Estimation of Achievable Rate of Tunneling: A Case Study of Lower Likhu Hydropower Project

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ABSTRACT

The process of tunneling is very challenging process in case of Nepal due to complex geology and managerial complications. Proper prediction of monthly progress rate under a definite set of ground and management condition is important in tunneling project for achieving the milestone within the projected timeframe. This paper predicts achievable progress rate in the tunnel of the Lower Likhu Hydropower Project.

Key words: Lower Likhu Hydropower Project, Achievable rate of tunneling, Run-off river type project, Tunnel

INTRODUCTION

The Lower Likhu Hydropower Project (28.1 Mw) is run-off river (RoR) type project located at Ramechhap and Okhaldhunga Districts. The total length of the headrace tunnel is 4797 m, and the excavation of tunnel is done by traditional drilling and blasting process from six portals. The total of 1046.7 m has been excavated till 13.04.2019.

There are numerous uncertainties encountered during the excavation of tunnels. The probable time of completion of tunneling is grossly underestimated due to varying geology, management complications, and different types of breakdown or hold-ups. This paper includes the prediction of achievable progress rate in the tunnel of the Lower Likhu Hydropower Project using classification system developed by Chauhan (1982).

METHODOLOGY

The assessment of rate of tunneling is done according to the classification system (Table 1) proposed by Chauhan (1982). The classification system comprises of classification of two conditions: ground conditions and management conditions.

Classification of Ground Conditions

The rate of tunneling is seriously affected by the ground conditions. The factors are:

a) Geology (RQD, dip/strike of strata, presence of major faults, rock mass properties)

b) Method of excavation including blast pattern and drilling arrangement

c) Type of support system and its capacity

d) Inflow of water

e) Presence of inflammable gas

f) Size and shape of the tunnel

g) Construction adits

h) High temperature in very deep tunnels.

These geologic conditions are classified in the tunnel into good, fair and poor conditions.

Classification of Management Conditions

The rate of tunneling varies in the same ground condition depending upon management quality. The management factors affecting the tunneling quality are:

a) Overall job planning, including selection of equipment and decision making process,

b) Training of personnel,

c) Equipment availability including parts and preventive maintenance,

d) Operating supervision,

e) Incentives to workmen,

f) Co-ordination,

g) Punctuality of staff,

h) Environmental conditions, and

i) Rapport and communication at all levels.

These factors are assigned to weighted rating and the rating of all factors is added to obtain a collective classification rating for management condition. Using this rating, the management condition is classified into good, fair and poor.

Table 1: Ground and management factors (Chauhan 1982)

	Management conditions		
Ground Conditions	Good	Fair	Poor
Good	0.78	0.60	0.44
Fair	0.53	0.32	0.18
Poor	0.30	0.21	0.13

Table 2: Classification of ground and management factors

Tunnel Location	Ground Condition	Management Conditions	Ground and Management Factors
Main Inlet	Poor	Poor	0.13
Seti Outlet	Poor	Fair	0.21
Seti Inlet	Fair	Fair	0.32
Poku Outlet	Fair	Fair	0.53
Poku Inlet	Fair	Fair	0.53
Main Outlet	Fair	Fair	0.53

Table 3: Calculation of achievable monthly progress

Tunnel Location	Date of First blast	Progress till 13.04.2019 (m)	Total Months	Actual Monthly Progress (m)	Achievable Monthly Progress (m)
Main Inlet	19.11.2018	102	4.9	20.82	23.52
Seti Outlet	19.11.2018	174.8	4.9	35.67	43.16
Seti Inlet	22.11.2018	237.8	4.8	49.54	65.39
Poku Outlet	29.01.2019	122.8	2.5	49.12	75.15
Poku Inlet	19.01.2019	202.5	2.8	72.32	110.65
Main Outlet	27.12.2018	206.8	3.6	57.44	87.89
Total		1046.7		284.92	405.77

These two factors are combined to nine categories for studying the combined effect into a matrix, which is defined as the ratio of actual monthly progress to achievable monthly progress under corresponding set of ground and management conditions. The six tunnels of the Lower Likhu Hydropower project were considered for the analysis.

RESULTS

The ground conditions and management conditions were classified at six tunnel locations, namely Main inlet, Seti outlet, Seti inlet, Poku outlet, Poku inlet and Main outlet tunnel.

The geology of the Main inlet and the Seti outlet tunnel comprises of thinly foliated, fresh to slightly weathered, grey phyllite with intercalation of metasandstone. The Q-value ranges from 0.01 to 0.18, and are classified as poor ground condition. The remaining tunnel comprises of thinly to thickly foliated, coarse to fine grained, fresh to slightly weathered bluish green metasandstone with partings of phyllite. The Q-value ranges from 0.18 to 4, which is classified as fair ground conditions.

The actual rate of tunneling was calculated from Table 3. Using the factors from Table 2, the achievable rate of tunneling was calculated. It is found that total actual monthly progress is 284.92 m and achievable monthly progress is 405.77 m (Table 3).

CONCLUSION

The management of the project directly affects the progress of tunneling. By optimization and improvement of management condition at current ground conditions, 120.85 m more could be expected to be excavated per month, which will ease the project completion on the designed time and costs.

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