TBM Tunneling at Parbati Hydroelectric Project, Stage -II

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Abstract

Use of Tunnel Boring Machine in tunneling in Himalayan rocks is difficult and challenging task for geologists and engineers. Himlayan rocks are known for heterogeneity and complexity. Investigation and construction using any method is always difficult. Presently, at Parbati Hydroelectric Project, Stage -II, two different types of TBM are under operation, single shield TBM for excavation of HRT and double shield TBM for inclined pressure shafts, in different geological conditions For lot PB-III work of project, left inclined pressure shaft is completed and right pressure shaft is under excavation, this is the first inclined TBM tunnel in Himalayan rocks completed successfully in record time. This paper deals in brief, excavation of inclined pressure shaft and future of TBM tunneling in Himalayan rock conditions.

Introduction

Parbati Hydroelectric Project is located in Kullu district of Himachal Pradesh and has been divided into three stages, with a total generating capacity of 2070 MW. Stage-II and -III of the project are under construction. 800 MW of hydro power is envisaged to be generated from the second stage. The scheme includes construction of a 85 m high concrete gravity dam, three nos. of desilting chambers, 31.23 km long, 6 m diameter horse-shoe shape HRT by DBM and circular HRT by TBM, 5 nos of trench weirs to tap water from various streams, underground surge shaft, 130 m high & 17 m diameter, two no's of pressure shafts, four no's of penstock, a surface powerhouse and 4 nos. tailrace channels. The authors are associated with the construction of part of HRT, surge shaft, penstocks, open power house and a tailrace channel.

General Geology

The Project lies in the Kullu District of Himachal Pradesh within the Lesser Himalayan Zone. The area is bounded in the north by MCT and towards the extreme south by MBF. The Parbati valley exhibits a complex geology, where various rock formations have undergone extensive structural deformations. Regional geology of the project area shows sequence of rock types belonging to Jutogh, Banjar and Larji Formations. Rocks of Banjar formations are exposed in this part of project, which are represented by four litological units as Bandal Member, Bhallan Member, Green Bed Member and Manikaran Quartzite. Rocks of Banjar Formations are encountered during .eft pressure shaft excavation.

Incline Pressure Shaft

Salient features of inclined pressure shaft are shown in the following table:

Sl. No.	Features	Description
1.	Excavation Diameter	4.88 m
2.	Lining Thickness	20 cm
3.	Internal Diameter	4.3 m
4.	Shaft Length (By TBM)	2 × 1496 m
5.	Invert Gradient	30°
6.	Final Lining Diameter	3.5 m
7.	Segment Concrete	M 35 A20
8.	Total Segment Required	12140 Nos.

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Inclined pressure shaft excavation was anticipated through moderately foliated to massive Meta Volcanic rock with intermediate bands of Chlorite Schist. Five no's of holes were drilled at different elevations for the investigation of inclined pressure shaft. Moderately foliated to Massive Meta Volcanic is reported in the upper portion and closely foliated and jointed rock mass in the lower portion. Folding, faulting, open joints, major shear zone were not expected along the tunnel alignment. Dripping to moderate flow of water was anticipated along the inclined shaft. Rock cover above the inclined pressure shafts vary from 70-250 m, which is not very high. The alignment of the shaft is an acute angle with respect to the foliation (050-060^0/60-65^0). Chlorite schist bands are anticipated parallel to the foliations, which are unfavorable for tunneling. Massive Met volcanic contain good excavation conditions, but closely jointed and fractured zones requires heavy support. Chlorite schist is a weak rock with low shear strength also requires heavy support.

Left Inclined Pressure Shaft - Excavation

The entire length of the left inclined pressure shaft is excavated through Meta Volcanic and Chlorite Schist rock. Some bands of shear seams are also observed which make tunneling difficult. At some places quartz veins are observed. Moderate to heavy flow of water is encountered throughout the length. The main problems observed during excavation was corrosion of drain portion of segmental lining which increased with the excavation and occurrence of weak rock. Pressure shaft was excavated using double shield TBM and supporting elements are segmental lining. Casting of segment and view of segmental lining is shown in photograph no. 1 & 2 respectively. An estimated 6000 no's of segments for one pressure shaft were required.

Photo -1 : Casting of segment at casting yard

Photo -2 : Segmental lining at ILPS

Conclusions

TBM excavated tunnel in Himalayan rocks is first completed at Parbati Hydro Electric Project for left inclined pressure shaft and excavation of right pressure shaft is under progress. This achieve-ment was done only because of choice of type of TBM i.e. Double Shield. Precast segmental lining is used for supporting purpose, is a best choice in inclined tunnels. It is surmised that mechanized tunneling can be successful in Himalayan region, if geological, geotechnical investigations and selection of type of TBM is done precisely.

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