DAFTAR PUSTAKA

Abdullah, A,. (2021). *Pengaruh Konstruksi Terowongan Penyangga terhadap Subsidens PLTA Kerinci Merangin*. Tesis. UPN, Yogyakarta.

Ahmad, A. J., (2020). *Analisis Rancangan Sistem Penyangga Berdasarkan Pengaruh Ketidakpastian Sifat Mekanik*.Tesis. UPN, Yogyakarta.

Barton, N., Lien, R., and Lunde, J. (1974). *Engineering Classification of Rock Masses for the Design of Tunnel Support*. Norwegian Geotechnical Institute; Oslo.

Bieniawsky, Z. T., (1989). *Engineering Rock Mass Classification*. Mining and Mineral Resources Research Institute. Pennsylvania State University.

Dinas PUPR, (2015), *Dokumen RPI2JM Kabupaten Kerinci*, Pemkab Kerinci; Jambi.

Hoek, E., and Bray, J., (1981). *Rock Slope Engineering Civil And Mining 4th Edition. Spon* Press. London and New York.

Hoek, E., and Brown., (1980). *Underground Excavation In Rock*. The Institution of Mining and Metallurgy; London.

Hoek, E., Carranza, C. T., and Corkum, B., (2002). *Hoek-Brown failure criterion - 2002 Edition*; Canada.

Hoek, E., Kaiser P.K., and Bawden W.F., (1998). *Support Of Underground Excavations in Hard Rock*. A.A. Balkema; Rotterdam.

Kusnama, R., Paradede, S., Manggo, A. dan Sidarto. (1992). *Peta Geologi Lembar Sungai Penuh dan Ketauan, Sumatera*. Pusat Penelitian dan Pengembangan. Geologi, Bandung.

Lama, K. Z., (2017). *Analisis Tingkat Kecukupan Penyangga pada Lubang Bukaan Tambang Bijih Emas di Batuan Terkekarkan*. Tesis, UPN, Yogyakarta.

Nita. A. W., dan Junedi, H. (2020). *Kualitas Sub Das Siulak dan Batang Merao Daerah Mukai Tinggi dan Sekitarnya*. In Prosiding Seminar Teknologi Kebumian dan Kelautan (Vol. 2, No. 1, pp. 507-515).

Patrick, M, F. (2013). *Rancangan Alternatif Penyangga dan Kestabilan Ramp Down PT. Aneka Tambang*. Tesis. ITB; Bandung..

Rai, M. A,, Suseno K. & Ridho, K. W., (2014). *Mekanika Batuan*. ITB Press; Bandung.

Ridho, K, W. (2019). *Mekanika Batuan dan Rancangan Kontruksi Bawah Tanah*. ITB Press; Bandung.

Terzaghi, K., and Richart, F. E. (1952). *Stresses in rock about cavities*. Institution of Civil Engineers; London.

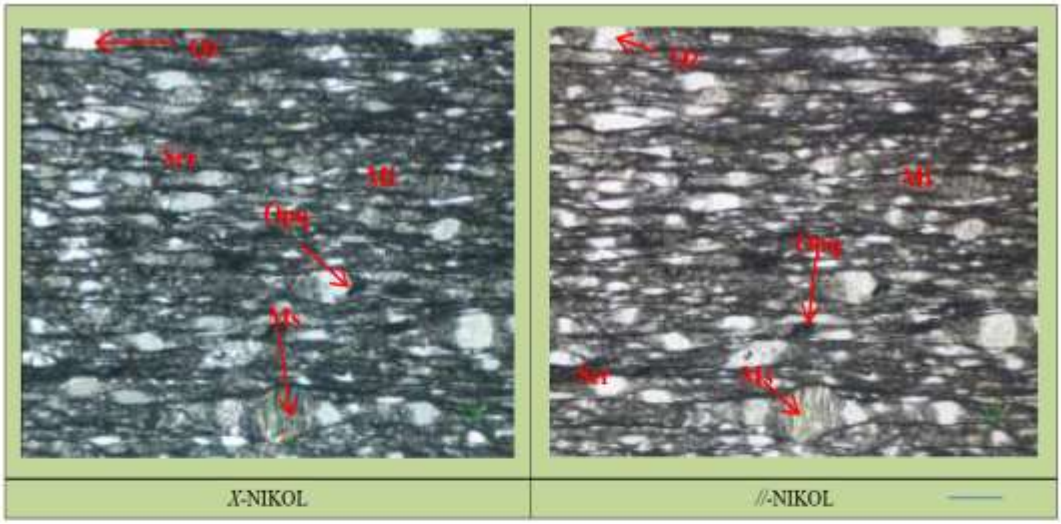
Wibowo, A,. (2019). *Evaluasi Kondisi Geologi Teknik dan Analisis Kestabilan Ekskavasi Terowongan Air Nanjung Provinsi Jawa Barat*. Tesis, UGM, Yogyakarta.

Yance D. F., Nata R. A., dan Putra. (2020). *Analisis Kestabilan Terowongan menggunakan Metode Rock Tunnelling Quality Index (Q-System) di Tambang Batubara PT. Allied Indo Coal Jaya*. STTIND. Padang.

LAMPIRAN 1

No Sampel : 1

Foto



X-NIKOL | //-NIKOL

Tipe Batuan	: Batuan Metamorf
Struktur	: Foliasi
Klasifikasi	: Travis, 1955

Deskripsi Mikroskopis :

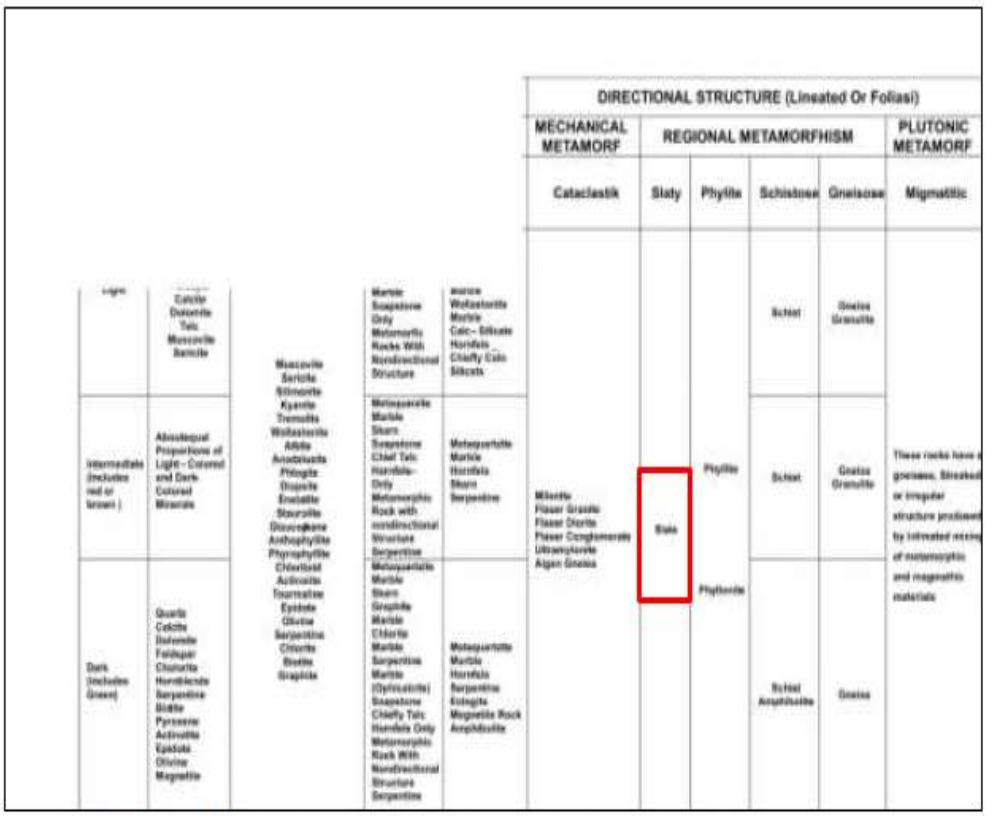
Warna absobsi coklat kehitaman, warna interferensi putih kehitaman, bentuk mineral subhedral – anhedral. Tekstur *kristaloblastic* berupa nematoblastik dimana menampakan mineral – mineral yang dominan prismatik dan struktur foliasi berupa *slaty cleavage*. Komposisi mineral berupa muskovit, serisit, kuarsa, mineral lempung dan opaq. Ukuran mineral 0.05 – 0.25 mm.

Deskripsi

Komposisi Material	Jumlah (%)	Keterangan Optik
Muskovit (Ms) $KAl_2(AlSi_3O_{10})(F,OH)_2$	10	Warna absorbsi *colourless*, warna interferensi biru hingga merah keunguan (Orde III), bentuk subhedral – anhedral, relief sedang, intensitas sedang, belahan satu arah, pecahan *uneven*, ukuran mineral 0.08 – 0.25 mm, jenis gelapan miring.
Serisit (Ser) $KAl_2[(OH)_2AlSi_3O_{10}]$	10	Warna absorbsi abu-bu kecoklatan, warna interferensi abu-abu, bentuk subhedral – anhedral, relief tinggi, intensitas rendah, ukuran mineral 0.01 – 0.1 mm. Jenis pemadaman miring dengan sudut gelapan 35°.
Kuarsa (Qz) SiO_2	25	Warna absorbsi tidak berwarna, warna interfernsi putih hingga hitam (Orde I), bentuk subhedral – anhedral, relief sedang, intensitas cahaya tinggi, belahan tidak ada pecahan tidak ada, ukuran mineral 0.1 – 0.15 mm, jenis gelapan bergelombang.
Mineral lempung (Ml)	50	Warna absorbsi abu-abu kecoklatan, warna interferensi abu-abu kebiruan, bentuk subhedral – anhedral, relief sedang, intensitas rendah, ukuran mineral < 0.02 mm.
Opaq	5	Warna absorbsi hitam, warna interferensi hitam, bentuk anhedral, ukuran mineral 0.05 – 0.1 mm

Nama Batuan : *Slate (Travis, 1955)*

Gambar 1. Menunjukkan kenampakan batuan metamorf berupa slate dengan kenampakan penjajaran mineral mika halus, tekstur kristaloblastik.



Gambar 2. Klasifikasi batuan metamorf menurut Travis 1955

LAMPIRAN 2

HASIL UJI LABORATORIUM SIFAT FISIK

PT KERINCI MERANGIN HIDRO

LABORATORIUM
PEMERIKSAAN & PENGUJIAN MATERIAL
PT. KERINCI MERANGIN HIDRO
Project : Hydroelectric Power Plant 4 x 87,5 MW
Batang Merangin Kerinci - Jambi

BUKAKA
PT. BUKAKA TEKNIK UTAMA, Tbk

PENGUJIAN SIFAT FISIK

No	Samples	Depth (m)	Lithology	Natural Density (d)	Natural Water Content	Saturat Density (s)	Absorpt/ ST. Water Content	Dry Density (d)	Deg. Of Saturate (s)	Porosity (n)	Apspec (Gravity)	True Spec. Gravity	Void Ratio (e)
		(from - to)	-	gr/cm3	%	gr/cm3	%	gr/cm3	%	%	-	-	-
1	EP-01 A	30,60 - 30,65	Batu Sabak (Slate)	1,415	34,32	1,620	55,20	1,086	62,48	54,47	1,085	2,219	1,248
2	EP-02 B	33,51 - 33,56	Batu Sabak (Slate)	1,168	16,77	1,617	65,50	1,022	25,44	60,52	1,021	2,379	1,571
3	EP-03 C	37,79 - 37,85	Batu Sabak (Slate)	1,196	19,02	1,515	64,10	1,028	29,55	59,63	1,091	2,345	1,517

Mengetahui,
Ka. Lab Pemeriksaan dan Pengujian Material

RIFAN, ST

LAMPIRAN 3

HASIL UJI LABORATORIUM KUAT TEKAN UNIAKSIAL

UNCONFINED COMPRESSION STRENGTH

No. Permintaan *Request No.*	: -				No. Conto *Sample No.*	: EP-01	
Permintaan dari *Request from*	: PT. Kerinci Merangin Hydro				Kedalaman *Depth*	: 64.25-67.57	m
Peroyek *Project*	: PLTA Kerinci				Litologi *Lithology*	: -	
Lokasi *Location*	: -				Kondisi uji *Test Condition*	: Natural	
Tanggal *Date*	: 29 September 2019				Berat *Weight*	: 392,7	gr
Ukuran conto *Size of speciment*	Tinggi *Height*	:	9,10	cm	γ n	: 2,775	
	Diameter *Diameter*	:	4,45	cm	Diuji oleh *Tested by*	: Gatot Cs.	
	Luas *Area*	:	15,55	cm^2	Diperiksa oleh *Checked by*	: Said Saleh, BSc.	
Koreksi L/D *L/D Correction*	: 1,011726259						

No.	LOAD	STRESS	DIAL READING ($X10^{-3}$)mm				STRAIN ($x10^{-4}$)	
			AXIAL		DIAMETRAL		AXIAL	DIAMETRAL
	(kg)	(kg/cm^2)	d	d.1	d	d.1	a	d + d1
1	0	0,000	0				0,000	
2	173	11,507	61				6,703	
3	367	24,367	111				12,198	
4	632	41,966	180				19,780	
5	897	59,565	200				21,978	
6	948	62,949	222				24,396	
7	1071	71,072	245				26,923	
8	1193	79,194	266				29,231	
9	1377	91,378	289				31,758	
10	1632	108,299	314				34,505	
11	1978	131,313	338				37,143	
12	2192	145,527	373				40,989	
13	2570	170,572	392				43,077	
14	2733	181,402	420				46,154	
15	3120	207,123	444				48,791	
16	3498	232,167	468				51,429	
17	3722	247,058	494				54,286	
18	3793	251,796	521				57,253	
19	3916	259,919	555				60,989	
20	4007	266,011	583				64,066	
21	4120	273,456	617				67,802	
22	4293	284,963	651				71,538	
23	4446	295,116	685				75,275	
24	4538	301,208	727				79,890	
25	4721	313,392	752				82,637	
26	4986	330,990	803				88,242	
27	1764	117,099	1044				114,725	
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

REMARK : SAMPLE FAILURE AT :

-

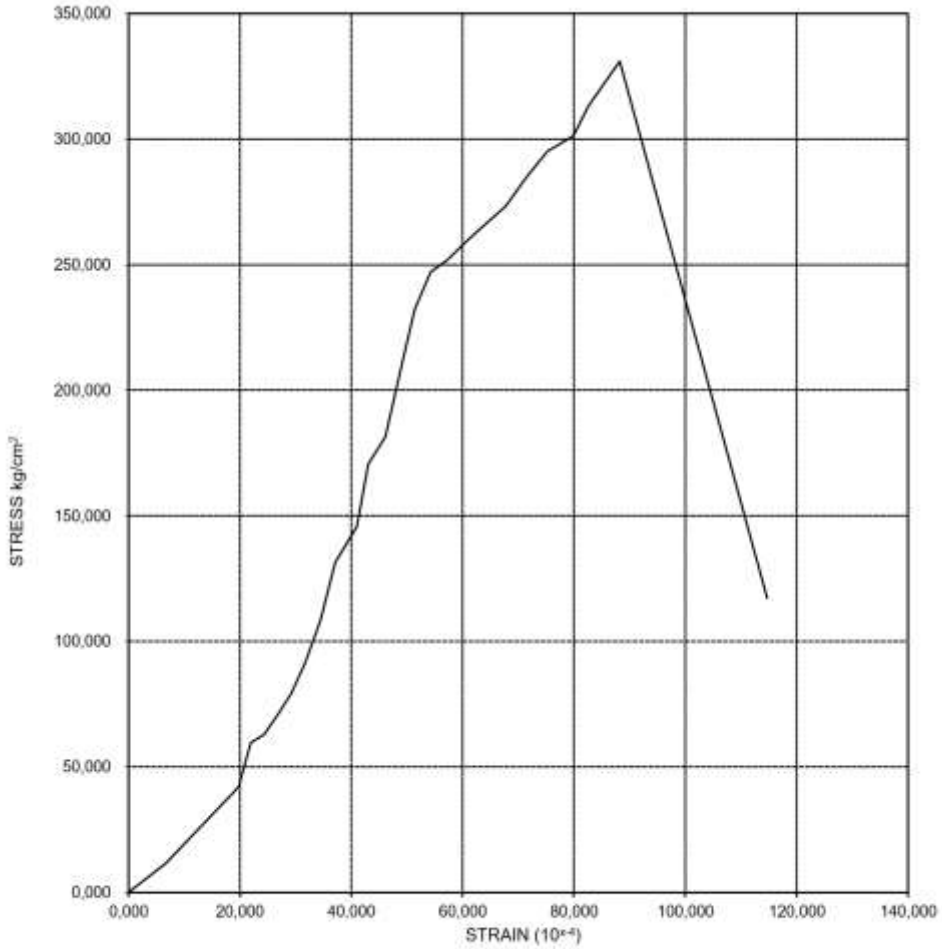
σC = **330,990** kg/cm²
E Axial = **3,96E+04** kg/cm²
v = **0,25**

Pursuant to SNI 03-2825-1992

UNCONFINED COMPRESSION STRENGTH

No. Permintaan *Request No.*	: -				No. Conto *Sample No.*	: EP-01	
Permintaan dari *Request from*	: PT. Kerinci Merangin Hydro				Kedalaman *Depth*	: 64.25-67.57	m
Peroyek *Project*	: PLTA Kerinci				Litologi *Lithology*	: -	
Lokasi *Location*	: -				Kondisi uji *Test Condition*	: Natural	
Tanggal *Date*	: 29 September 2019				Berat *Weight*	: 392,7	gr
Ukuran conto *Size of speciment*	: Tinggi *Height*	:	9,10	cm	γ n	: 2,775	
	Diameter *Diameter*	:	4,45	cm	Diuji oleh *Tested by*	: Gatot Cs.	
	Luas *Area*	:	15,55	cm^2	Diperiksa oleh *Checked by*	: Said Saleh, BSc.	
Koreksi L/D *L/D Correction*	: 1,011726259						

UNCONFINED GRAPH



Pursuant to ASTM D3148-02 / SNI 03-2825-1992

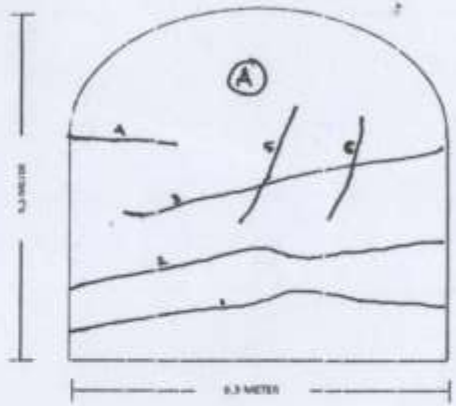
LAMPIRAN 4

PENGAMATAN FACE LUBANG BUKAAN

NUMBER FACE : 1
LOKASI : END PORTO - [redacted]
STRIKE : N 220 E
HEIGHT : 6.3 m
WIDTH : 6.3 m

EXCAVATION METHOD : Drilling & Blasting
CONDITION : Berdebu & Lembab
LOGGED BY : Apriadi Saputra & Engineer
DATE : 11 Sep 2021

No.	Strike	Dip	DD	spasi cm	Diskontinuity Condition					
					Persistence (m)	Separation (mm)	Roughness	Infiling (mm)	Weathering	Groundwater
1	117	90	207		8	0.4	slightly R	hard >5	moderately w.	Dripping
2	115	37	205	80	8	0.6	slightly R	hard >5	moderately w.	Dripping
3	115	32	205	118	6	0.4	slightly R	hard >5	moderately w	wet
4	104	42	194	124	2	1.0	smooth	Soft <5	slightly w.	wet
5	203	82	293		2	-	Smooth	Soft <5	moderately	wet
6.	207	81	297	116	2	0.9	smooth	Soft <5	Unweather	Dripping



: Slate
: Metasandstone
: Quartz
: Discontinuity

NOTE :
(A) Slate : Gray Dark, Foliasi, Infiling Quartz & Clay.

LOGGED BY	CHECKED BY
APRIADI SAPUTRA.	

CLASSFICATION PARAMETERS AND THEIR RATINGS

1. Uniaxial Compressive Strength (UCS)

UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	4
Rating	15	12	7	(4)	2	1	0	

2. Rock Quality Design (RQD)

RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25	3
Rating	20	17	13	8	(3)	

3. Spacing of Discontinuities (SJ)

spasi	> 2 m	0,5 - 2 m	200 - 600 mm	60 - 200 mm	< 60 mm	15
rating	20	(15)	10	8	5	

4. Condition of discontinuities (CJ)

PARAMETER									15
	Persistence	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	
		rating	6	(4)	(2)	1	0		
	Separation	Aperture (mm)	none	< 0,1	0,1 - 1	1 - 5 mm	> 5 mm	4	
		rating	(6)	5	(4)	1	0		
	Roughness	Roughness	Very rough	Rough	Slightly rough	Smooth	Slickensided	2	
		rating	6	5	(3)	(1)	0		
	Infilling	Gouge (mm)	none	Hard <5	Hard >5	Soft <5	Soft >5	2	
		rating	6	4	(2)	(2)	0		
	Weathering	Weathering	Unweathered	Slightly W.	Moderately W.	Highly W.	Decomposed	4	
		rating	(6)	(5)	(3)	1	0		

5. Groundwater (GW)

Condition	Dry	Damp	Wet	Dripping	Flowing	6
Rating	15	10	(7)	(4)	0	

6. Rating adjustment for discontinuities (AJ)

Strike Perpendicular to Tunnel Axis				Strike Parallel to Tunnel Axis		Irrespectif of Strike	-2
Drive with Dip		Drive Against Dip		Dip 45° - 90°	Dip 20° -45°	Dip 0° - 20°	
Dip 45° - 90°	Dip 20° -45°	Dip 45° - 90°	Dip 20° -45°				
Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	fair	fair	
0	-2	-5	-10	-12	-5	-5	

LOGGED BY

APRIADI SANTRA

CHECKED BY

RMR = UCS + RQD + SJ + CJ + GW – AJ

RMR	UCS	RQD	SJ	C	GW	AJ	41
	4	3	15	15	6	-2	

RMR Face 1 = 41

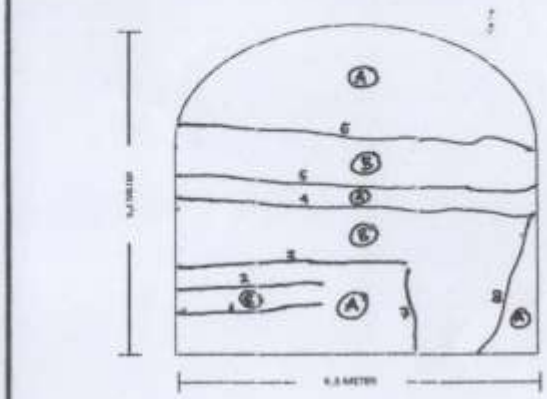
MEANING OF ROCK MASS CLASSES

Rating & Class	81-100 (I)	61 - 80 (II)	41 - 60 (III)	21 - 40 (IV)	< 20 (V)
Deskripsi	Very Good R.	Good Rock	Fair Rock	Poor Rock	Very Poor Rock
Stand-up Time	20 Years	1 Years	1 weeks	10 hours	30 minutes
	15 m span	10 m span	5 m span	2,5 m span	1 m span

NUMBER FACE : 2
LOKASI : END PORTAL [illegible]
STRIKE : N 220 E
HEIGHT : 6.3 m
WIDTH : 6.3 m

EXCAVATION METHOD : Drilling & Blasting
CONDITION : Tertutup Debu & Lembab
LOGGED BY : Apriadi Saputra & Engineer
DATE : 12 Sep 2021

No.	Strike	Dip	DD	spasi cm	Diskontinuity Condition					
					Persistence (m)	Separation (mm)	Roughness	Infiling (mm)	Weathering	Groundwater
1	130	38	220		5,5	2	Slightly	Soft <5	Moderatly	damp
2	135	40	225	20	3,9	0,9	Slightly	hard >5	Moderatly	damp
3	129	38	219	18	5	0,9	Smooth	hard >5	Moderatly	wet
4	128	43	218	75	8	0,8	Smooth	hard >5	Slightly	wet
5	128	44	218	23	8	4	Smooth	hard >5	Slightly	wet
6	129	43	219	48	8,2	0,8	Smooth	hard >5	Slightly	dripping
7	209	81	299		2	0,9	Slightly	hard >5	Moderatly	dripping
8	208	79	298	50	2,1	3	Slightly	hard >5	Moderatly	dripping



: Slate
: Metasancstone
: Quartz
: Discontinuity
:
:

NOTE :
(A) State : Gray Dark, Foliasi, Infiling Kuarsa & Clay
(B) Metasandstone : Gray Dark - Gray Fresh, Kuarsa Infiling.

LOGGED BY	CHECKED BY
Apriadi Saputra	

CLASSIFICATION PARAMETERS AND THE R RATINGS

1. Uniaxial Compressive Strength (UCS)

UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	<1	4
Rating	15	12	7	(4)	2	1	0	

2. Rock Quality Design (RQD)

RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25	3
Rating	20	17	13	8	(3)	

3. Spacing of Discontinuities (SJ)

spasi	> 2 m	0,6 - 2 m	200 - 600 mm	60 - 200 mm	< 60 mm	16
rating	20	(15)	(10)	(8)	5	

4. Condition of discontinuities (CJ)

PARAMETER									
Persistence	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	14
	rating	6	(4)	(2)	1	0		
Separation	Aperture (mm)	none	< 0,1	0,1 - 1	1 - 5 mm	> 5 mm	3	
	rating	6	5	(4)	(1)	0		
Roughness	Roughness	Very rough	Rough	Slightly rough	Smooth	Slickensided	2	
	rating	6	5	(3)	(1)	0		
Infilling	Gouge (mm)	none	Hard <5	Hard >5	Soft <5	Soft >5	2	
	rating	6	4	(2)	(2)	0		
Weathering	Weathering	Unweathered	Slightly W.	Moderately W.	Highly W.	Decomposed	4	
	rating	6	(5)	(3)	1	0		

5. Groundwater (GW)

Condition	Dry	Damp	Wet	Dripping	Flowing	7
Rating	15	(10)	(7)	(4)	0	

6. Rating adjustment for discontinuities (AJ)

Strike Perpendicular to Tunnel Axis				Strike Parallel to Tunnel Axis		Irrespectif of Strike	−2
Drive with Dip		Drive Against Dip		Dip 45° - 90°	Dip 20° -45°	Dip 0° - 20°	
Dip 45° - 90°	Dip 20° -45°	Dip 45° - 90°	Dip 20° -45°				
Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	fair	fair	
0	(-2)	-5	-10	-12	-5	-5	

LOGGED BY

Adha

ADHADI SAPUTRA

CHECKED BY

RMR = UCS + RQD + SJ + CJ + GW − AJ

RMR	UCS	RQD	SJ	CJ	GW	AJ	36
	4	3	10	14	7	-2	

RMR FACE 2 = 36

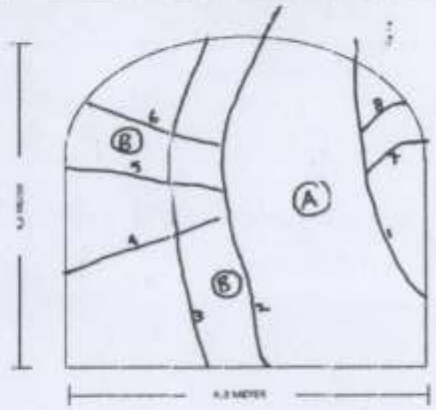
MEANING OF ROCK MASS CLASSES

Rating & Class	81-100 (I)	61 - 80 (II)	41 - 60 (III)	21 - 40 (IV)	< 20 (V)
Deskripsi	Very Good R.	Good Rock	Fair Rock	Poor Rock	Very Poor Rock
Stand-up Time	20 Years	1 Years	1 weeks	10 hours	30 minutes
	15 m span	10 m span	5 m span	2,5 m span	1 m span

NUMBER FACE : 3
LOKASI : END PORTAL 04 [redacted]
STRIKE : N 220 E
HEIGHT : 6.3 m
WIDTH : 6.3 m

EXCAVATION METHOD : Drilling & Blasting
CONDITION : Berdebu & Lembab
LOGGED BY : Apriadi Saputra & engineer
DATE : 16 Sep 2021

No.	Strike	Dip	DD	spasi cm	Diskontinuity Condition					
					Persistence (m)	Separation (mm)	Roughness	Infilling (mm)	Weathering	Groundwater
1	200	67	290		4	2	Slightly	hard >5	Moderately	Dripping
2	209	72	299	234	8	4	Smooth	soft <5	Slightly	wet
3	197	66	287	66	7	1	Smooth	soft <5	Slightly	wet
4	145	30	235		2.7	1	Slightly	hard >5	Slightly	wet
5	318	22	48	97	2.6	1	Slightly	hard >5	Slightly	wet
6	321	23	51	49	2.7	1	Slightly	hard >5	Slightly	wet
7	216	72	306		1	3	Smooth	soft <5	Moderately	Dripping
8	221	64	311	43	1	1	Smooth	soft <5	Moderately	Dripping



: Slate
: Discontinuity
: Metasandstone
:
: Quartz
:

NOTE :
(A) Slate : Grey Dark , Foliasi, Mineral Quartz & Clay
(B) Metasandstone : Grey Dark - Grey Fresh, Quartz Mineral.

LOGGED BY
Apriadi Saputra.

CHECKED BY

CLASSIFICATION PARAMETERS AND THEIR RATINGS

LOGGED BY

APPIADI SAPUTRA

CHECKED BY

1. Uniaxial Compressive Strength (UCS)

UCS (MPa)	>250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1	4
Rating	15	12	7	(4)	2	1	0	

2. Rock Quality Design (RQD)

RQD (%)	90 - 100	75 - 90	50 - 75	25 - 50	< 25	3
Rating	20	17	13	8	(3)	

3. Spacing of Discontinuities (SJ)

spasi	> 2 m	0,6 - 2 m	200 - 600 mm	60 - 200 mm	< 60 mm	13
rating	(20)	(15)	(10)	8	5	

4. Condition of discontinuities (CJ)

PARAMETER									
	Persistence	Length (m)	< 1	1 - 3	3 - 10	10 - 20	> 20	3	14
		rating	6	(4)	(2)	1	0		
	Separation	Aperture (mm)	none	< 0,1	0,1 - 1	1 - 5 mm	> 5 mm	3	
		rating	6	5	(4)	(1)	0		
	Roughness	Roughness	Very rough	Rough	Slightly rough	Smooth	Slickensided	2	
		rating	6	5	(3)	(1)	0		
	Infilling	Gouge (mm)	none	Hard <5	Hard >5	Soft <5	Soft >5	2	
		rating	6	4	(2)	(2)	0		
	Weathering	Weathering	Unweathered	Slightly W.	Moderately W.	Highly W.	Decomposed	4	
		rating	6	(5)	(3)	1	0		

5. Groundwater (GW)

Condition	Dry	Damp	Wet	Dripping	Flowing	6
Rating	15	10	(7)	(4)	0	

6. Rating adjustment for discontinuities (AJ)

Strike Perpendicular to Tunnel Axis				Strike Parallel to Tunnel Axis		Irrespectif of Strike	-2
Drive with Dip		Drive Against Dip		Dip 45° - 90°	Dip 20° -45°	Dip 0° - 20°	
Dip 45° - 90°	Dip 20° -45°	Dip 45° - 90°	Dip 20° -45°				
Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	fair	fair	
0	(-2)	-5	10	-12	-5	-5	

RMR = UCS + RQD + SJ + CJ + CW – AJ

RMR	UCS	RQD	SJ	CJ	CW	AJ	38
	4	3	13	14	6	-2	

RMR FACE 3 = 38

MEANING OF ROCK MASS CLASSES

Rating & Class	81-100 (I)	61 - 80 (II)	41 - 60 (III)	21 - 40 (IV)	< 20 (V)
Deskripsi	Very Good R.	Good Rock	Fair Rock	Poor Rock	Very Poor Rock
Stand-up Time	20 Years	1 Years	1 weeks	10 hours	30 minutes
	15 m span	10 m span	5 m span	2,5 m span	1 m span

PENENTUAN RQD

Proyek	: PLTA KERINCI	Koordinat	E : 806878
Lokasi	: POWER HOUSE		N : 9755953
No. Lubang	: EP-01		Z ; 359,443
Total Kedalaman	: 50,00 m		
Kedalaman	: 60,00 m – 65,00 m		
Core Box	: 5 – 8		

60,00

65,00

$$RQD = \frac{\text{Length of Core Place>10 Cm}}{\text{Total core Run Lenght}} \times 100\ \%$$

$$RQD = \frac{10 + 11 + 21 + 10 + 20 + 11 + 10}{500} \times 100\ \%$$

RQD = 18 %

LAMPIRAN 5

PROPERTIES DARI SOFWARE ROCKLAB