Geotechnical Investigation and Grouting Work for the Headrace Tunnel, Pyu Chaung Area

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Abstract

Pyu Chaung Hydropower project is one of the Sittaung Valley Projects in 2011. This project had been constructed for development of electric power for Bago region. Construction of the dam project was undertaken by the Department of Hydropower Implementation (DHPI). The project area is mainly composed of thick bedded sandstone, siltstone, and intercalated mudstone layer in some places trending nearly ENE-WSW with slightly folded nature. The investigation and analysis on uniaxial compressive strength of intact rock, Rock Quality Designation (RQD), Spacing of joints and beddings, Joint condition, Ground water inflow, Adjustment for joint and tunnel orientation and Dip and strike perpendicular to tunnel axis are carried out as geotechnical investigation. The total RAR classification is fair to poor condition. Surface Geological Investigation indicates the general rating of the site conditions is fair, while some part of the site area is in poor condition especially in RD 90 to RD 525. In fair condition of RMR class area, foundation treatment is used by contact and curtain grouting method and consolidation grouting method is used in poor condition.

Introduction

Pyu Chaung Hydropower project is one of the Sittaung Valley Projects in 2011. The Pyu Chaung hydropower project had been constructed for development of electric power. Construction of the dam project was undertaken by the Department of Hydropower Implementation (DHPI).

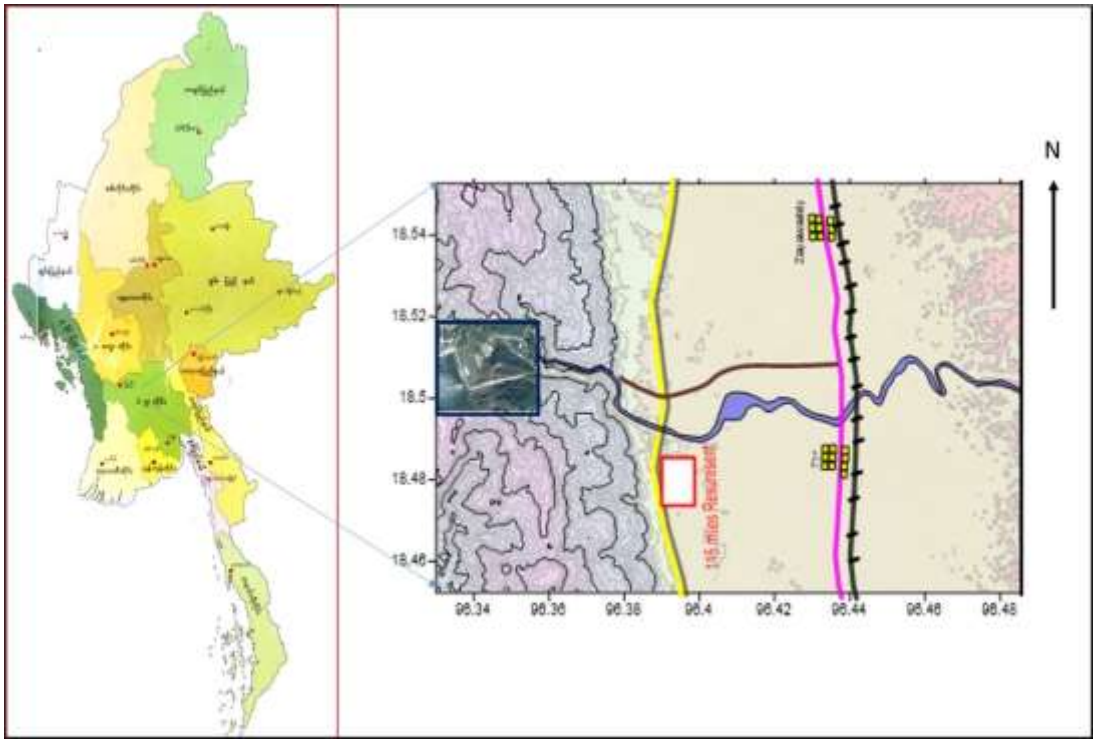
The project site is situated about 9 miles, southwest of Pyu, Pyu Township, Taungoo District, Bago Region. It is located between Latitude 18° 50´ N and Longitude 96° 30´ and at grid 802442, topographic map index 94 B/6 (Fig. 1).

Topography

Physiographic feature of the Pyu Chaung dam site area is typically expressed by roughly parallel ridges with moderate relief. The elevation differences of the Pyu Chaung channel are more than 150m just like erosional gorge (Fig. 2). It flows from southwest to northeast near main Dam Pyu Chaung Implementation Project. Both sides of the Pyu Chaung are relatively found as hills, ridges and small Mountain ranges. These occupy steep slope in the left bank and a low slope in the right bank.

Purpose of study

The main purpose is to understand geotechnical condition of the project area, expecially for Headrace Tunnel Backfill grouting task of Pyu Change Hydropower project and it includes the following purposes: (1) To prevent the seepage and lugeon problem of the infrastructure, (2) To maintain the uplifted water pressure and erosion, and (3) To improve consolidation and strength of the bed rock.



Fig(1) Location and Physiographic feactures of the study area.

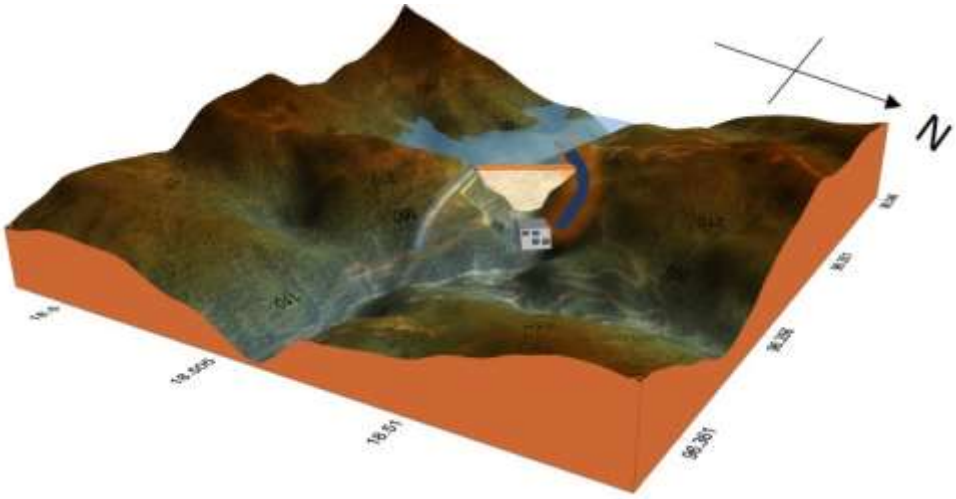


Fig. (2) Topography of Pyu chaung Tunnel area

General geology

The project area is mainly composed of sandstone and shale of Tertiary clastic sedimentary rock as Obogon Formation and Kyaukkok Formation. Obogon Formation (Middle Miocene) is composed of fine to medium grained, thick bedded sandstone, sandy shale and alteration of clays, and Kyaukkok Formation (Middle Miocene) comprises of yellowish –brown, massive sandstone and horizons of ripple cross –laminated silty shale. Thin layer of residual ferruginous soil cover on massive Sandstone and mudstone is the prominent characteristic of this

unit. This area lies in the eastern flank of Bago Yoma and just west of the Sagaing active dextral Fault, and it is, therefore, highly jointed and friable due to intense deformation.

Geotechnical Investigation

In the first stage, detail measurement of surface mapping and core log study of six drilling holes are carried out for Geotechnical mapping of the project area (Fig. 3). The project area is mainly composed of thick bedded sandstone, and siltstone. In some place thin layers of mudstone are intercalated between them. All of rock units are nearly ENE-WSW trending and gently dipping to the NWN and slightly folding. A thin layer of talus (overburden) cover is present especially near the power house. NNE –SSW striking narrow width crumbling and contorted brecciated mudstone with shear sense indicators point out that minor fault passes through to the project site, near RD 260m. The length of the Tunnel is about (2000) feet and width about 6.2m. According to six drilling core log, the rock exposed in the upper part of the project area deforms more than the lower part.

Detailed Geotechnical Investigation

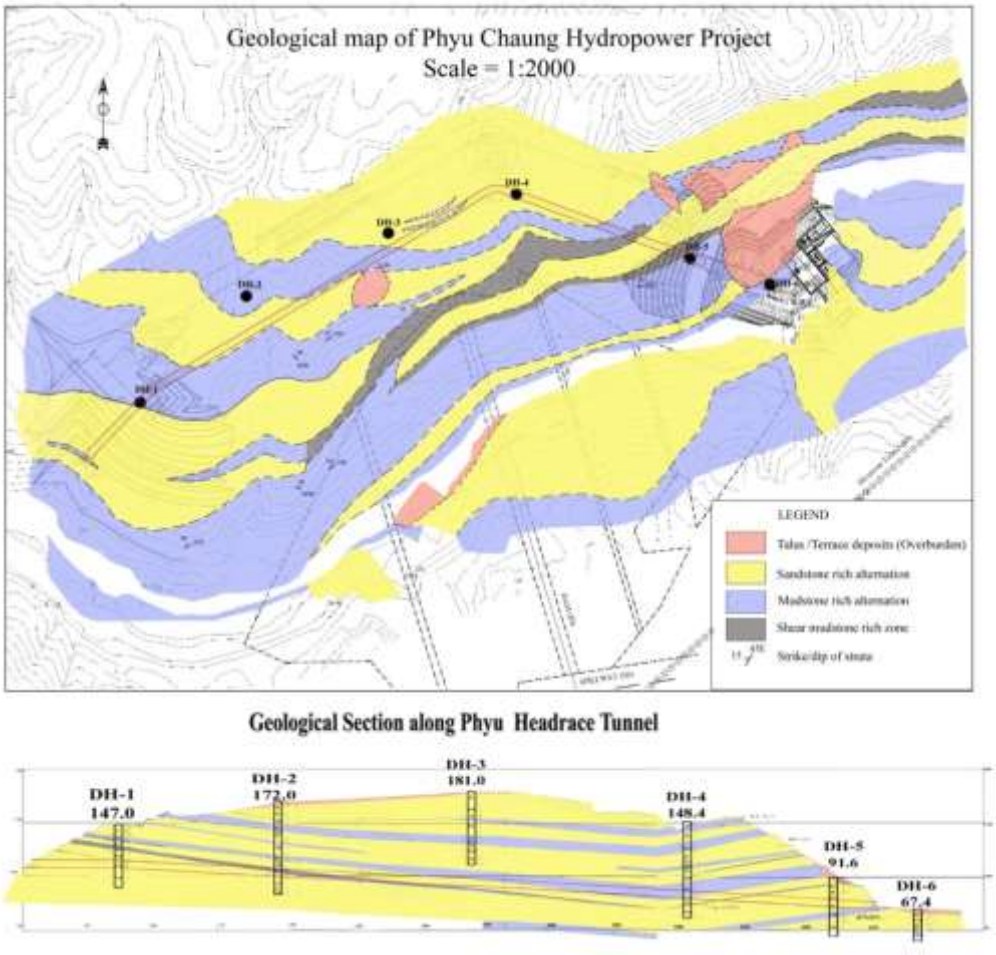


Fig (3) Surface geological mapping and cross section of Pyu Chaung Hydropower Project

Information obtained by detailed geotechnical invitation of the Pyu chaung Headrace Tunnel, using Rock Mass Rating, RMR method (Bieniawski, 1973) and Rock mass Index (RMI) method (Palmström, 1995, 1996), is shown in Table (3). The single blow uniaxial compressive strength of the intact rock core sample material of the site area is 60-75Mpa. Joint spacing from of drill core and collected data are also applied for calculate RQD value. RQD value of the rock in the project site is about 50-75. This value suggested that the maximum rating is about 14. Rock strength directly depends on the spacing of all discontinuities such as joint, fault, bedding plane and other surface weakness. Joint spacing of the core log in the site area is about 200mm, and its rating is good condition. Joint condition is considered to be the aperture a, roughness, infilling material and weathering condition of the joint in the core log. Two sets of measurement and calculation show the rating of 1. Ground water flow influences on the stability of underground excavation. The ratio of join and water pressure causes major principal stress and some general qualitative observation of ground water conditions. The flow rate of ground water in the site area is less than 10m/min, and its inflow type is, therefore, dump.

Adjustment for joint and tunnel orientation is about 20° - 45°. Strike perpendicular to tunnel axis drive with Dip and strike perpendicular to tunnel axis drive against Dip is unfavorable condition. Strike parallel to tunnel is fair condition.

All of the about conditions are considered and the calculated total rating is about 48. This value generally lies within fair condition in RMR classification.

Table (3) Rock Mass Classification, RMI analysis of Pyu Chaung Headrace tunnel.

Rock Mass Classification, RMR analysis , Pyu Chaung Headrace tunnel

Location- ALT(1) wier (Right Bank)												VALUE	RATING
Intact Rock Strength	PLST	10	8	6.5	5.5	5	4.5	3	2	1	<1		
	UCS, Mpa	250	200	160	140	125	110	75	50	25	<25		
	Field Est	chipped by hammer		many blows by hammer to break				single blow		pocket knife			
	RATING	15	14	13	12	11	10	8	6	4	<3		8
RQD	J Spacing	>200	40	20	14	10	8	7	6	5	4		
	RQD%	100	90	80	70	60	50	40	30	20	0		
	RATING	20	18	16	14	12	10	9	5	4	3		14
Joint Spacing	Js, cm	>200	40	20	14	10	8	7	6	5	4		
	RATING	20	18	16	14	12	10	9	8	7	5		20

							Set 1	Set 2	Set 3		
						Orientation J Spacing					
Joint Condition	Persistence	< 1m	1 - 3 m	3 - 10 m	10 - 20 m	> 20 m					
	RATING	6	4	2	1	0	4	4			
	Aperture	None	< 0.1 mm	0.1 - 1.0	1 - 5	5 - 10					
	RATING	6	5	4	1	0	1	1			
	Roughness	V Rough	Rough	SL Rough	Smooth	Slicks					
	RATING	6	5	3	1	0	3	5			
	Infilling	None	Hard Infilling		Soft Infilling						
			< 5 mm	> 5 mm	< 5 mm	> 5 mm					
	RATING	6	4	3	2	0	2	4			
	Weathering	FRESH	SW	MW	HW	CW					
	RATING	6	5	3	1	0	3	3			1
						Sub-Total	13	17			

Groundwater	Inflow l/min/10m	None Dry	< 10 Damp	10 - 25 Wet	25 - 125 Dripping	> 125 Flowing		10
	RATING	15	10	7	4	0		

Adjustment for Joint Orientation	DIP OF ADVERSE JOINT SET				
	0° - 20°	20° - 45°	45° - 90°		
Strike Perpendicular to Tunnel Axis drive with Dip	Unfavourable	Favourable	Very Favourable		
	-10	-2	0		
Strike Perpendicular to Tunnel Axis drive against Dip	Unfavourable	Unfavourable	Fair		
	-10	-10	-5		
Strike Parallel to Tunnel	Unfavourable	Fair	Fair		
	-10	-5	-12		-5

RMR RATING	80 - 100	60 - 80	40 - 60	20 - 40	0 - 20	
DESCRIPTION	VERY GOOD	GOOD	FAIR	POOR	VERY POOR	
ROCK CLASS	1	2	3	4	5	48

Foundation Treatment

Grouting

Surface geological investigation indicates the general rating of the site conditions is fair, and some parts of the site area are of poor condition, especially in RD 90 to RD 525. In fair condition of RMR class area, foundation treatment is used by contact and curtain grouting method and consolidation grouting method is used in poor condition. After grouting, quality testing process were done by primary and secondary checking hole.

Contact grouting

Contact grouting is grouting between the wall rock and concrete pipe. Contact grouting work is carried out nearly the whole tunnel especially in RD 90 to 520m. The thickness of the contact grouting is about 20 cm (Fig. 4.A and B).

Fig. (4) Grouting along the headrace tunnel: (A) Contact grouting, (B) Grouting machine in the outside area, (C) Consolidation grouting, (D) Grouting machine in the outside area.

Consolidation grouting

Consolidation grouting is filling cement into the wall rock including wall rock fracture and concrete pipe (Fig. 4.C and D). This type of grouting has been used for all types of structure

including Tunnel, building and a large number of structures. This grouting consolidate the foundation materials and to seal the cracks, joints, fracture and other associated structures. In addition, it can also increase the strength of the rock and resist the high pressure. Six localities of consolidation grouting are carried out in the project site. The location of consolidation grouting in the headrace tunnel are shown in Fig. (5)

Curtain Grouting

Curtain grouting is the final stage of the grouting. After the above grouting, 66mm width and 10m length drill hole are dug with the spacing of 1.5m. After that injection of cement is performed to improve the strength of the tunnel and to prevent the seepage problem.

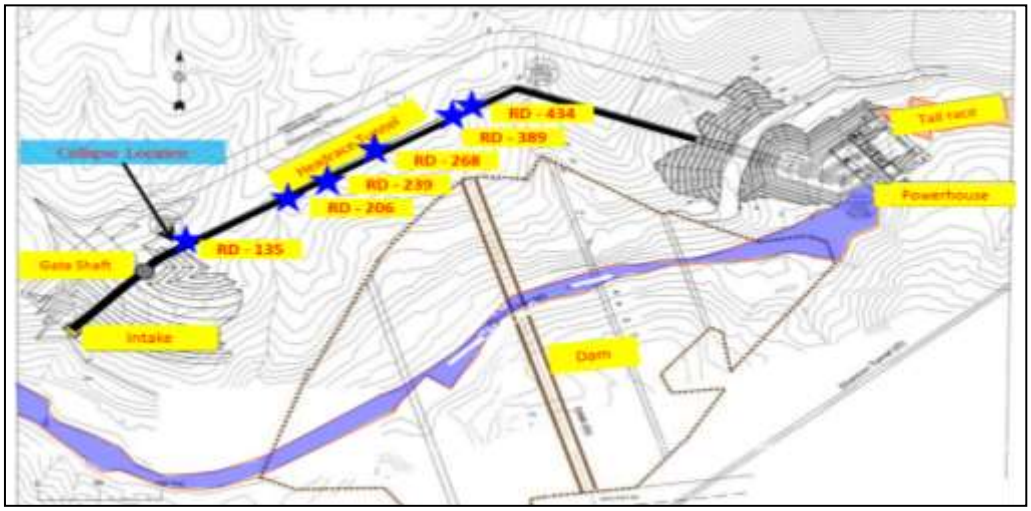


Fig. (5) Location of Consolidation Grouting On the project site.

Summary and Conclusion

Pyu Chaung Hydropower project is one of the Sittaung Valley Projects in 2011. This project had been constructed for development of electric power for Bago region. Construction of the dam project was undertaken by the Department of Hydropower Implementation (DHPI). The project area is mainly composed of thick bedded sandstone, and siltstone, with intercalated mudstone layer in some places trending nearly ENE-WSW and slightly folding. Geological investigation on uniaxial compressive strength of intact rock, Rock Quality Designation (RQD), Spacing of joints and beddings, Joint condition, Ground water inflow, Adjustment for joint and tunnel orientation and Dip and strike perpendicular to tunnel axis are carried out for the project site. The total RMR classification is fair to poor condition. Surface Geological Investigation indicates the general rating of the site conditions is fair. Some part of the site area is in poor condition especially in RD 90 to RD 525. In fair condition of RMR class area, foundation treatment is used by contact and curtain grouting method and consolidation grouting method is used in poor condition. This type of grouting has been used for all types of structure including Tunnel, building and a large number of structures. After grouting, quality testing process were done by primary and secondary checking hole. Moreover, injection of cement is also applied to improve the strength of the tunnel and to prevent the seepage problem.

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