Measurement Data*. Proceeedings of ISRM Symposium Design and Performance of Underground Excavation. Cambridge UK. 3-6 September. 1984. British Geotechnical Society. London. Halaman 221-229.

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