13 32 9 8

2 2

1969 1970 1975

800 t -54m 1992

5100 t/a 1700

t/a 3400 t/a -270m 12m 15m -30m

2300 t 1700 t/a

2

3400

4657 60 4657

+138m -450m

2024 5

2300×10⁴t/a +138m -450m

“ ”

1.2

1.2.1

1 1992 65
2009 8 27
2009 8 27

2 1986 36
2009 8 27
2009 8 27

3 2013
4 2014 1 1

4 2008 6
2021 4 29
2021 4
29

5 2002 70
2021 6 10
2021 9 1

1.2.2

1 2003 393 2004 2
1

2 2006 466 2014
7 29 653 2014
7 29

3 2019 708 2019 4 1

1.2.3

1

2015 13 2015 2 13

2

2015 75 2015 7 1

3 2006

3 2015 5 29 80

2015 7 1

2024 1 16

14

10 GB 50052-2009

11 GB5 7-2010

12 (GB5 1-2010[016])

13 GB2 2010

14 GB 50 -2011

15 GB 43-2012

16 B50187-20 0 ó ‡ •'@

17 GB50029-2014

18 GB50201-2014

19 GB 51016-2014

20 2018 GB50016-2014

21 GB55037-2022

22 GB 18306-2015

23 GB50150-2016

24 < > 1 GB 6722-2014/XG1-2016

25 GB/T13869-2017

26 GB/T10595-2017

27

GB/T8196-2018

28 GB18218-2018

29 GB51119-2015

30 GB 2811-2019

31 GB/T 38304-2019

32 GB/T 385092020

33 5

GB/T 2893.5-2020

GB50070-2020

37 4 GB 39800.4-2020

38 GB16423-2020

39 GB/T29639-2020

40 GB/T12265-2021

41 GB/T12719-2021

42 GB/T 20645-2021

43 GB/T23821-2022

44 GB/T13861-2022

1.2.5.2

1 AQ2005-2005

2 AQ8001-2007

3 AQ8002-2007

4 AQ1043-2007

5

AQ2027-2010

6 AQ/T 2063-2018

7

AQ/T2073-2019

8 AQ/T 1009-2021

9 AQ/T 1118-2021

1

2020 10

2

2022 2

3

2023 6

4

2023 10

5

2023 42 2023 12 27

6

2023 43 2023 12 26

7

2024 4

1

2

3

2

2.1

1

13 32 9 8

2 2

12km

4650m -1300m

-300m 2016 2 29

-1300m 1981795.46 t TFe 31.42% 2023

6 30 -450m 685286.32 t TFe 31.15%

5100 t/a 1700 t/a 3400 t/a

60 3400 -270m 12m

15m -30m

900 t/a

1440 /

2300 t 1700 t/a

2

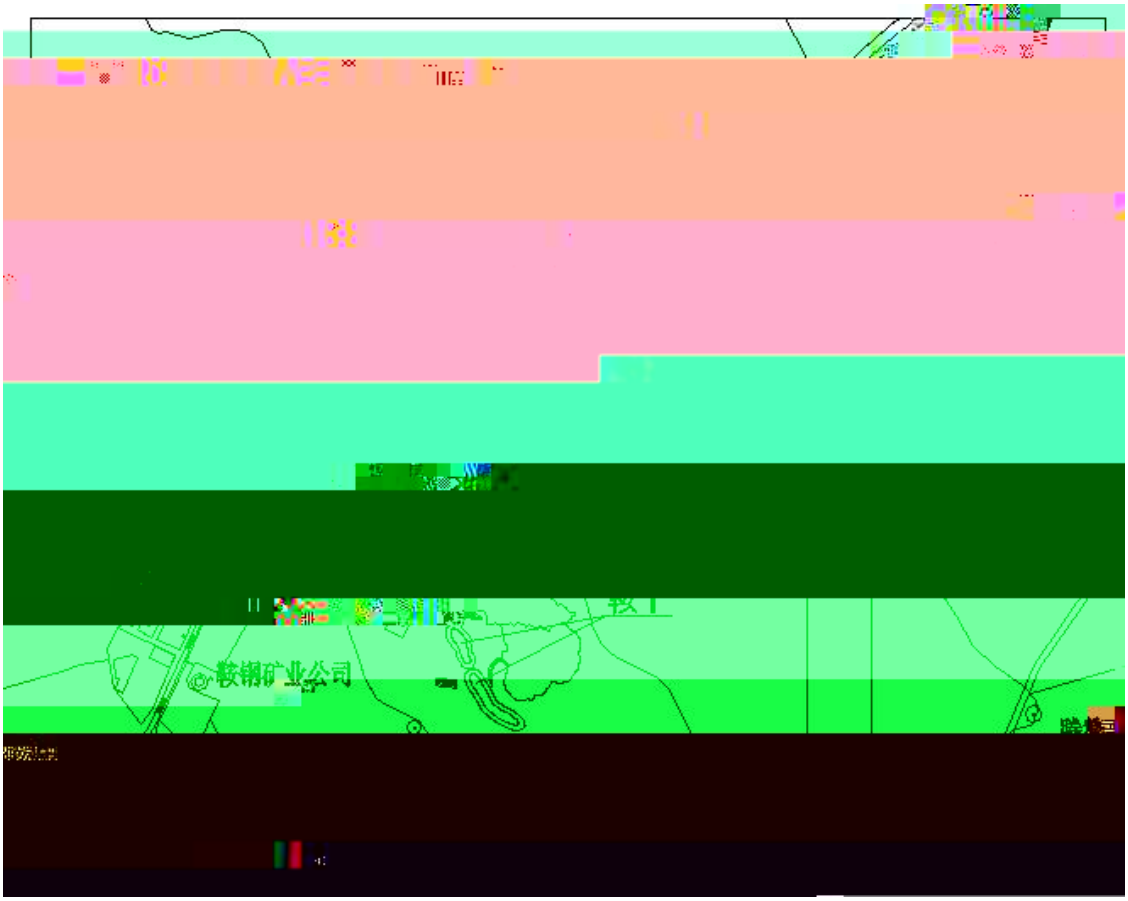
12km

1.3km 6km

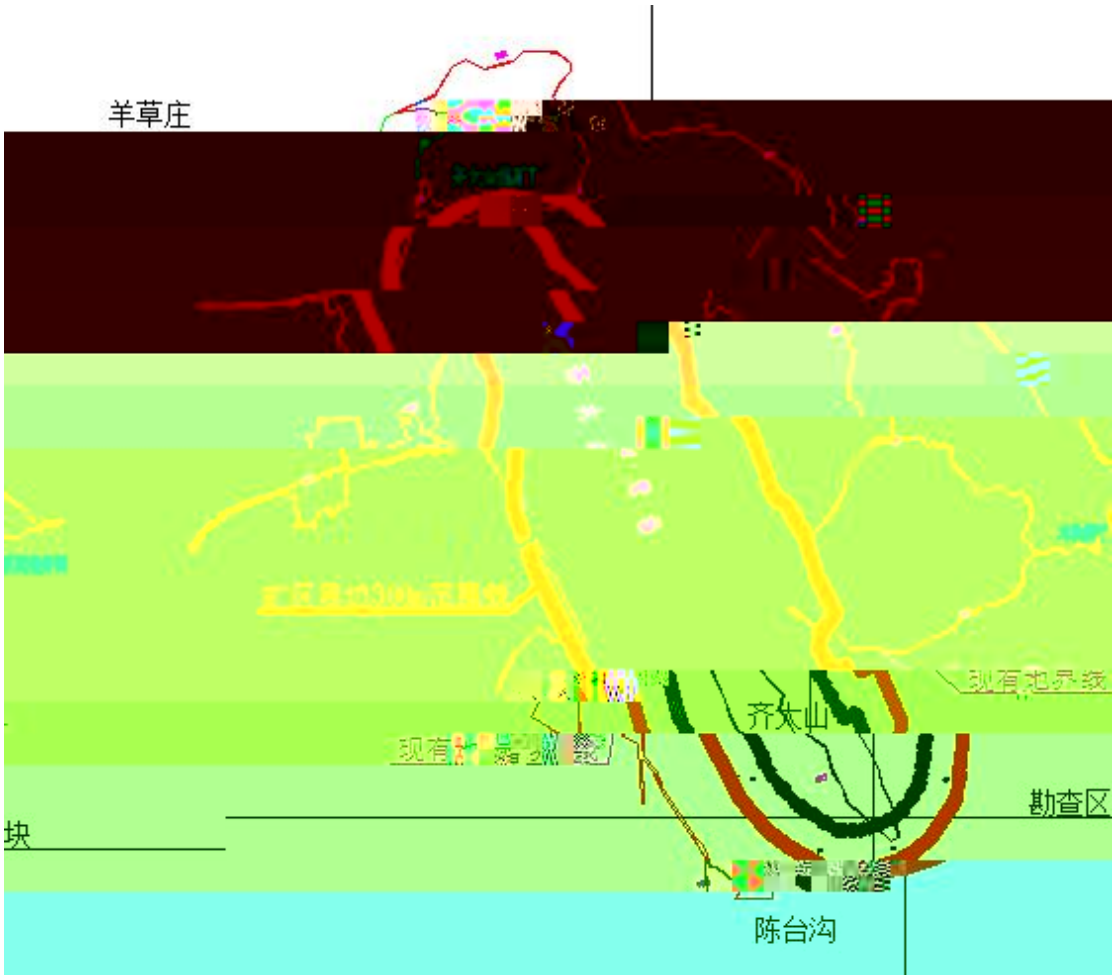
2-1

123 ° 05 ′ 07 ′

41 ° 07 ′ 09 ′



2


羊草庄
齐大山
勘查区
陈台沟

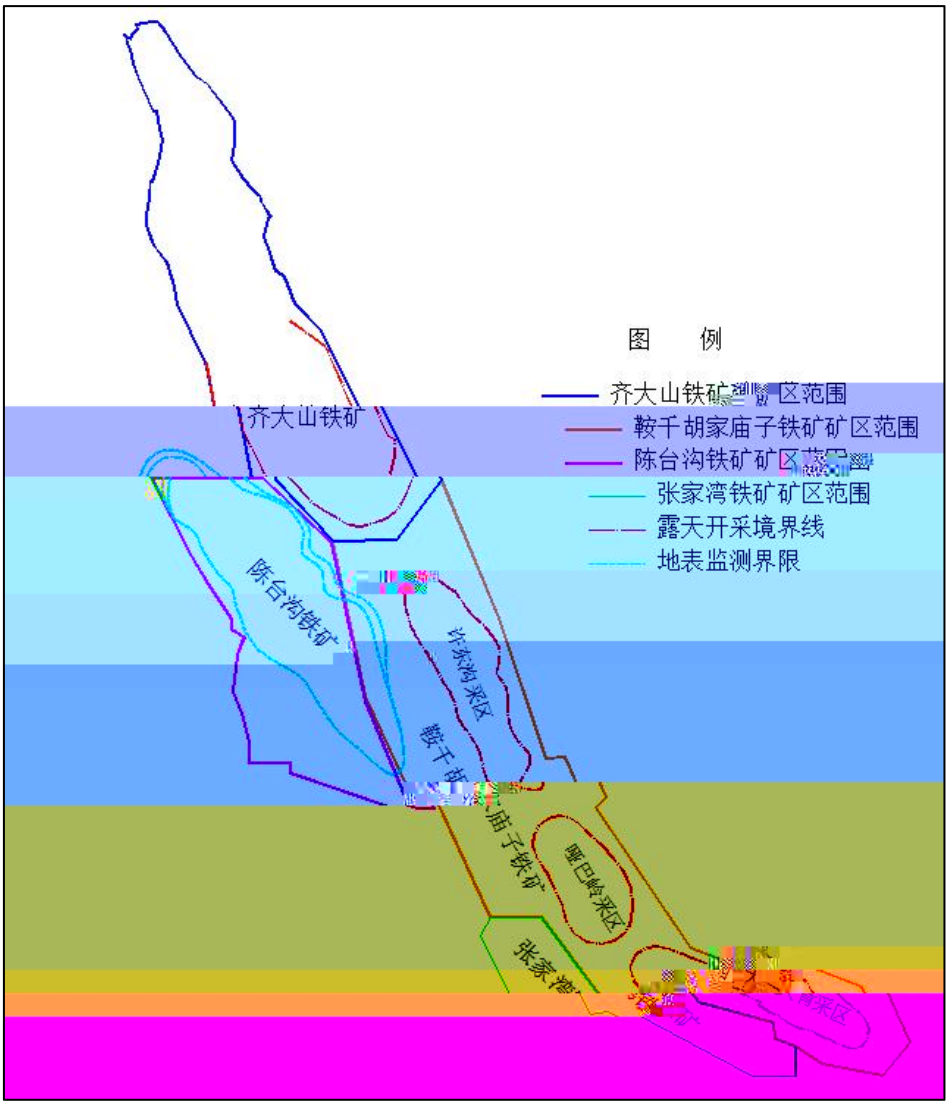


图　例
齐大山铁矿矿区范围
鞍千胡家庙子铁矿矿区范围
陈台沟铁矿矿区范围
张家湾铁矿矿区范围
露天开采境界线
地表监测界限
齐大山铁矿
陈台沟铁矿
许家沟采区
鞍千胡
庙子铁矿
腰巴沟采区
张家湾
采区

3

1 3m 50

2.3.1.2

1

1480 3420m

310° 335° 86°

2-3

2.3.1.3

1 γ_1^2

1680 4500

-1200m

2

a. δ

b. μ

1

60

4900 173 100 200m

3400m 1410m

133.72 -1385m 0m 1230m

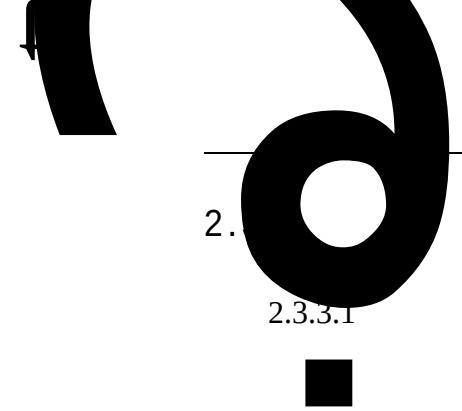
305 335° 70 90° TFe

31.20% 9.23% 36.3 267.5m 152.58m

ظمحس 42.92%

60 1060 t كم

2.3.3.1



10 25° 100 200m

234.67m 37m

9.6 36.5

-26.9 710.5mm 994.5mm 1975

416.7mm 1985 7 236.8mm 1975 9 1

7 8 9 1750.5mm 91mm

3 10m

0.16m^3/s

34.5m^3/s

2.3.3.2

γ_1^2

Ar_3y Pt_1l

Q_4

1 Q_4

35m DK1 q=0.71L/s·m

k=1.91m/d ,

2 Ar_3y

3L/s

0.0319L/s·m 0.0074m/d

HS-CM PH 7.35

400.64mg/L

3 γ_1^2

0.0034 L/s·m

0.0011 m/d , HS-CMN PH 7.78

422.57mg/L

4 Pt_1l

,

0.0006L/s·m 0.00027m/d

5

70-80°

40-50° 50-60°

2.3.3.3

1

1-4m 1-2

1m 2-3

2

,

0.0006L/s·m 0.00027m/d

-48m -69m

2.3.3.4

3P k : b@B@ k

1260 1880

30m 50m

2cm 5cm 240 250° 32° 38°

	RQD		RQD
	90.63%		91.06%
	82.54%		94.36%

3

2000m

2000m 500m F_{1-1}

500 30m ~ m" F_{3-3}

2.3.4.3

2.4

2.4.1

1

-270m 42m 330m

3480m 1010m -270m

520m 70m 38° 46° -30m

12m -30m 15m 24m 30m

24 65° 35° 8m

16m 30m 60m

60m -240m -255m -270m

2

“ ”

“ ” 6km

4km

→ → 10 → 9 →

5 → 4 → 3 → 2 → 1 →

-135m -108m

2.6km

→ → →3# →2#

→ 1# →1# → → →

I 26.5m 8%

45m 2 16M 4

TR50 0.6m 1.2m

1.6m 5m

1.2m 0.4m 0.4m

3

45R 5 YZ55 4 YZ35 1

KY310 1 11

52000m/ · 3% 110t/m

16.8m³ 5 10m³ 3 2 4m³

16.8m³ 600 t/ 10m³ 300 t/

37 154t 29 190t 8

360 tkm/ 11520 tkm/ 2.9km

4000 t

2-11

2-11

1

90m 66m 42m

3740.0m 90m 1334m 66m 1048m 42m

966m 350m C20 2.0m

2.0m 0.30m 0.15m C30

3.0m 2.0m

0.5m

2

3

2.4.4

4650m

3400 4657 -270m

-450m

2.4.5

2

42m

-6m 50m

-330m

154 190t

30m 22m 1m 0.4m × 0.4m

4m 2m 8% 60m 30m

1

2

— — —

— — —

5 3 ——

2 ——

1

1997 -135m

-108.5m 1700

00×3		4	0t/h	1800mm
5.47m/	ST4	/mm	672.4	84m	7.59°
				0m

ω	3	φ159mm	φ1400×1	00mm

2#		4950h	8150t/h	1800mm
5.47m/s				

3# 2#

b

1# 1# 4950h

1150t/h 1200mm 2.5m/s ST1000N/mm 472.485m

28.3m 12.718° 400kW

35° φ133mm φ1000×1400mm

2# 4950h 1150t/h

1200mm 2.5m/s ST3150N/mm 693.523m 173.5m

14° 2×630kW

35° φ133mm φ1400×1400mm

3# 4950h 1150t/h 1200mm

2.5m/s ST1000N/mm 178m 0m 0°

160kW 35°

φ133mm φ1000×1400mm

4

500 t/a

→ → → 1# → 2#

①

:500 t/a 330 3 8

1000mm

②

a

+52.15m

14.15m

1200mm×1600mm 1000mm 300mm 0mm

1050t/h

54m 400 t/a

72.69m 200 t/a

500 t/a 500 t

400 t/a 200 t/a

2.4.6

1

-30m 12m -30m 15m 24m 30m

-210m 60 ° -210m 65 °

65 ° 35 °

8m

14m

30m

-30m -120m -210m 30m

35m

≤ 8%

9 ≥ 60m

2

2-12

2-12

1			m	12 15 24 30
2				35
				60

						65
						14.57
						41.59
3						44.68
						41.98
					m	8 8 14
4						
					m	8 8 14
5	-30	-120	-210		m	30
6					m	30
1					m	4849 × 1568 850
2					m	2549 × 110 35
3					m	-450
4					m	596
5					m	42
					t	36704.88
6					t	79682.45

φ 250 310mm 14.5

17.5m 2.5m 250mm 7m × 6m 310mm

8m × 8m 550 t/ • 3% 110t/m

7300 t/a

3 7 4 6

200m

2

10m^3 3 16.8m^3 5 13.5m

16.8m

2 1 1

3

2300 t

6400 t/a 1900 t

5500 t 2800 t

6200 t/a 2100 t

“ ”

6 10kV 130#

1# 2 1# 2#

3# 2 1# 2# 4# 2

3

-450m

PE

1

2.4.8

2.4.8.1

1

-270m 6 1222m³/h

185m 1000kW 3 φ426mm 3

-135m 1 9#

7# 6# 5# 4# 2# 2

4 2

2520m³/h

2

1

79m 537m 2195m 2811m 4.0m

6.0m 1 0.5 3.0m 2.0m

0.5m 3 × 2.5m

C30 C30

2

3740.0m 90m 1334m 66m 1048m 42m

966m 350m C20 2.0m

2.0m 0.30m 0.15m C30

3.0m 2.0m

0.5m

3

+a

-120m -270m

30m×16m×5m -450m

30m×16m×5m

8

47

8369 m^3

50m 20m 10m

2.4.9.3

78859 t 38084 m^3

31729 m^3 6355 m^3

8369 m^3 2-14

2-14

			m^3	
1		320	16176	
2		320	15553	
3		330	8369	
			40098	
			38084	
			2014	

2.4.9.4

850m 320m 16176 m^3

1200m 320m 15553 m^3

-

2.4.9.5

1

2 2% 5%

2

118m -5.5m 49

4

3

2-5

3

1

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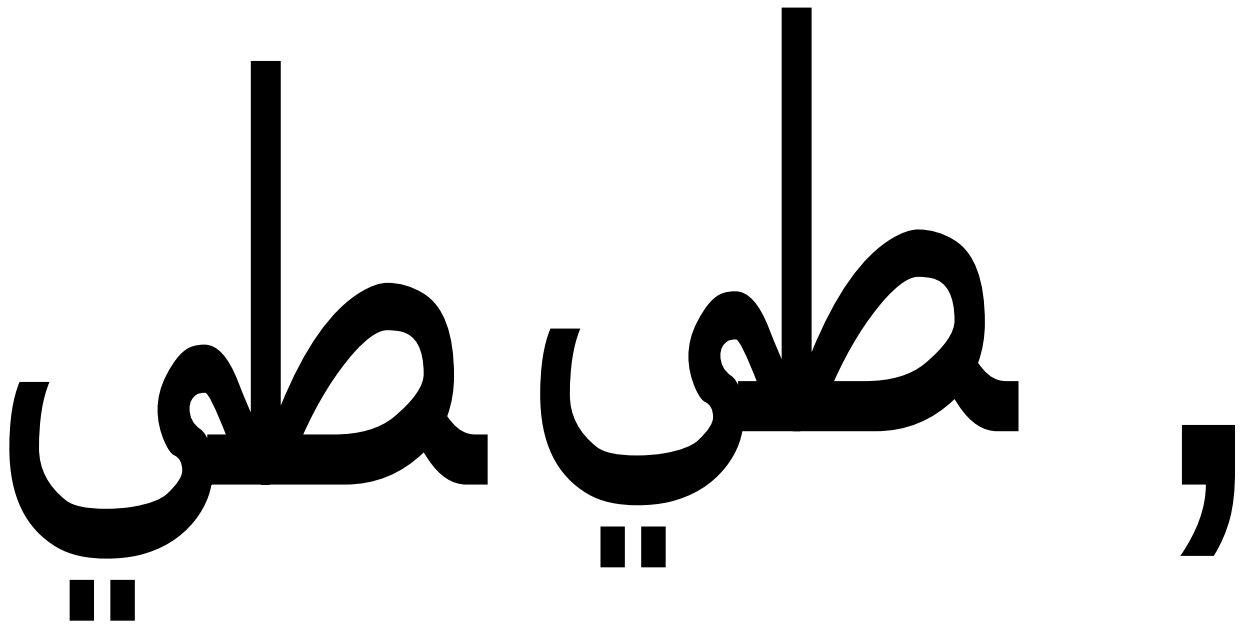
8

3

3-1

3-1



3.

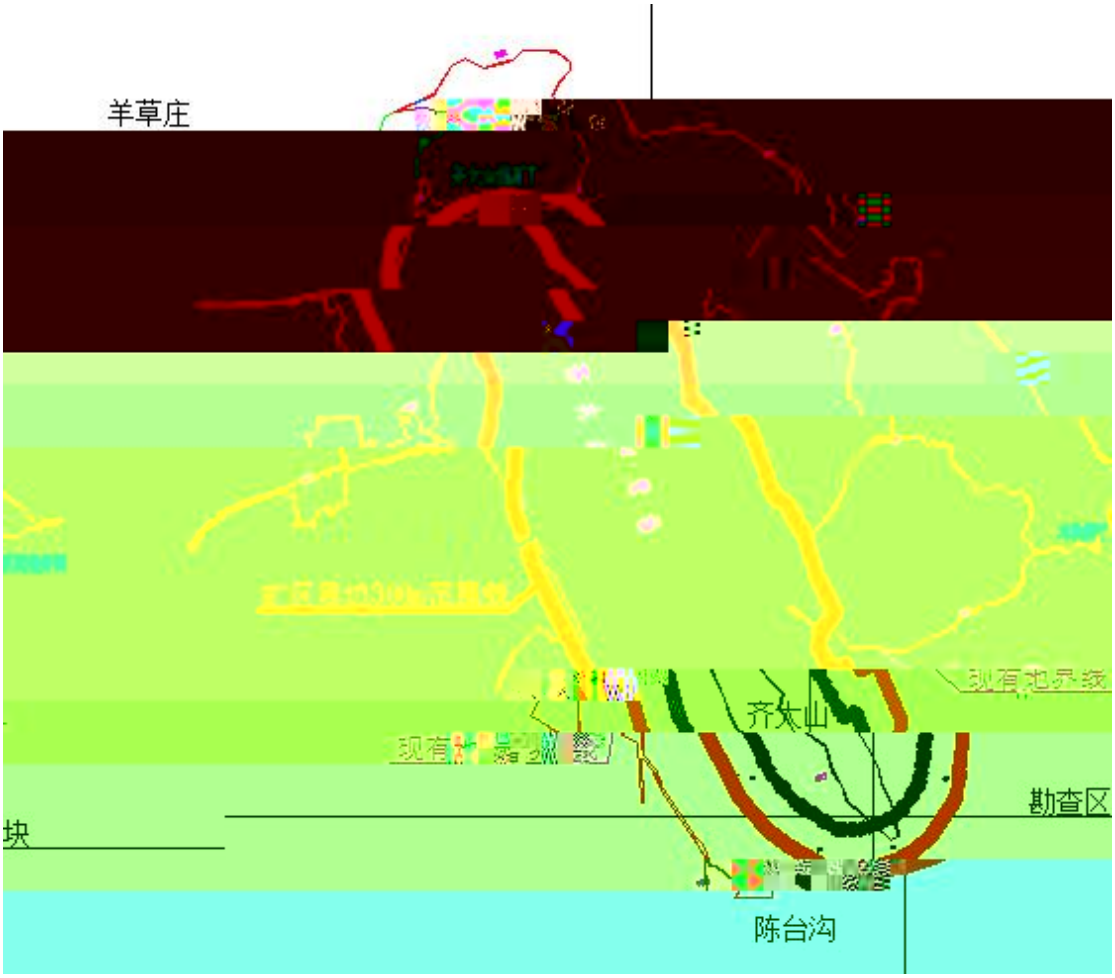
3.0.10

4

-

3.1.2

1



1		220m	
2		820m	
3		1300m	
4		500m	
5		20m	
6		600m	
7			
8		500m	

9		320m	
10		550m	
11		500m	
12			

1		220	
2		20	
3			
4			

2

“

”

500m

30m Ã

3-3

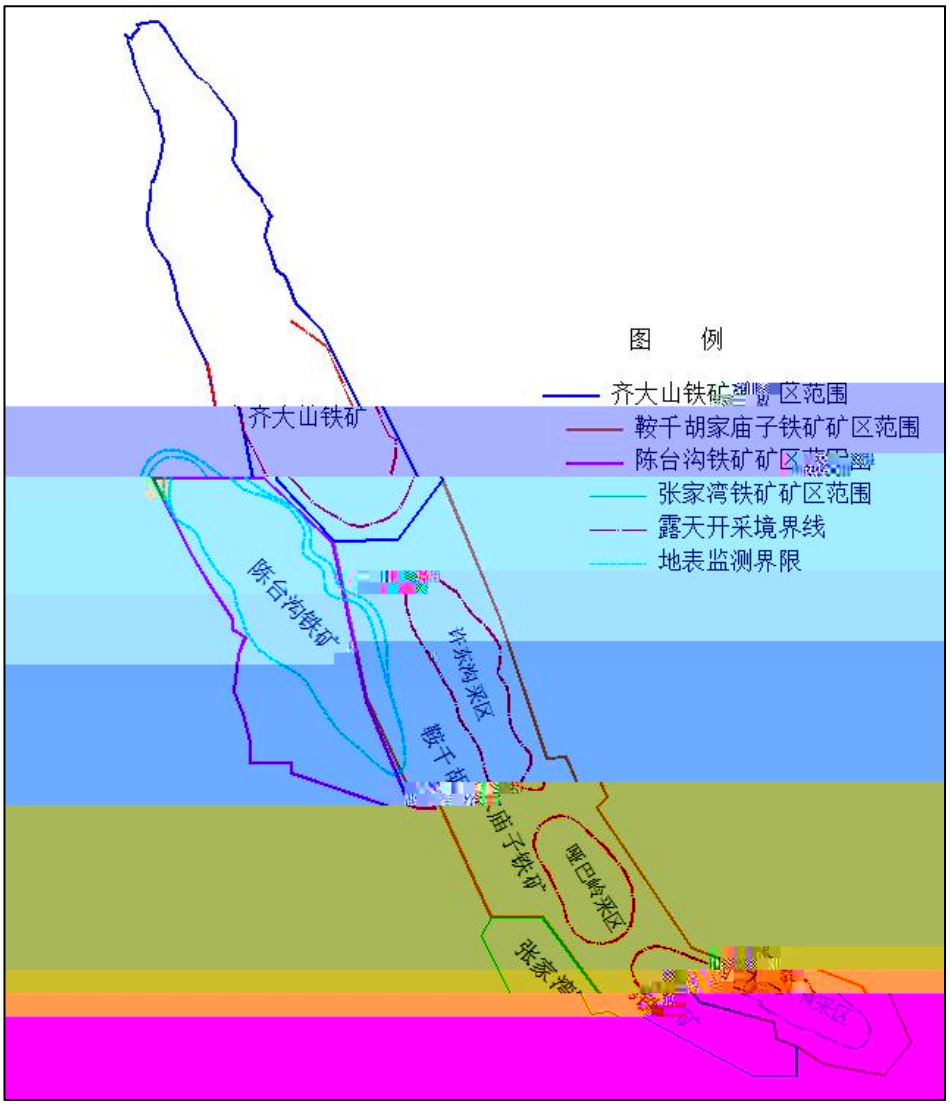


图 例
齐大山铁矿矿区范围
鞍千胡家庙子铁矿矿区范围
陈台沟铁矿矿区范围
张家湾铁矿矿区范围
露天开采境界线
地表监测界限
齐大山铁矿
陈台沟铁矿
许东沟采区
鞍千胡家庙子铁矿
腰巴岭采区
张家湾

3

1		≥1.5H	≥1.5H	≥1.25H	≥1.0H
2		≥1.0H	≥1.0H	≥0.75H	≥0.75H
3		30 1.0H			
4		≥2.0H	≥2.0H	≥2.0H	≥2.0H

1 m 320 320 240

2

3.2

3.2.1

154 190t

1

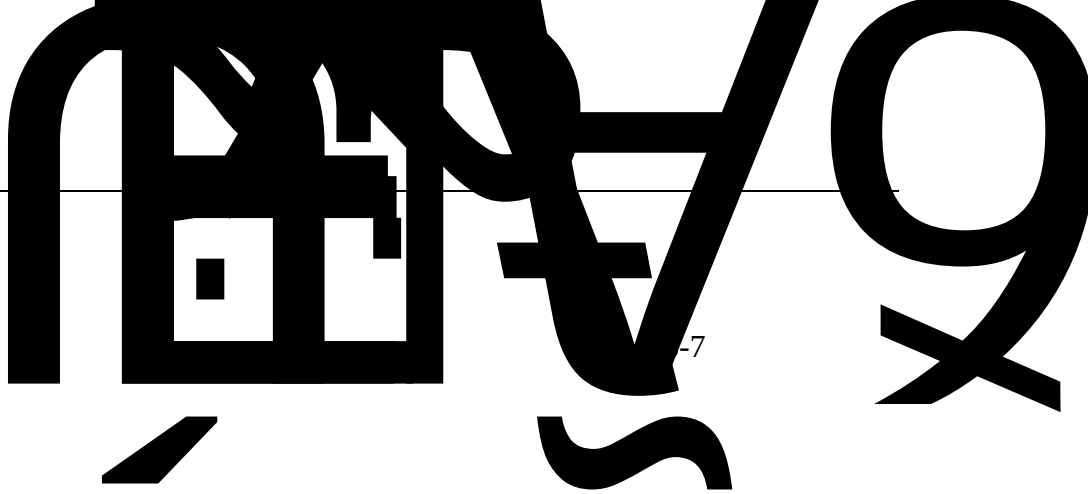
2

3

4

5

3.2.2



-7

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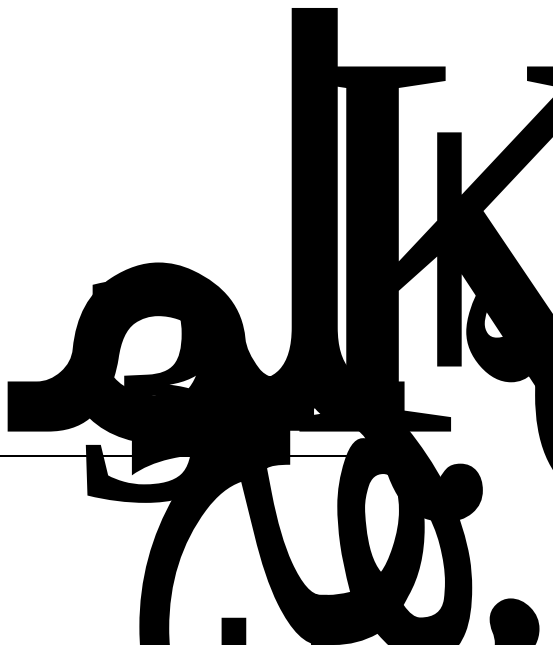

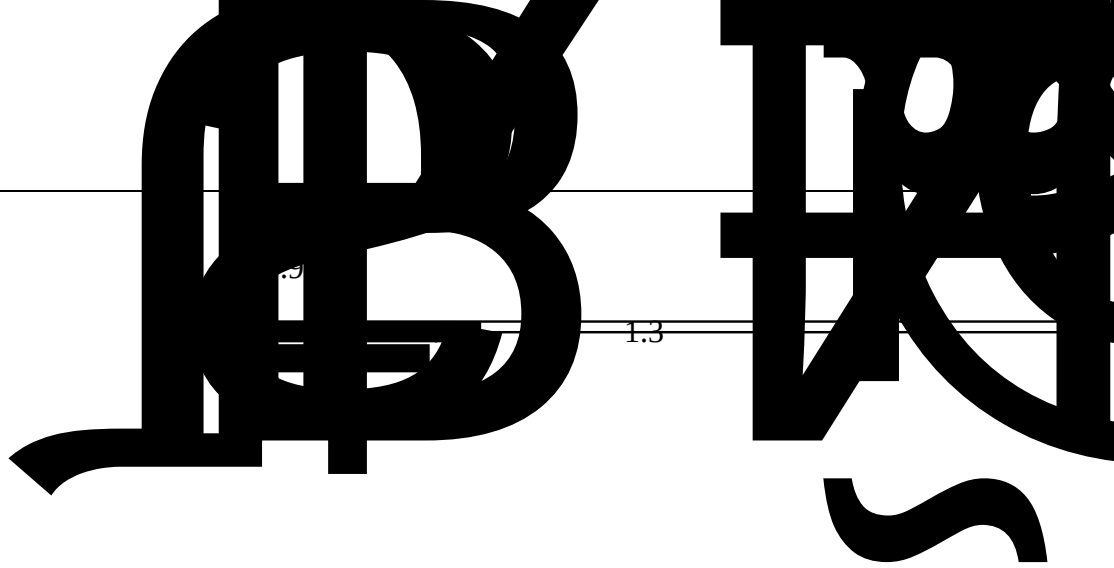

K2—

K—F

1.3

25 85

59.2

2

			1. 2. 3. 4.		1. 2.
			1. 2. 3. 4. 5. 6. 7. 8. 9. 10.		1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
			1. 2.		1. 2.
2			1. 2.		1. 2. 3.
			1. 40 2.		
3			1. 2.		1. 2.
			1. 2. 3.		
4			1. 2.		1. 2.

					3.
			1. 2.		
			1. 2.		1. 2.
5					
6			1. 2.		
7			1. 2. 30% 10% 3. 10 20		
8					

8

Sf Sd S

1 10 RPN= Sf×Sd×S RPN

Sf Sd S 5

3-9

3-9

	Sf	Sd	S	RPN		
	8	3	5	120	2	2
	4	3	4	48		

	4	4	4	16		
	7	4	6	168	1	1
	3	2	3	18		
	5	3	6	90	4	4
	4	4	6	96	3	3
	5	3	5	75	5	5
	3	5	3	45		

3-9 3

FMEA

3.2.5

3-10

3-10

	1. — — — —	GB18152-2000 7.1.1		
	2.	GB18152-2000 7.1.2		

3.

GB18152-2000
“ 7.1.3
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GB18152-2000
9.2.4

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GB18152-2000 2 o ď
9.2.8

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	8. 7 8 10	GB16423-2020 5.4.3.3		
	9. 3	GB16423-2020 5.4.3.4		
	10. —— —— —— —— ——	GB16423-2020 5.4.3.5	—— ——	
	11.	GB16423-2020 5.4.3.6		

12.

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1.0m

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1.0m

0.6m

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3.3.1.2

1 3-11

1.

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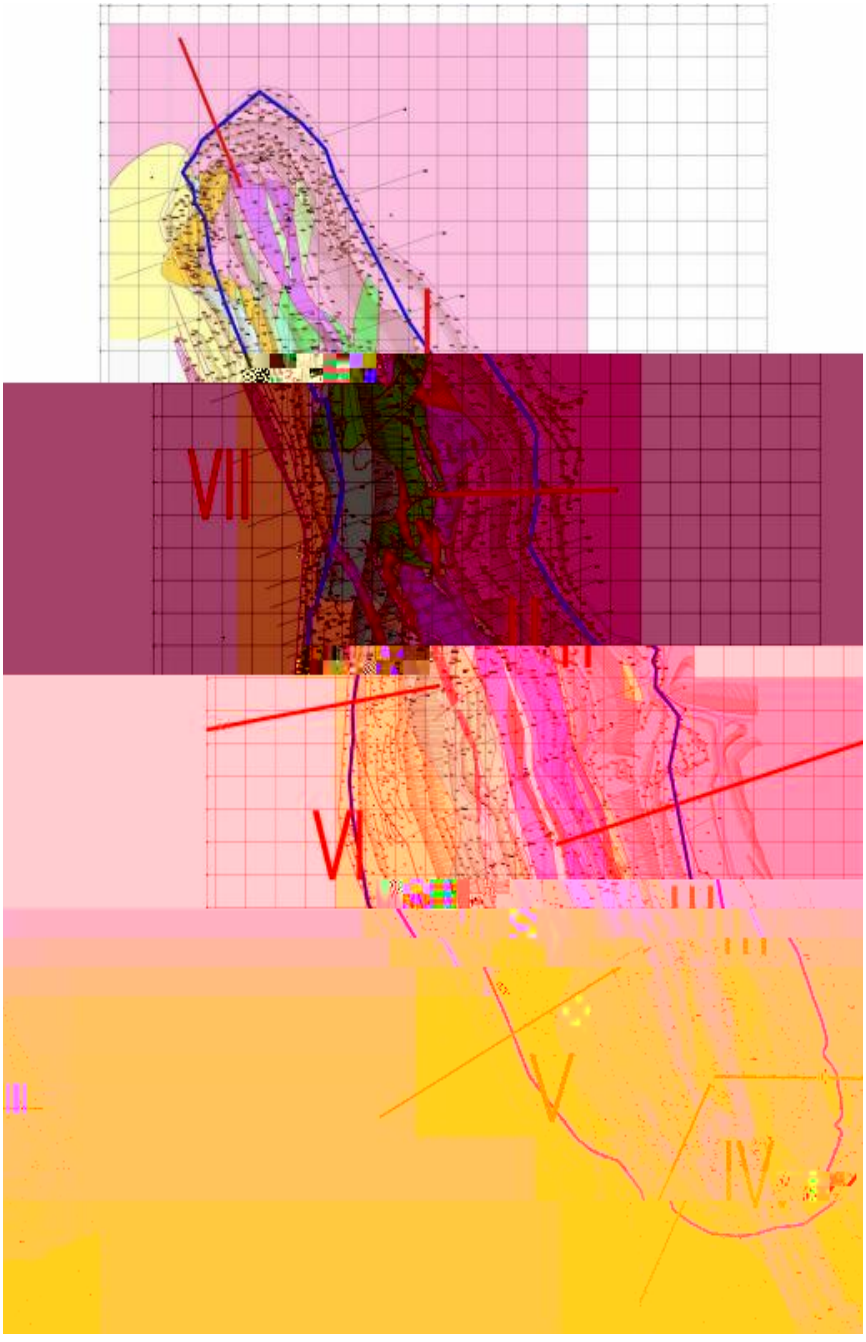
2023 6

2



3

Bishop Janbu

Spencer

c φ F c ′

φ ′

∅

596m

Fs=1.25 Fs=1.23 Fs=1.20 I +

II + III + +

Fs ≥ 1.25 Fs ≥

1.23 Fs ≥ 1. 20

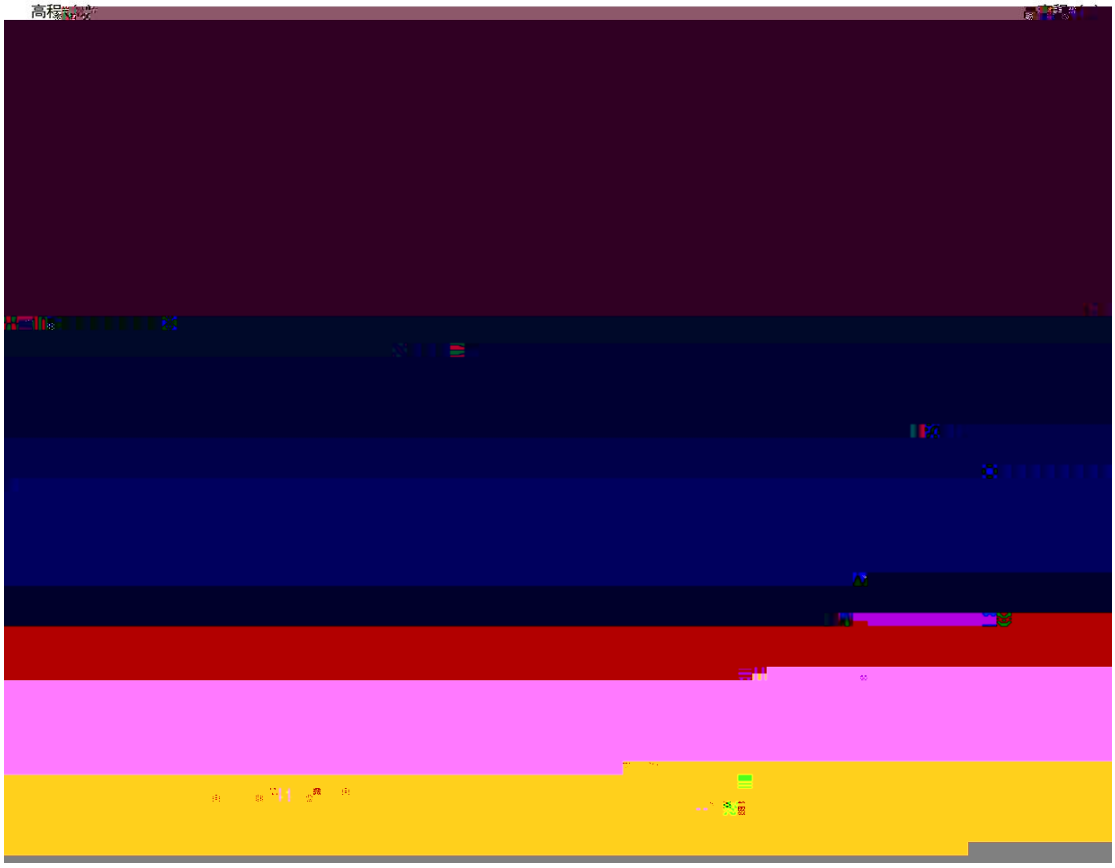
1 15 1-1’ 2-2’ 3-3’

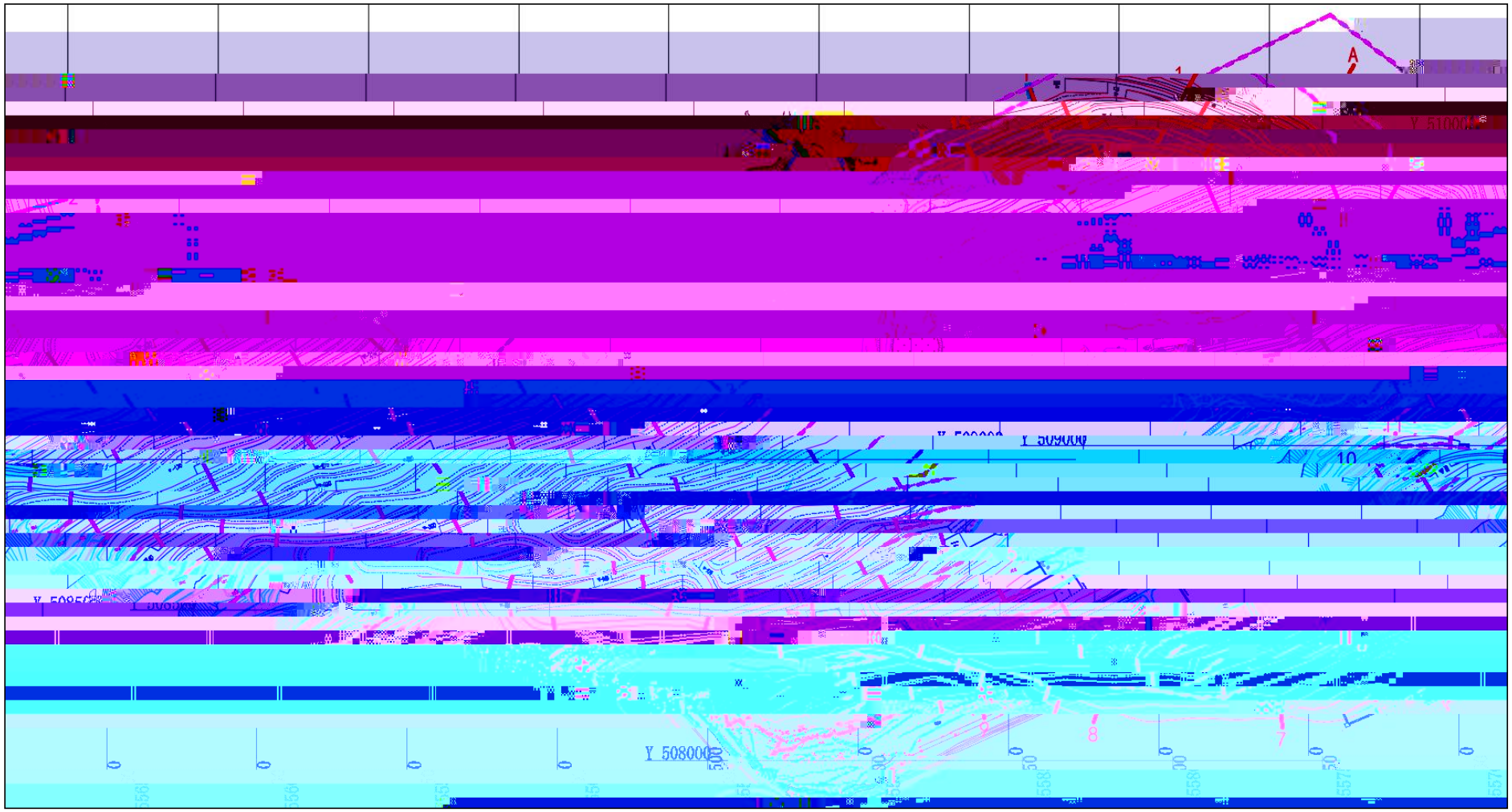
4-4’ 5-5’ 6-6’ 7-7’ 8-8’ 9-9’ 10-10’

11-11’ 12-12’ 13-13’ 14-14’ 15-15’ A-A’

3-6 A-A’

3-7




A
Y 510000
Y 509000
10
Y 508000

④

1994 Hoek GSI RMR Hoek-Brown

$$\sigma_1 = \sigma_3 + \sigma_{ci}(m_b \frac{\sigma_3}{\sigma_{ci}} + S)^a$$

2002 Hoek 94

D Hoek-Brown S a

GSI=25 mb S a

= · (————)

= (————)

= − + − [(——) − (−20/3)

	kN/m^3		/GPa				/MPa				/°		/MPa	
1	24.00	28.00	8.00	33.30	0.25	0.40	4.00	11.00	30.00	42.00	3.40	4.20		
2	24.00	28.00	8.00	33.00	0.25	0.40	4.00	11.00	30.00	42.00	3.40	4.20		
3	32.00	35.00	69.00	143.00	0.25	0.40	15.00	28.00	40.00	51.00	9.10	15.30		
4	32.00	35.00	68.00	84.00	0.25	0.40	11.00	24.00	39.00	45.00	8.30	13.60		
5	32.00	35.00	61.00	74.00	0.25	0.40	9.00	23.00	38.00	42.00	6.90	11.80		
6	24.00	28.00	25.00	38.00	0.20	0.40	5.00	14.00	35.00	47.00	4.40	10.70		
7	24.00	28.00	16.00	31.00	0.20	0.40	8.00	17.00	32.00	38.00	4.70	9.20		
8	28.00	31.00	34.00	69.00	.ᴹ	Ů								

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3-16

/					
			Bishop	Janbu	M-P
1-1’-	1	1.35	1.3373	1.3306	1.3301	
1-1’-	2	1.29	1.2831	1.2765	1.2760	
1-1’-	3	1.24	1.2534	1.2453	1.2546	
2-2’-	1	1.35	1.3328	1.3270	1.3268	
2-2’-	2	1.29	1.2793	1.2740	1.2735	
2-2’-	3	1.24	1.2436	1.2475	1.2485	
3-3’-	1	1.36	1.3494	1.3447	1.3441	
3-3’-	2	1.29	1.2806	1.2761	1.2758	
3-3’-	3	1.25	1.2554	1.2585	1.25784	
4-4’-	1	1.38	1.3557	1.3519	1.3519	
4-4’-	2	1.32	1.2963	1.2939	1.2934	
4-4’-	3	1.26	1.2678	1.2637	1.2696	
5-5’-	1	1.37	1.3462	1.3425	1.3420	
5-5’-	2	1.31	1.2913	1.2881	1.2874	
5-5’-	3	1.27	1.2731	1.2737	1.2796	
6-6’-	1	1.37	1.3515	1.3445	1.3440	
6-6’-	2	1.30	1.2880	1.2812	1.2808	
6-6’-	3	1.25	1.2567	1.2534	1.2512	
7-7’-	1	1.39	1.3767	1.3750	1.3748	
7-7’-	2	1.32	1.3101	1.3086	1.3082	
7-7’-	3	1.26	1.2675	1.2685	1.2634	
8-8’-	1	1.42	1.4078	1.4007	1.4006	
8-8’-	2	1.34	1.3344	1.3247	1.3246	

/			Bishop	Janbu	M-P
8-8’-	3	1.29	1.2944	1.2946	1.2935
9-9’-	1	1.43	1.4133	1.4066	1.4055
9-9’-	2	1.35	1.3268	1.3246	1.3240
9-9’-	3	1.28	1.2867	1.2858	1.2896
10-10’-	1	1.40	1.3805	1.3763	1.3744
10-10’-	2	1.33	1.3123	1.3086	1.3078
10-10’-	3	1.27	1.2788	1.2785	1.2795
11-11’-	1	1.38	1.3576	1.3503	1.3498
11-11’-	2	1.31	1.2952	1.2885	1.2880
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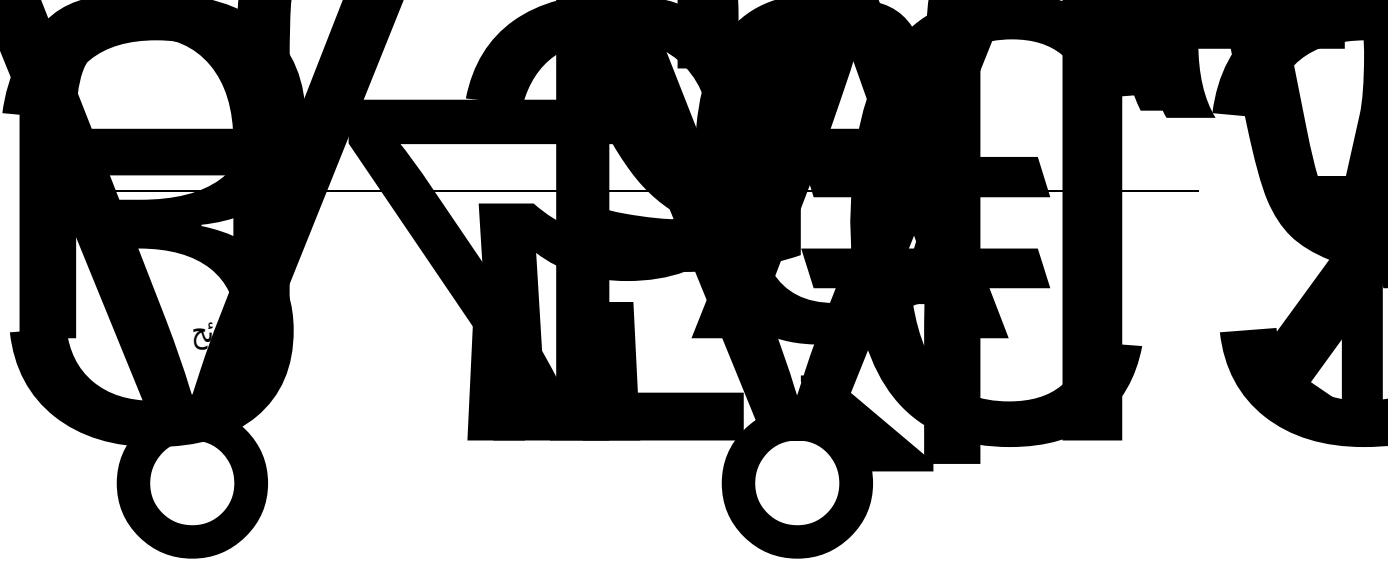

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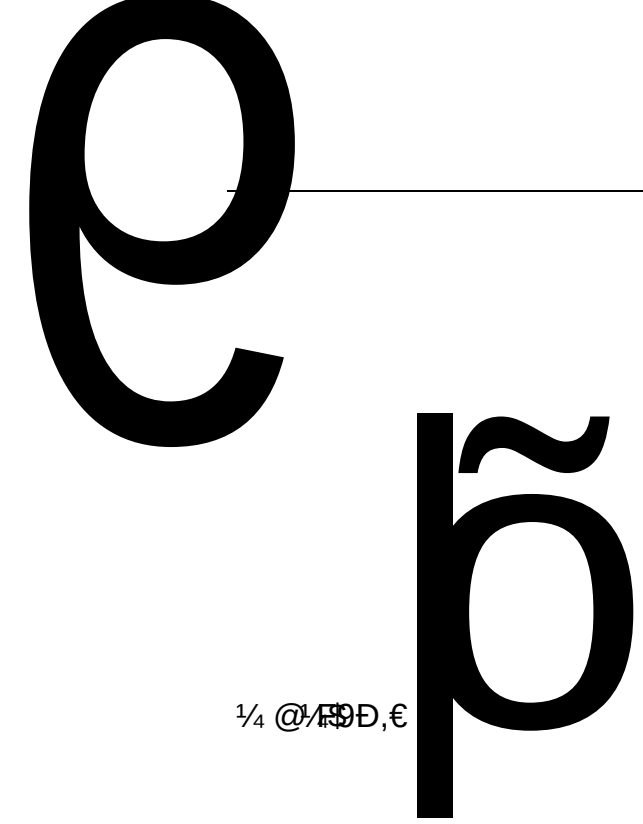

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3.3.2

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3.3.2.2

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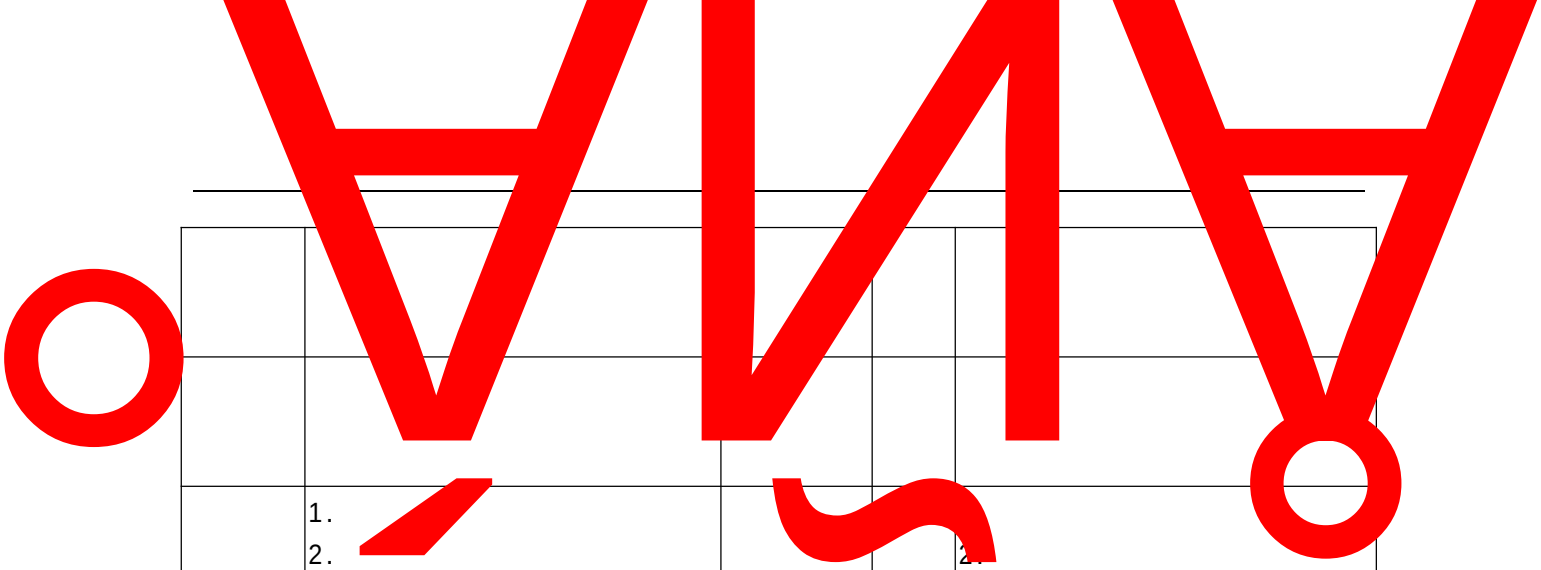

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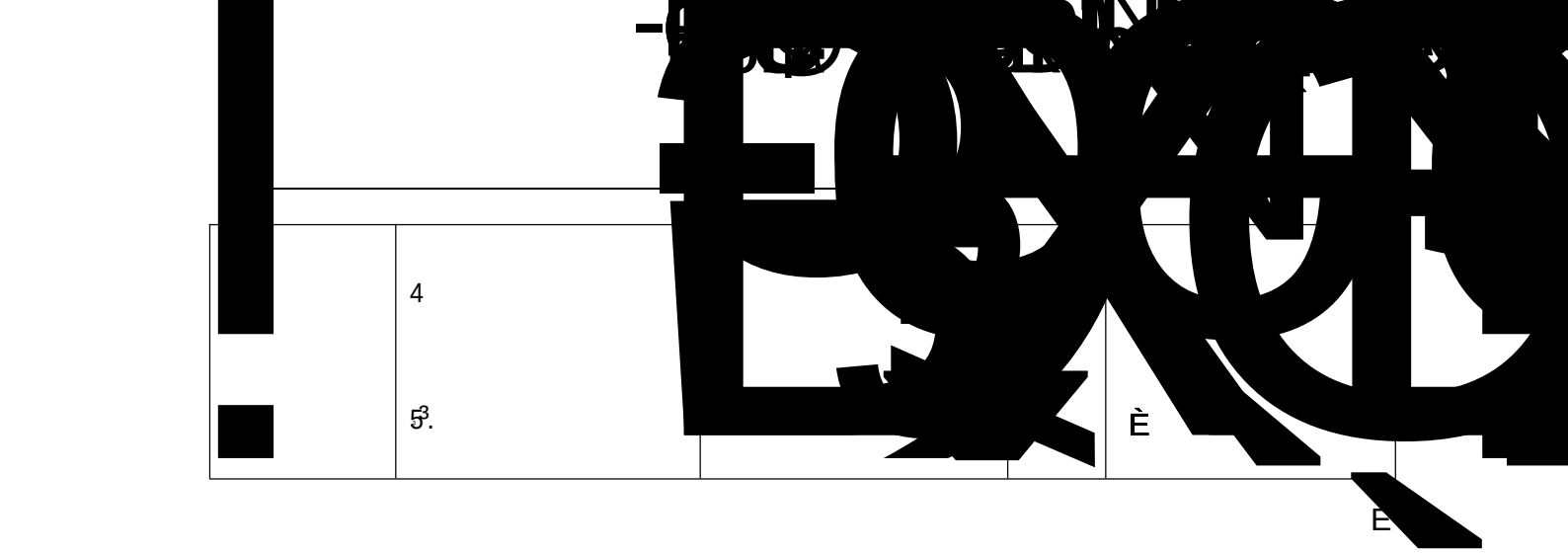

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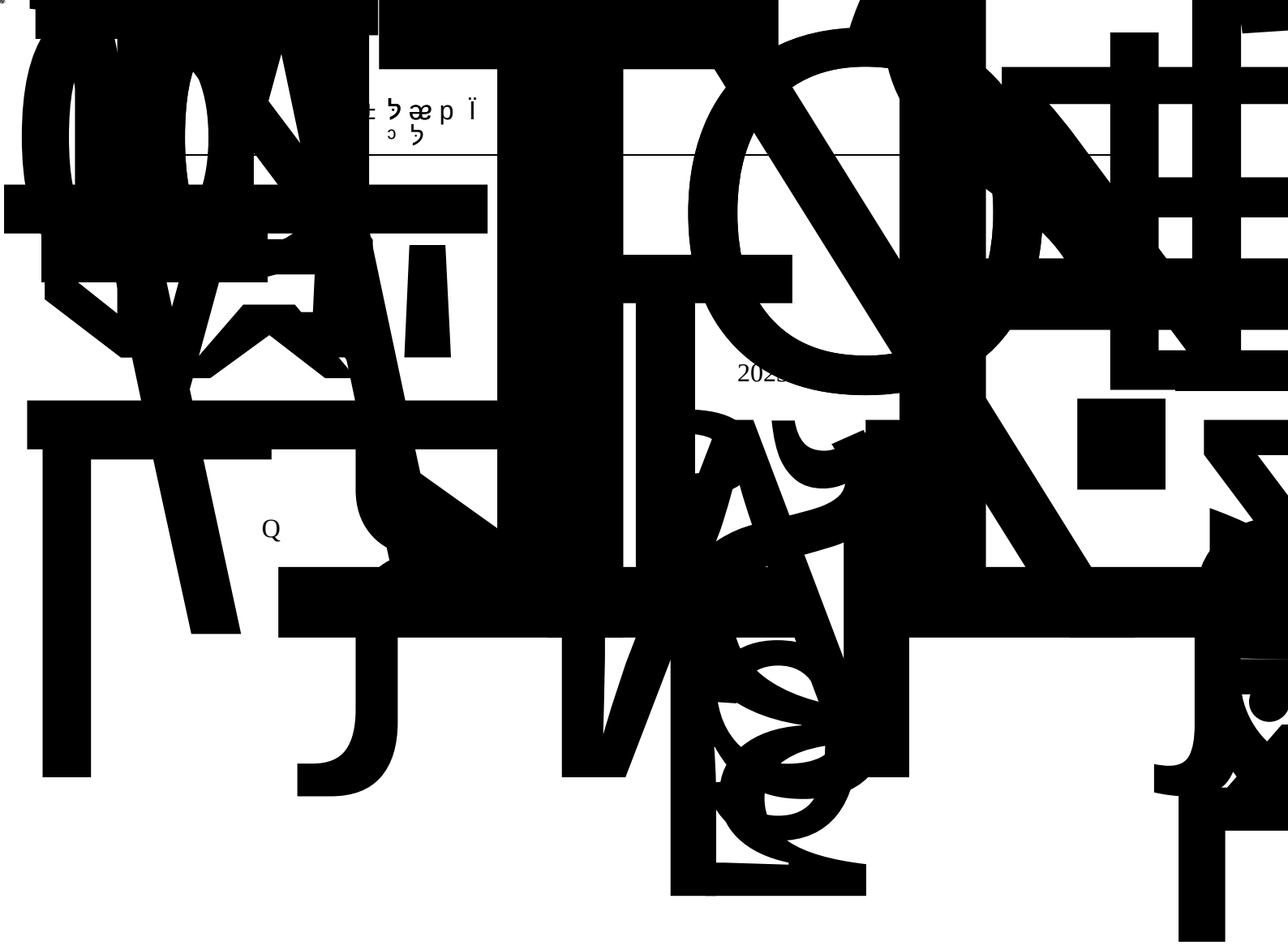
90m 66m 42m

3740.0m 90m 1334m 66m 1048m 42m

966m 350m C20 2.0m

2.0m 0.30m 0.15m C30



GB

50830-2013 20

P=5%

$_2$ F·H·Φ

$_2$= F·Hp·Φ

$_2$- m^3/d

$_2$- m^3/d

F- m^2

H- m/d

Hp- P=5% m/d

Φ-

5237145m^2

35.2mm

24h 48h 72h 120h 168h

P=5%

h	P=5% mm
24	189.00
48	209.42
72	252.00
120	275.67
168	304.95

		F m^2	H m/d	φ	Q_2 m^3/d	
		5237145	0.0352	0.4	73739	
	24h	5237145	0.189	0.6	593892	P=5%
	48h	5237145	0.20942	0.6	658058	P=5%

	72h	5237145	0.252	0.6	791856	P=5%
	120h	5237145	0.27567	0.6	866234	P=5%
	168h	5237145	0.30495	0.6	958240	P=5%

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——Qr m^3/d

——Q m^3/h

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$H_{-450\text{m}} = 1.15 \times (180 + 5) = 212.75\text{m}$

m

$H_{-120\mathrm{m}} = 1.15 \times (162 + 5) = 192.1\mathrm{m}$ +42m

3.5.3

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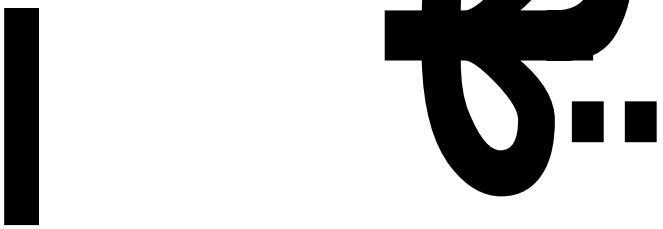

		320m 15553 m^3 -300m 30m 330m 30m 36~37 ° 30m 22.57 °	
2.	5.5		
3.	5.6		

3.6.3.1

2020 10

2022 2

280m “

” 320m “

”

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Bishop Janbu

Spencer

c φ F

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3-28

3-28

		H m	V 10^4m^3
		H 180	V 20000
		120 H≤180	5000 V≤20000
		60 H≤120	1000 V≤5000
		H≤60	V≤1000

GB51119-2015

3-29

1.25

3-29

	1.25 1.30
	1.20 1.25
	1.15 1.20
	1.10 1.20

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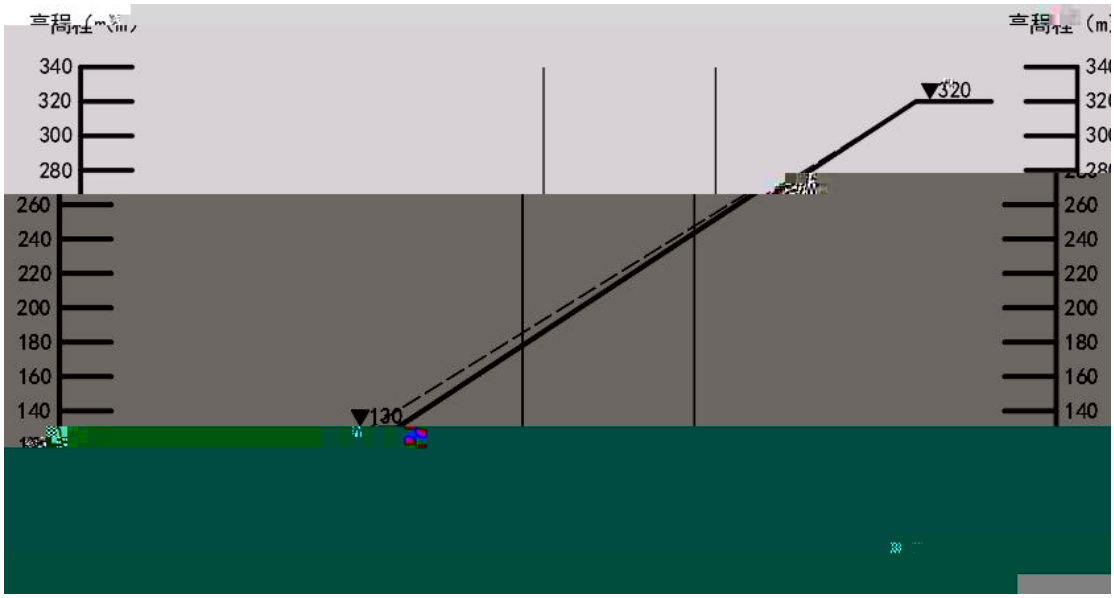
9 11 1-1’ 2-2’ 3-3’ 4-4’ 5-5’

6-6’ 7-7’ 8-8’ 9-9’ 10-10’ 11-11’

3-8 3-10 2-2’

6-6’


340
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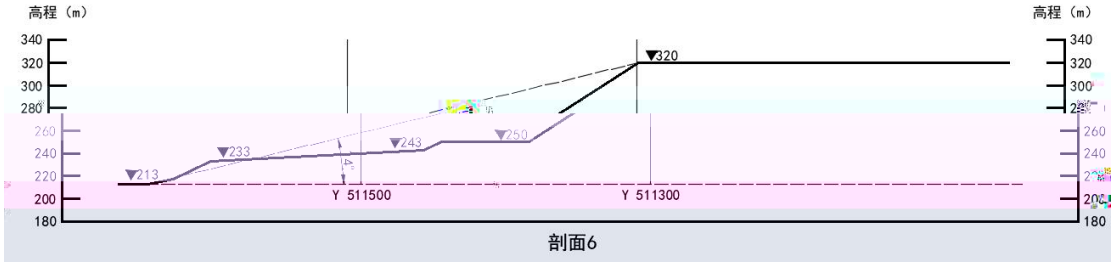
130

3-8 2-2


高程（m）
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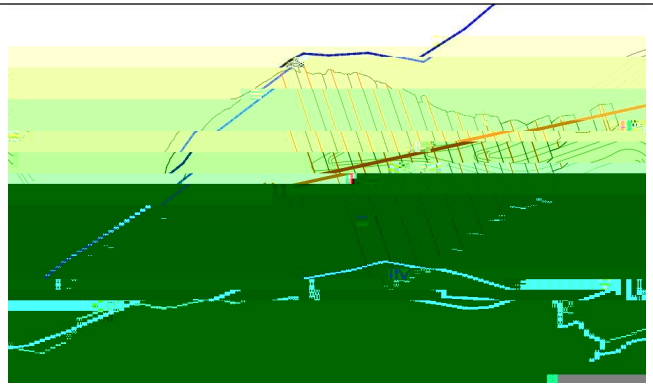

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Hoek-Brown

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3-30

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		kN/m^3	kN/m^2	°	°	10^4MPa		10^4MPa	10^4MPa	MPa
1		21	5	34	4	1.2	0.2	0.667	0.500	0.01
2	0	19.5	33	16	0	0.004	0.31	0.004	0.002	0.15
3		19.5	30	16	0	0.004	0.31	0.004	0.002	0.15
4		19.5	8	26	0	0.23	0.25	0.135	0.150	

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3-31

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			Bishop	Janbu	M-P
1-1’-	1	1.35	1.3299	1.3269	1.3270
1-1’-	2	1.28	1.2648	1.2617	1.2618
1-1’-	3	1.25	1.2467	1.2486	1.2478
2-2’-	1	1.34	1.3248	1.3216	1.3217
2-2’-	2	1.28	1.2593	1.2561	1.2562
2-2’-	3	1.24	1.2467	1.2424	1.2413
3-3’-	1	1.36	1.3370	1.3337	1.3338
3-3’-	2	1.29	1.2715	1.2684	1.2684
3-3’-	3	125	1.2546	1.2574	1.2574
4-4’-	1	1.34	1.3143	1.3107	1.3108
4-4’-	2	1.27	1.2493	1.2458	1.2459
4-4’-	3	1.23	1.2355	1.2352	1.2371
5-5’-	1	1.40	1.3853	1.3817	1.3818
5-5’-	2	1.31	1.2918	1.2884	1.2885

/				
	Bishop	Janbu	M-P	
9-9’- 2	1.30	1.2770	1.2747	1.2745	
9-9’- 3	1.24	1.2464	1.2463	1.2425	
10-10’- 1	1.35	1.3256	1.3221	1.3220	
10-10’- 2	1.28	1.2622	1.2589	1.2587	
10-10’- 3	1.24	1.2412	1.2462	1.2424	
11-11’- 1	1.43	1.4120	1.4093	1.4092	
11-11’- 2	1.34	1.3273	1.3247	1.3247	
11-11’- 3	1.27	1.2747	1.2746	1.2790	

GB51119-2015

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3.6.3.2

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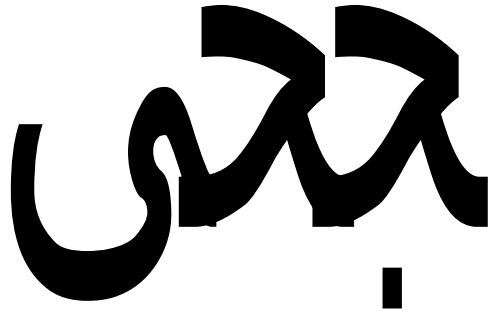

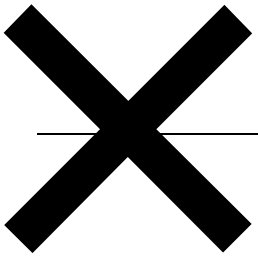

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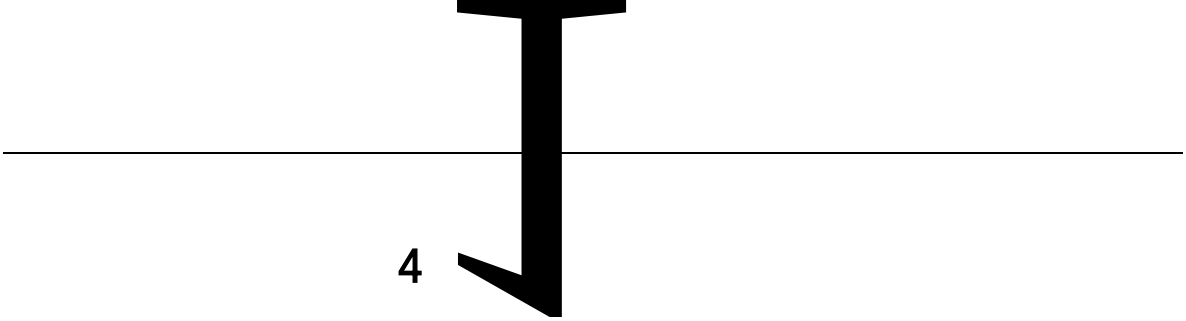

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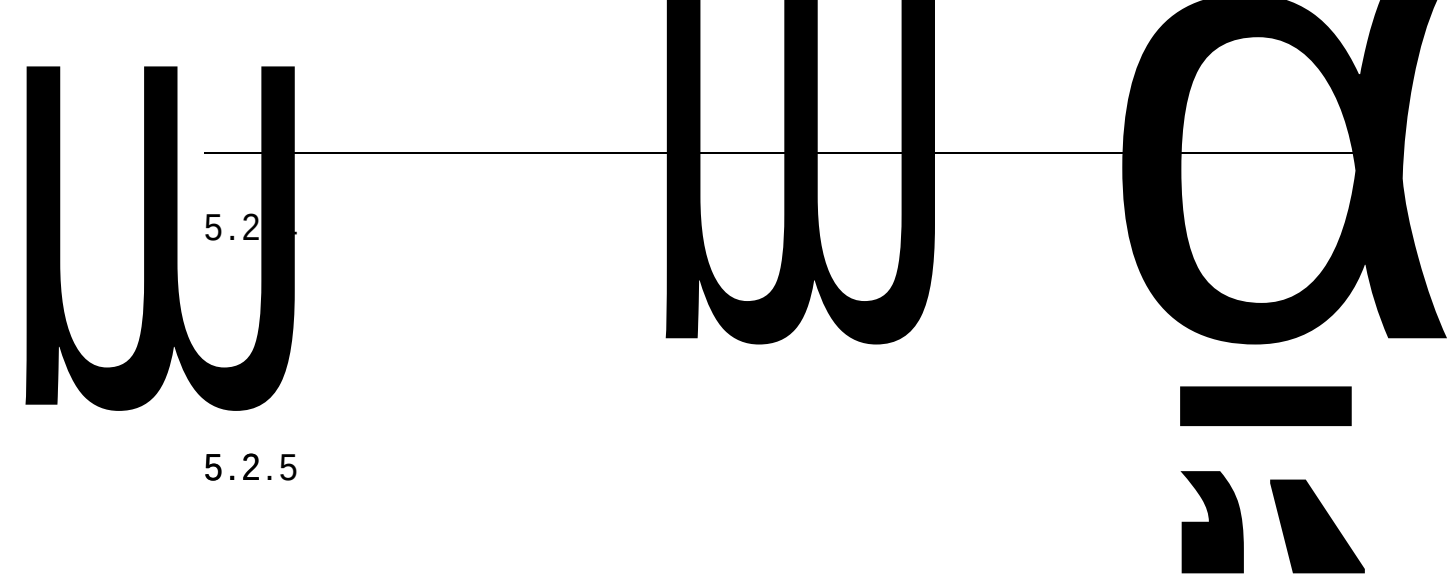

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3 42m

4 -120m

5 -300m

6 -450m

7 3250

8 3850