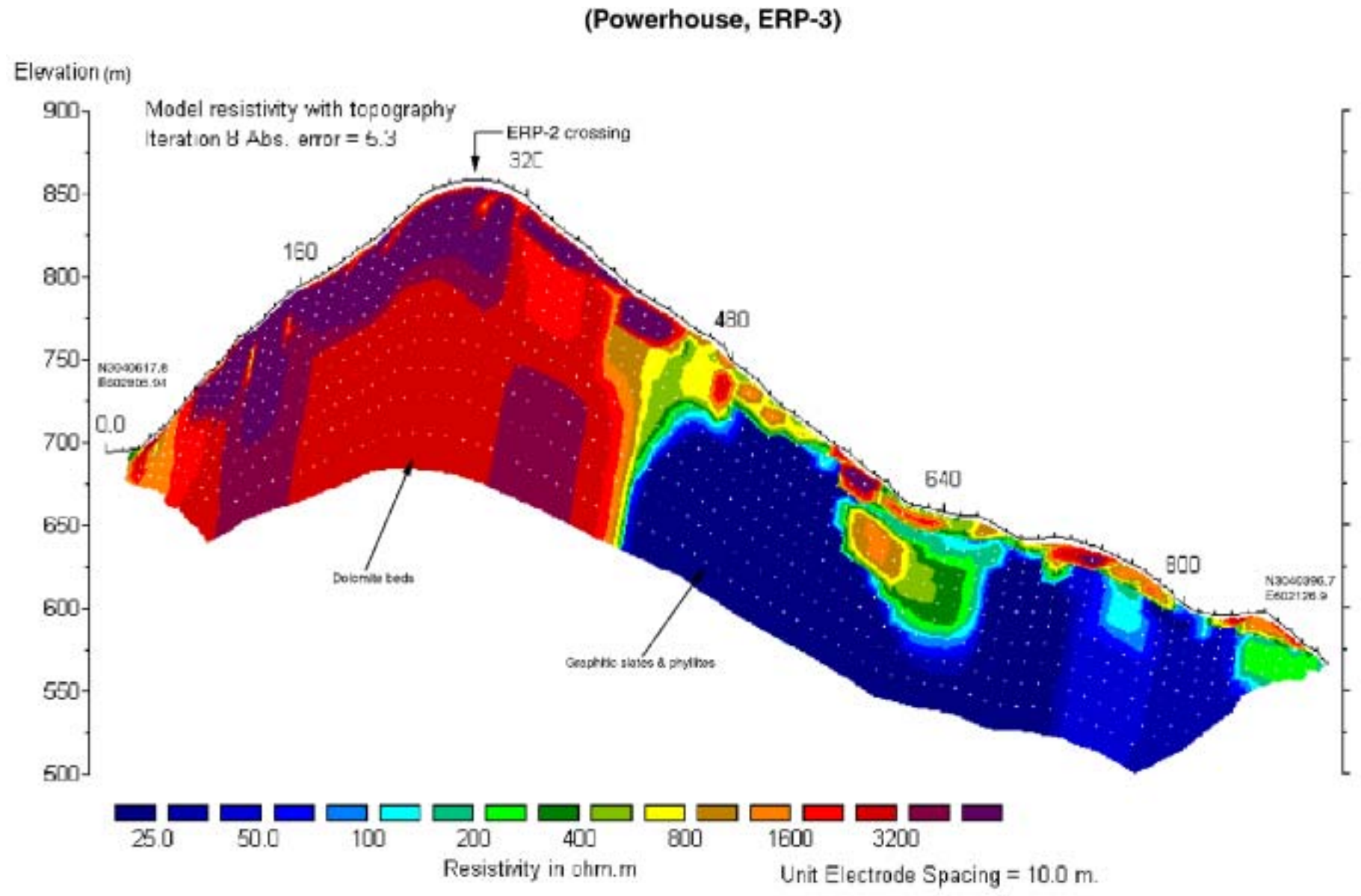


図3.3.7
電気探査結果解析図 (ERP-3測線)

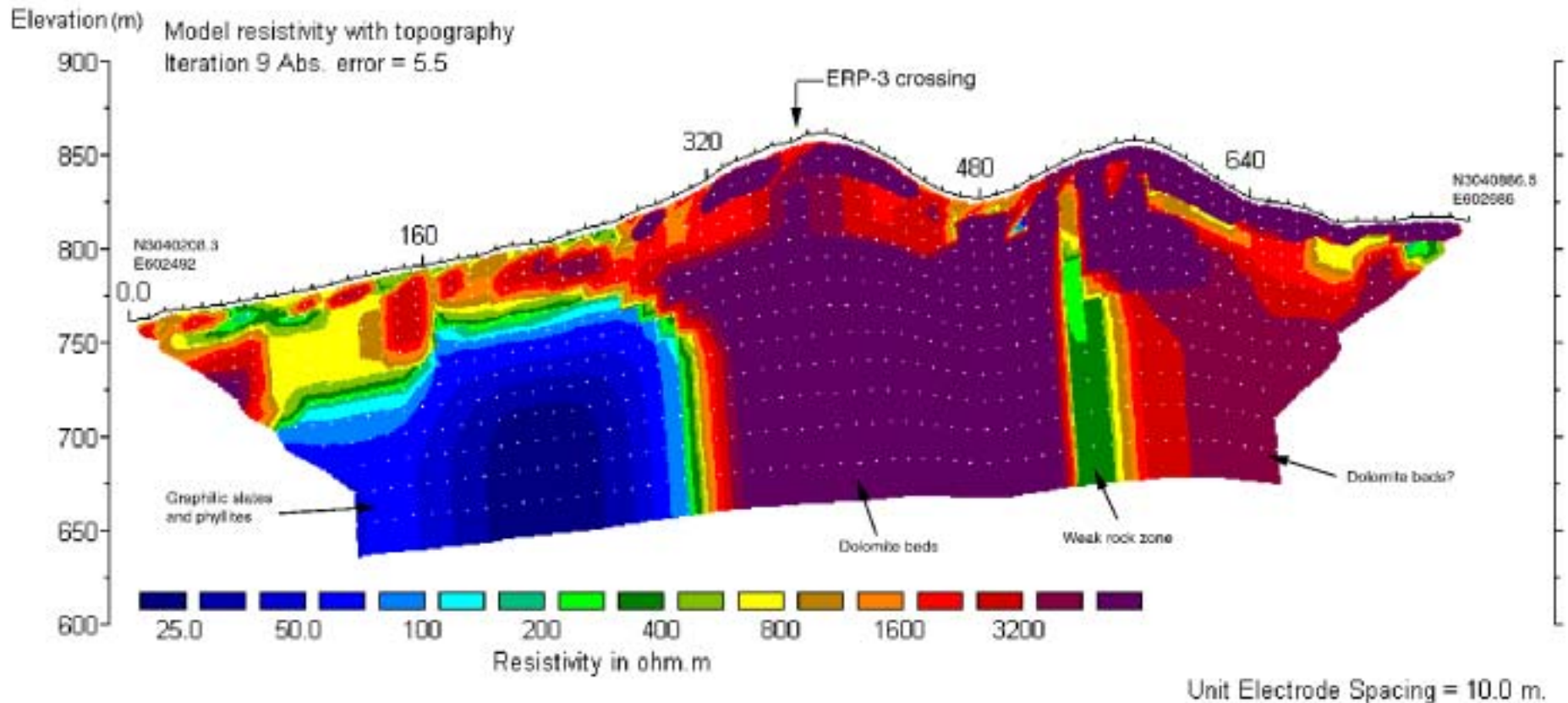


Horizontal scale is 10.00 pixels per unit spacing
Vertical exaggeration in model section display = 1.00

First electrode is located at 0.0 m
Last electrode is located at 900.0 m

Coordinates are given for the first and last electrodes

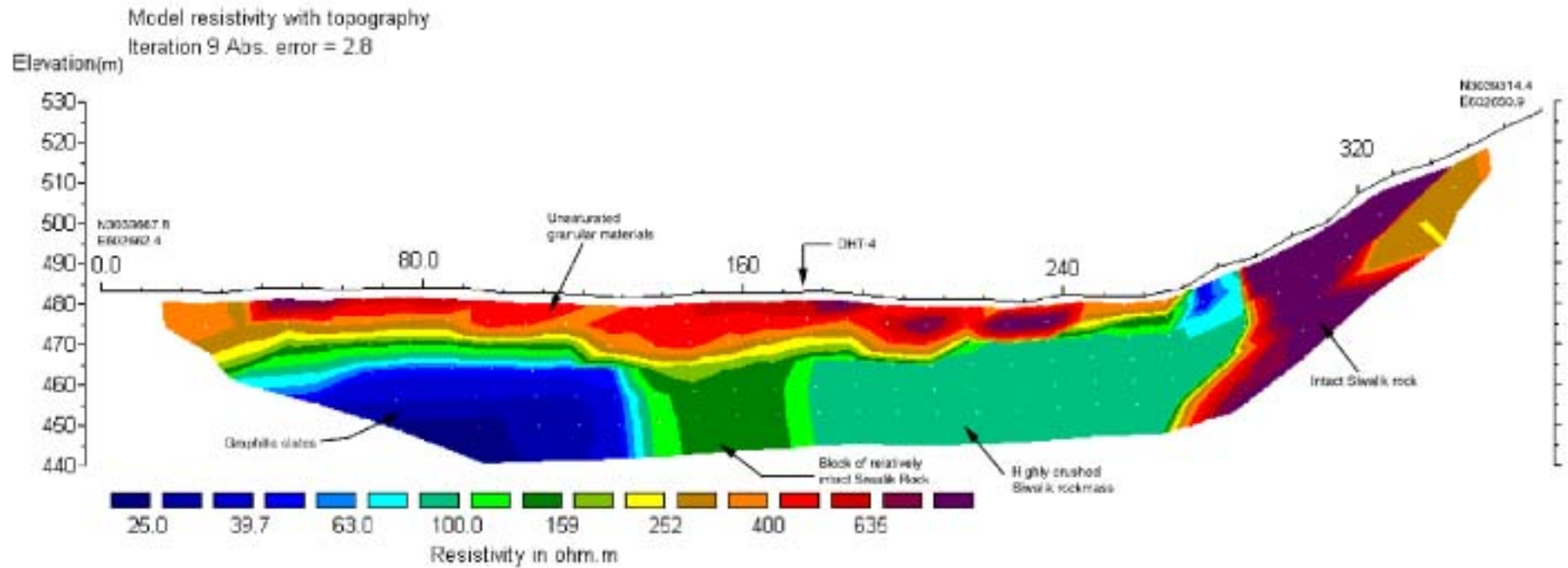
(Powerhouse, ERP-2)



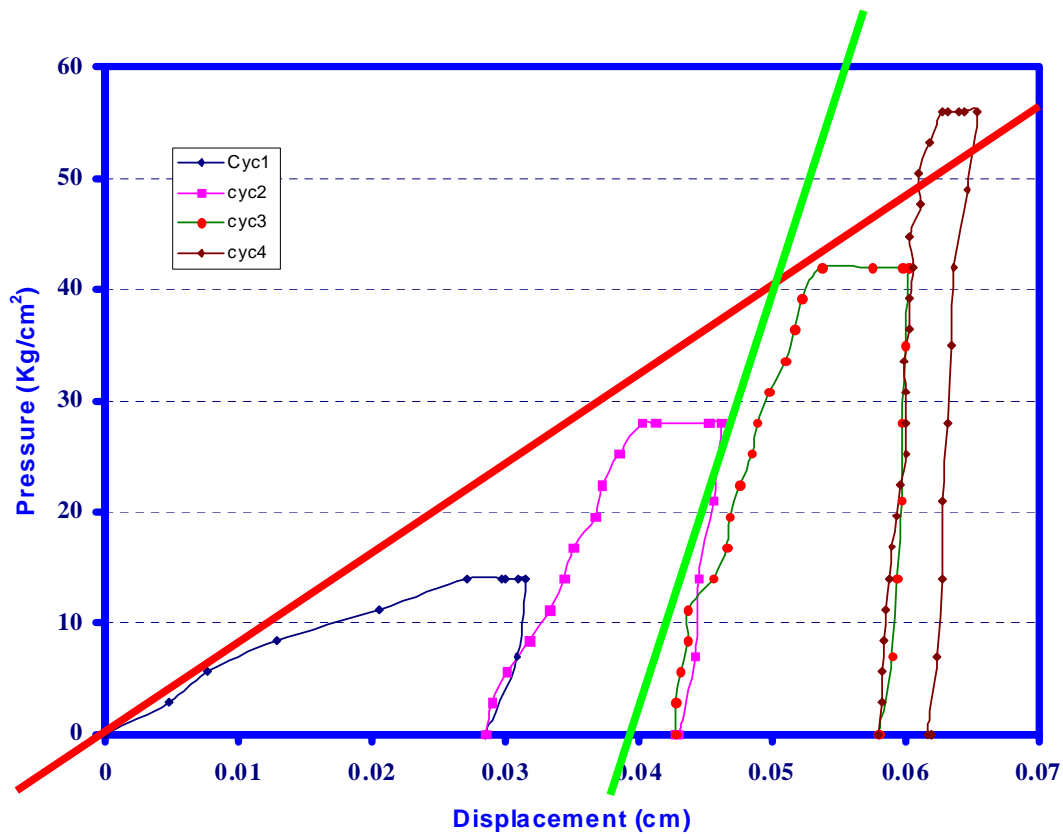
Horizontal scale is 10.00 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 m.
Last electrode is located at 760.0 m.

Coordinates are given for the first and last electrodes

(Tailrace, ERP-1)



Horizontal scale is 25.00 pixels per unit spacing
Vertical exaggeration in model section display = 1.00
First electrode is located at 0.0 m.
Last electrode is located at 370.0 m.



Kulekhani site 1, pressure vs, displacement curves

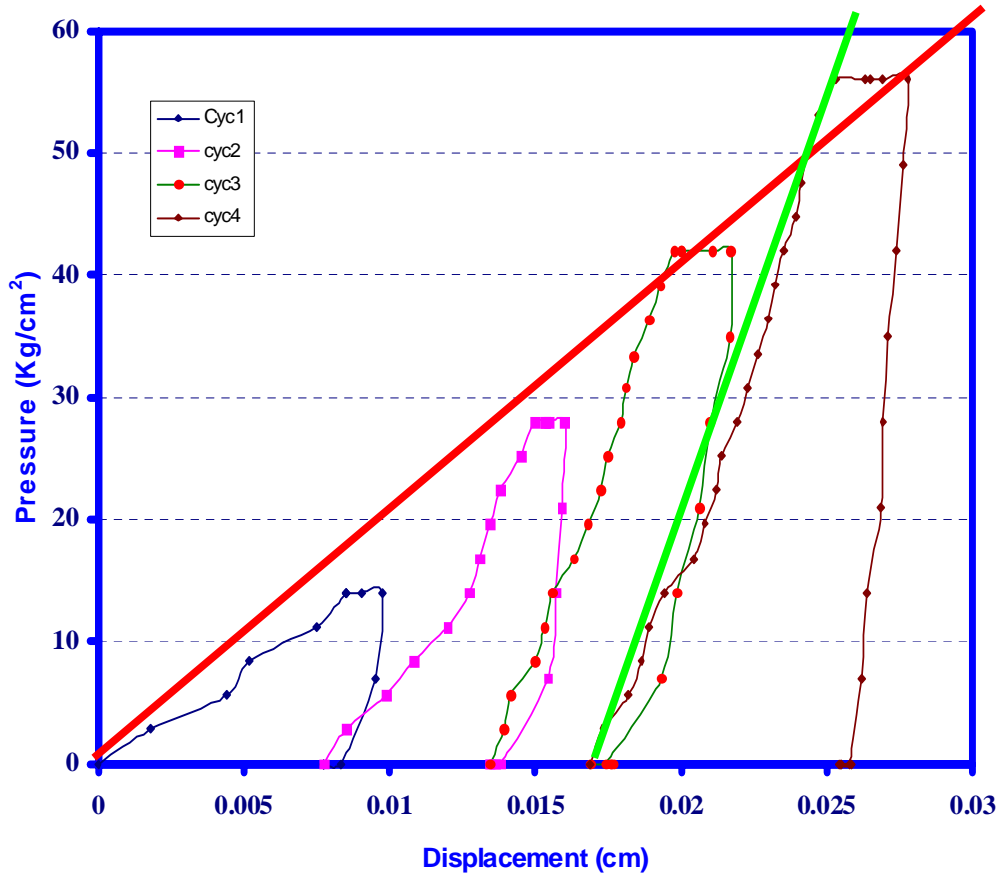
Legend:

- Modulus of Deformation
- Modulus of Elasticity

PL-1

$$\begin{aligned}
 D &= (1-\mu^2) \times \Delta F / \Delta S \times 0.5 a \\
 &= (1-0.2^2) \times (9.686 \times 10^4) / (0.0531-0.00) \times 1 / (2 \times 27.5) \\
 &= 3,183.9 \text{ Mpa}
 \end{aligned}$$

$$\begin{aligned}
 E &= (1-\mu^2) \times \Delta F / \Delta S \times 0.5 a \\
 &= (1-0.2^2) \times (9.686 \times 10^4) / (0.0531-0.04156) \times 1 / (2 \times 27.5) \\
 &= 14,650.3 \text{ Mpa}
 \end{aligned}$$



Kulekhani site 2, pressure vs. displacement curves

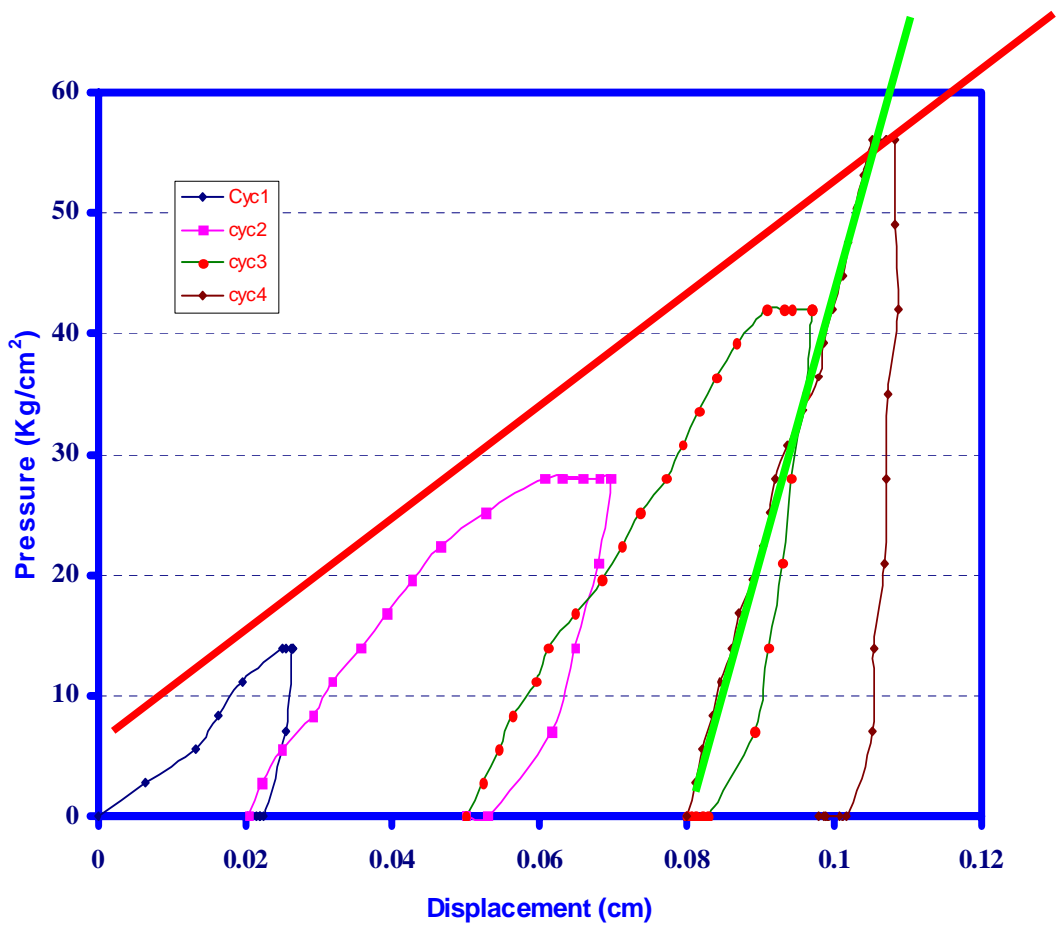
Legend:

- Modulus of Deformation
- Modulus of Elasticity

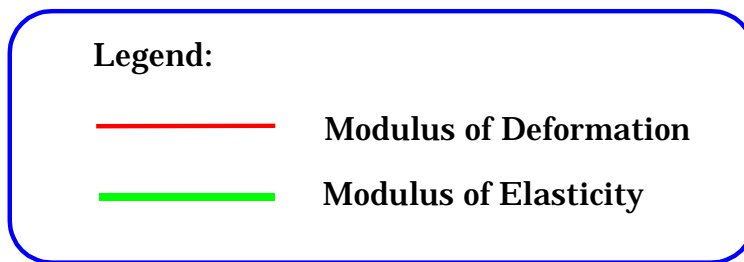
PL-2

$$\begin{aligned}
 D &= (1-\mu^2) \times \Delta F / \Delta S \times 0.5 a \\
 &= (1-0.2^2) \times (11.9672 \times 10^4) / (0.025-0.00) \times 1 / (2 \times 27.5) \\
 &= 9,366.9 \text{ Mpa}
 \end{aligned}$$

$$\begin{aligned}
 E &= (1-\mu^2) \times \Delta F / \Delta S \times 0.5 a \\
 &= (1-0.2^2) \times (11.9672 \times 10^4) / (0.025-0.0027) \times 1 / (2 \times 27.5) \\
 &= 25,340.5 \text{ Mpa}
 \end{aligned}$$



Kulekhani site 3, pressure vs. displacement curves

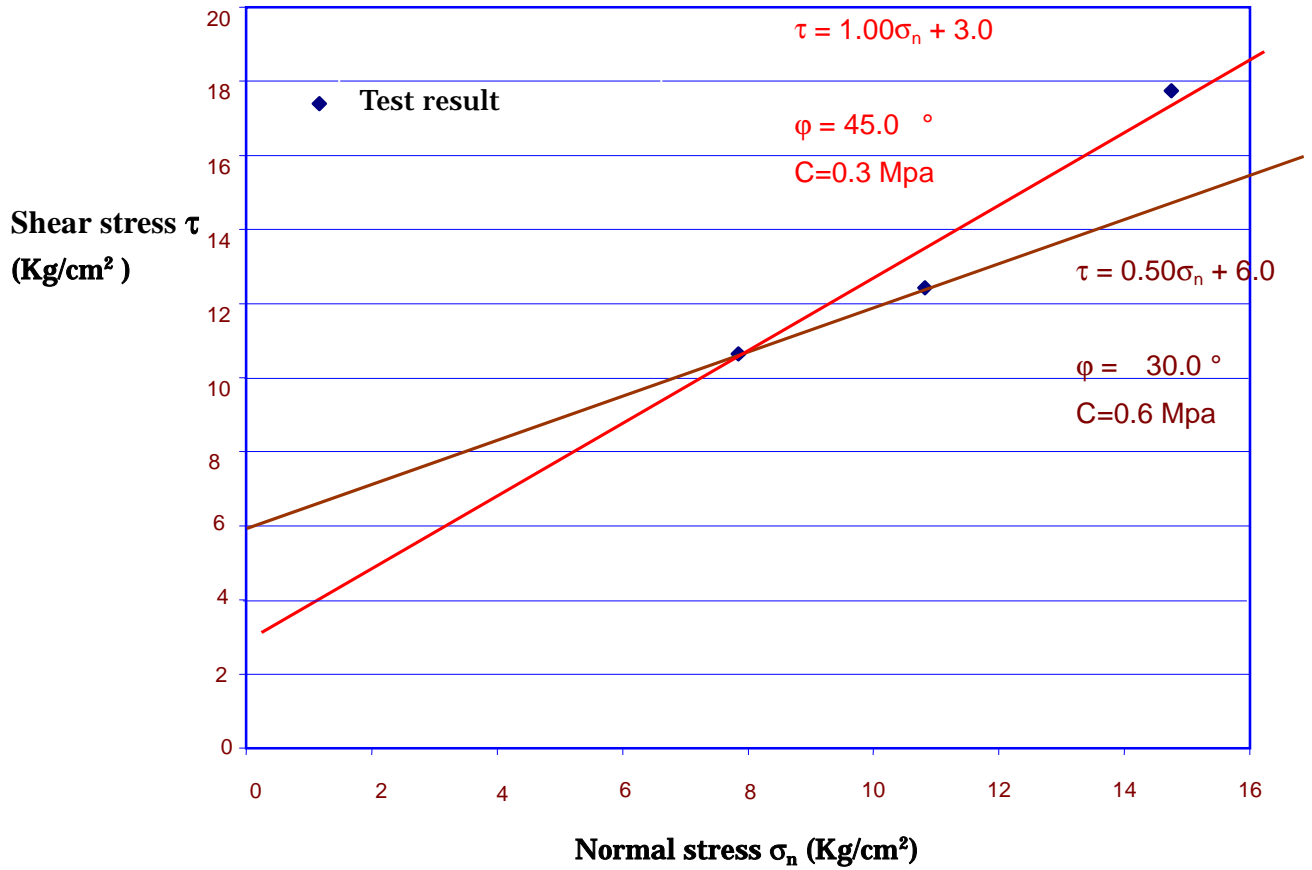


PL-3

$$\begin{aligned}
 D &= (1-\mu^2) \times \Delta F / \Delta S \times 0.5 a \\
 &= (1-0.2^2) \times (11.17522 \times 10^4) / (0.10270 - 0.00) \times 1 / (2 \times 27.5) \\
 &= 1,869.5 \text{ Mpa}
 \end{aligned}$$

$$\begin{aligned}
 E &= (1-\mu^2) \times \Delta F / \Delta S \times 0.5 a \\
 &= (1-0.2^2) \times (11.17522 \times 10^4) / (0.10270-0.00973) \times 1 / (2 \times 27.5) \\
 &= 8,392.9 \text{ Mpa}
 \end{aligned}$$

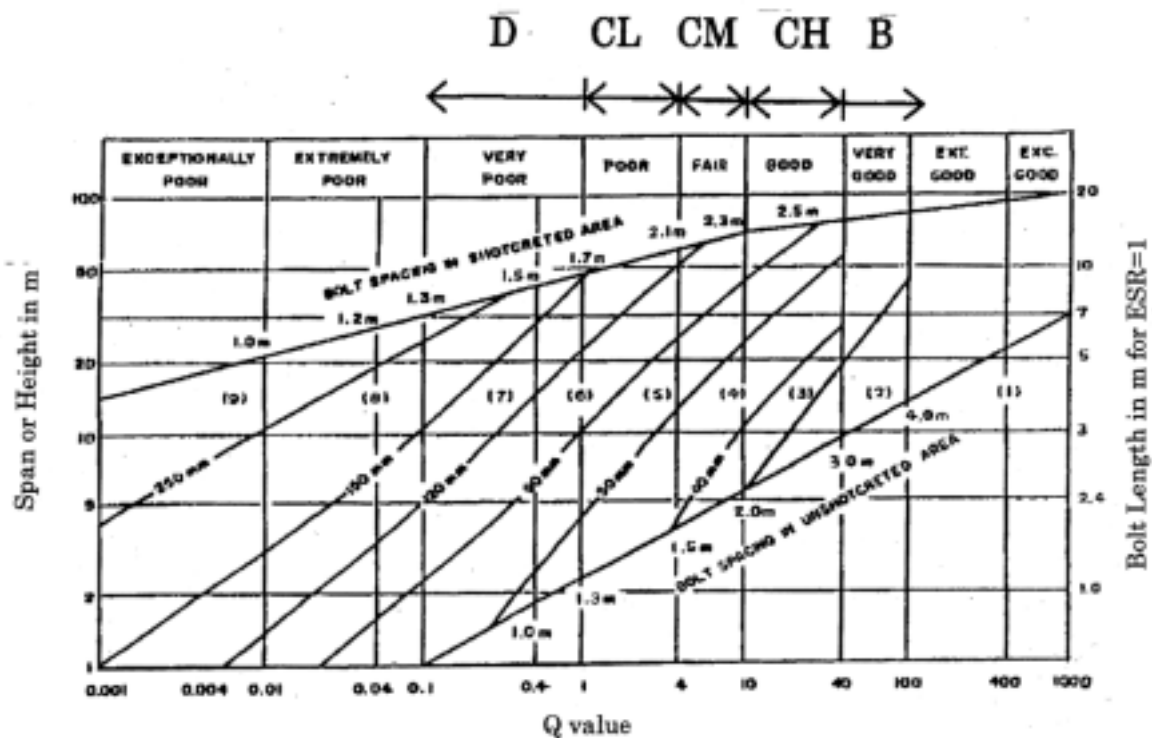
Shear Stress vs Normal Stress



ROCK CLASSIFICATION AND REINFORCEMENT CATERGORIES BY CRIEPI
ROCK CLASSIFICATION(1991)

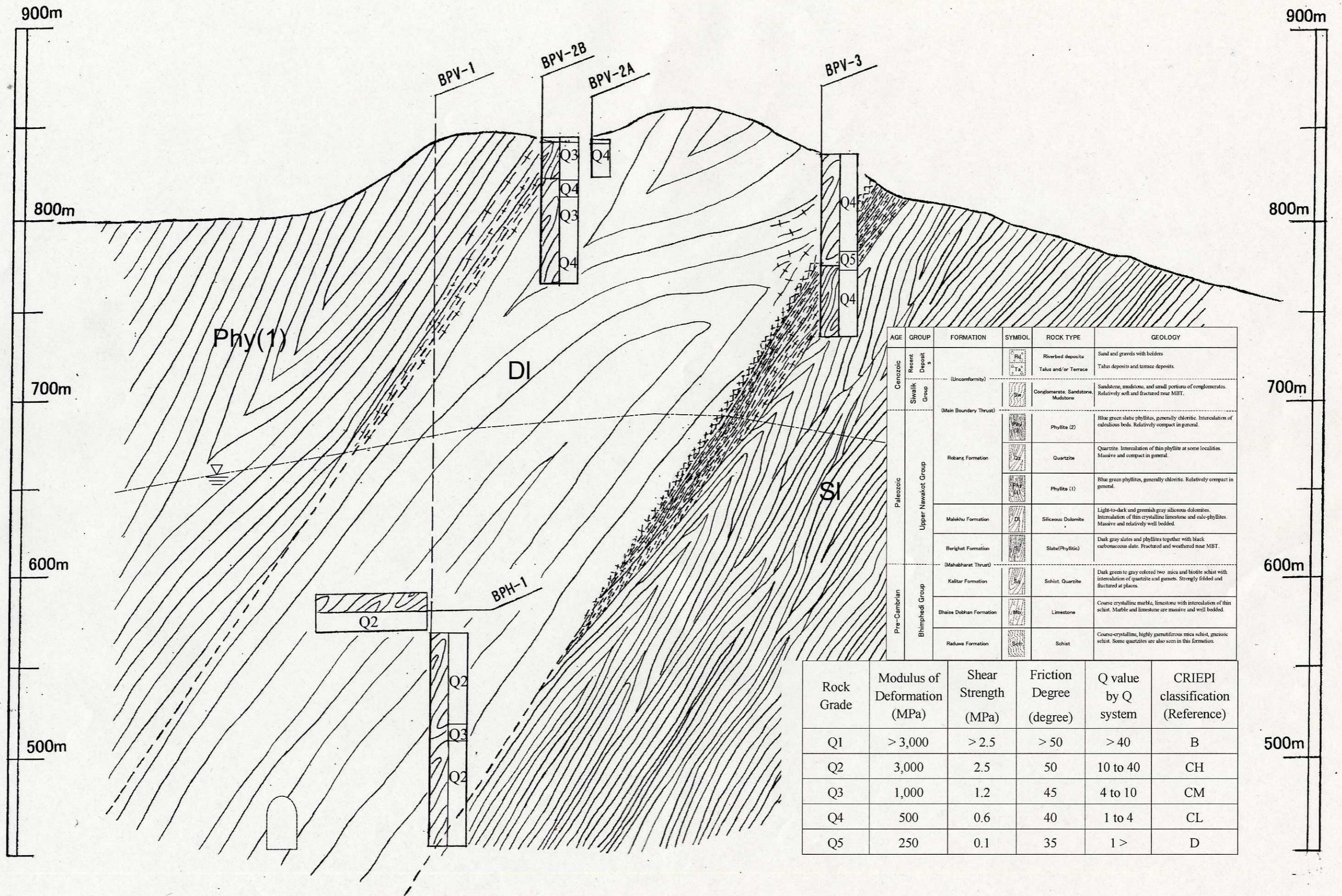
Rock Grade	Support Pattern	Shotcreting		Rock Bolting			Steel Support	
		Thickness (cm)	Area	Length (m)	Nos of bolts	Pitch (m)	Materials	Pitch (m)
B	A	5	Arch	2	0 to 5	-	-	-
CH	B	5	Arch·Wall	2	7	1.5	-	-
CM	CI	10	Arch·Wall	2	10	1.5	-	-
	CII	15	Arch·Wall	2	12	1.2	-	-
CL	DI	15	Arch·Wall	3	12	1.2	-	-
	DII	15	Arch·Wall	3	12	1.2	(100H)	1.0 to 1.2
D	E	15 to 20	Arch·Wall	3	14	1.0 to 1.2	(125H)	1.0 to 1.2

REINFORCEMENT CATEGORIES BASED ON Q SYSTEM AND ASSUMED CORRELATION WITH CRIEPI ROCK CLASSIFICATION



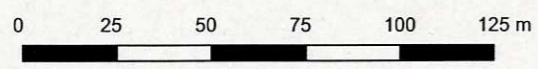
REINFORCEMENT CATERGORIES

- | | |
|---|--|
| (1) Unsupported | (6) Fibre reinforced shotcrete, 90 · 120 mm and shotcrete |
| (2) Spot bolting | (7) Fibre reinforced shotcrete, 120 · 150 mm and shotcrete |
| (3) Systematic bolting | (8) Fibre reinforced shotcrete, >150 mm with reinforced ribs of shotcrete and bolting. |
| (4) Systematic bolting with
40 · 100 mm unreinforced shotcrete | (9) Cast concrete lining |
| (5) Fibre reinforced shotcrete, 50 · 90 mm
and shotcrete | |



AGE	GROUP	FORMATION	SYMBOL	ROCK TYPE	GEOLOGY
Cenozoic	Recent Deposit		Rd	Riverbed deposits	Sand and gravels with boulders
			Ta	Talus and/or Terrace	Talus deposits and terrace deposits.
Paleozoic	Siwalik Group	(Unconformity)	Sw	Conglomerate, Sandstone, Mudstone	Sandstone, mudstone, and small portions of conglomerates. Relatively soft and fractured near MBT.
		(Main Boundary Thrust)			
	Upper Nawakot Group		Phy(2)	Phyllite (2)	Blue green slate phyllites, generally chloritic. Intercalation of calcareous beds. Relatively compact in general.
			Rokang Formation	Qtz	Quartzite. Intercalation of thin phyllite at some localities. Massive and compact in general.
			Phy(1)	Phyllite (1)	Blue green phyllites, generally chloritic. Relatively compact in general.
			Malekhu Formation	DI	Siliceous Dolomite. Light-to-dark and greenish gray siliceous dolomites. Intercalation of thin crystalline limestone and calc-phyllites. Massive and relatively well bedded.
		Beright Formation	Sl	Slate(Phyllitic). Dark gray slates and phyllites together with black carbonaceous slate. Fractured and weathered near MBT.	
Pre-Cambrian	Bhimphedi Group	(Mahabharat Thrust)			
			Kalitar Formation	Sg	Schist, Quartzite. Dark green to gray colored two mica and biotite schist with intercalation of quartzite and garnets. Strongly folded and fractured at places.
			Bhaise Dobhan Formation	Ms	Limestone. Coarse crystalline marble, limestone with intercalation of thin schist. Marble and limestone are massive and well bedded.
		Radawa Formation	Schist	Schist. Coarse-crystalline, highly garnetiferous mica schist, gneissic schist. Some quartzites are also seen in this formation.	

Rock Grade	Modulus of Deformation (MPa)	Shear Strength (MPa)	Friction Degree (degree)	Q value by Q system	CRIEPI classification (Reference)
Q1	> 3,000	> 2.5	> 50	> 40	B
Q2	3,000	2.5	50	10 to 40	CH
Q3	1,000	1.2	45	4 to 10	CM
Q4	500	0.6	40	1 to 4	CL
Q5	250	0.1	35	1 >	D



THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL
 JAPAN INTERNATIONAL COOPERATION AGENCY

図3.3.15 地下構造物周辺の地質断面図