GEOTECHNICAL OBSERVATIONS AND DEFORMATION MONITORING IN LAM TA KHONG HYDRO POWER TUNNEL, THAILAND

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INTRODUCTION

Geotechnical observations and deformation monitoring in the tunnel of Lam Ta Khong Hydro Power Project, Thailand are described. Geotechnical observations were the state of weathering, hardness and joint spacing of rock mass. The standard pattern of tunnel support based on the rock mass classification was used and it has worked satisfactorily. Rate of convergence was found to depend upon rock mass class, face advance and time elapse after the support application. An empirical convergence equation was approximated from back calculation, as **$d = a + b \ln t$;** where d is the deformation in mm, a = 0.8-0.9 and b = 0.98 - 1.0 - a function of rock mass and t - time of measurement in days.

GEOTECHNICAL OBSERVATION

The area consists of sedimentary sandstone, siltstone, clay/mud stone. Observation were degree of weathering, hardness and joint spacings, rock quality designation (RQD), rock mass rating (RMR), joints details e.g. strike/dip, aperture, infilling, roughness, state and persistence and inflow. Depending upon the state of weathering, hardness and joint spacing the mass of the rock quality were designated as per the system used by the Electric Power Development Company (EPDC), Tokyo taking into consideration of ISRM 1978 suggestion .Five states each for weathering, hardness and joints spacing were used to designate the rock class.

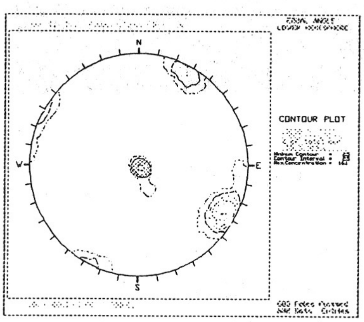
Table 1 Rock Mass Classification applied in the project site

		Sandstone (Fresh , W < 3) HARDNESS (H)									Siltstone (Fresh, W < 3) HARDNESS (H)								
		A	A-B	B	B-C	C	C-D	D	D-E	E	A	A-B	B	B-C	C	C-D	D	D-E	E
J	I																		
O	I-II		S	S	1														
I	II												S	T	1				
N	II-III																		
T	III			S	S	2													
	III-IV													S	T	2			
J	IV																		
	IV-V				S	S	3										S	T	3
	V																		

STEREOGRAPHIC PROJECTION OF JOINTS

The orientations (dip/strike) of joints from the observation were used to make stereographic plot. In an equal angle net in lower hemisphere .

Figure 1 Stereographic Projection of the poles of the total measured joints



The discontinuity concentration of poles as contours has been plotted in Figure 1. Five sets of distinct joint family are clearly observable.

TUNNEL SUPPORT PATTERNS

Following Support Patterns Table 6 were used and as per observations of the deformations additional support were applied to further strengthen the tunnels as where needed.

Table 2 Standard Support Pattern Adopted for Tunnels and Shafts (D > 6 m)

Rock Class	SS1	SS2	SS3	ST1	ST2	ST3	Talus Deposit
Shotcrete (cm)	10	10	10	10	10	15	20
+ Reinforcement	-	-	Wire mesh	-	Wire mesh	Wire mesh	Wire mesh
Rock Bolt (m)	-	2	2	2	2	3	3
Pieces/Section	-	6	6	6	6	8	8
Spacing (m)	-	1.8	1.5	1.8	1.5	1.2	1.0
Steel Support	-	-	-	-	-	H 125	H 150
Spacing (m)	-	-	-	-	-	1.0	0.8 - 1.0
Percentage (%)	-	-	-	-	-	30	50

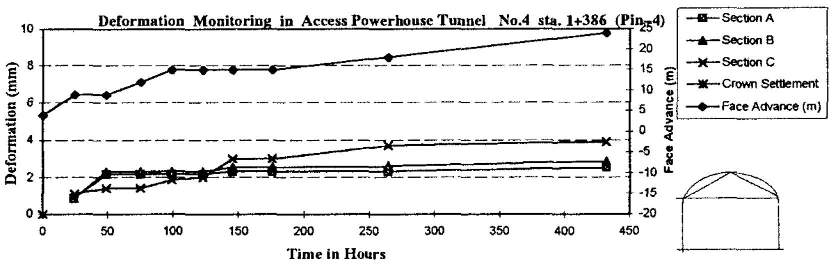
DEFORMATION MONITORING

Tape extensometer was used to measure the rate of movement and adequacy of the applied support as per the philosophy of the NATM . The following deformations criteria (Table 3) was used to observe the convergence of tunnel movement rate. The time deformation plot for the Access Powerhouse tunnel (SS-1) is illustrated in Figure .

Table 3 Specification for Convergence

Deformation (mm/day)	**Distance from Excavated Face**	***Time Interval***
movement > 10	0 - 1 D	Once or twice a day
10- 5	1 D- 2 D	Once a day
5- 1	2 D - 5 D	Once every two days
less than 1	more than 5 D	Once a week

Figure 2 Typical graphic plot of Deformation in Access Power House tunnel



CONCLUSION

The Geotechnical observation and convergence monitoring can verify the NATM philosophy in tunnel support and face stability. Geotechnical observation was very useful to provide a first hand support guidance to the Engineer. The EPDC standard pattern of support adopted for the project worked satisfactorily. The adequacy of the support was truly verified by following the frequent deformation monitoring in the tunnel. The deformations due to tunnel excavation were found to depend upon rock mass class, face advance and time elapse after the support application. An empirical equation may be expressed as **d = a + b ln t ;** where d is the deformation in mm, a = 0.8-0.9 and b = 0.98- 1.0 - a function of rock mass and t - time of measurement in days.

REFERENCES

Electricity Generating Authority of Thailand, 1995.Tender Document, Lam Ta Khong Project, Thailand
Hoek, E. and Brown, E.T., 1980. Underground Excavations in Rock. Inst. Min. Metall., London,
ISRM 1978. Suggested methods for quantitative description of discontinuities in rock masses. Int. Journal of Rock Mech., Min. Sci. Geomech.Abstract., 15: pp. 319-368