Rock Mass Characterization using Rock Mass Rating and Tunnel Seismic Prediction (TSP) Technique in Head Race Tunnel of Sewa Power Station, Stage-II, J&K, India

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Abstract

Sewa Stage-II project is a run of the river scheme, harnessing the potential of river Sewa, a tributary of Ravi river. A gross head of approx. 599 m in lower one third course of river Sewa between the Gatti (dam) & Mashka (powerhouse) is being utilized to generate 120 MW (40MW x 3) of power. A small reservoir of adequate capacity has been provided as an operating pool to meet diurnal peaking load demand.

Wide geological diversity and structural complexity characterizes the area. Rocks of Bhadarwa group, Tanawal group, Panjal volcanics and Murree formations cover the project area separated by major thrusts. A 10.084 km long head race tunnel was constructed to carry 24.25 cusec of water from dam to powerhouse. In order to facilitate the excavation of HRT four Adits (with eight faces) were provided at RDs 364m, 2729m, 5609m and 10028m respectively. RMR classification was used for identifying the rock class and based on rock class, support was provided in all underground structures.

HRT is crossing from high grade metamorphic rock to medium and low grade metamorphic rock. In the upstream part of HRT, about 5115 m length is traversed by augen/granite gneisses. The contact of Dalhousie granite and Tanawal group is thrusted but the same is sharp (encountered at RD 493m U/S of Adit-III, Face-V). The remaining part of HRT lies in the tectonically affected sequence of Tanawal Formation. In view of the obliquity of the tunnel alignment with the general disposition of rocks, a considerable portion of tunneling is through folded and faulted sequence of Tanawal group of rock. Further, the strike of the formations is generally EW, dipping steeply towards N or S giving negative rating to RMR value.

Number of sheared rock encountered in tunnel particularly along the vicinity of fault zones. Main part of sequence comprises of calcareous slates, phyllitic slates, limestone and quartzites representing competent rock. The subordinate part comprises of carbonaceous phyllites, sericitic/ choritic phyllites and sheared limestones, representing incompetent rock, which is highly foliated, partly soft and at places sheared. Mainly the poor tunneling medium includes carbonaceous phyllites & crushed limestones. At places due to Karstic nature of limestones water bearing zones were encountered. Heavy seepage in slate was also observed especially at Face-VI & VII.

As per RMR classification, out of the total length of 10084m, 0.2% (20m length) is in Class-I category, 54.3% (5453) is in Class-II category, 38% (3835m length) is in Class-III category and 7.7% (776m length) is in Class-IV category (Figure-1).

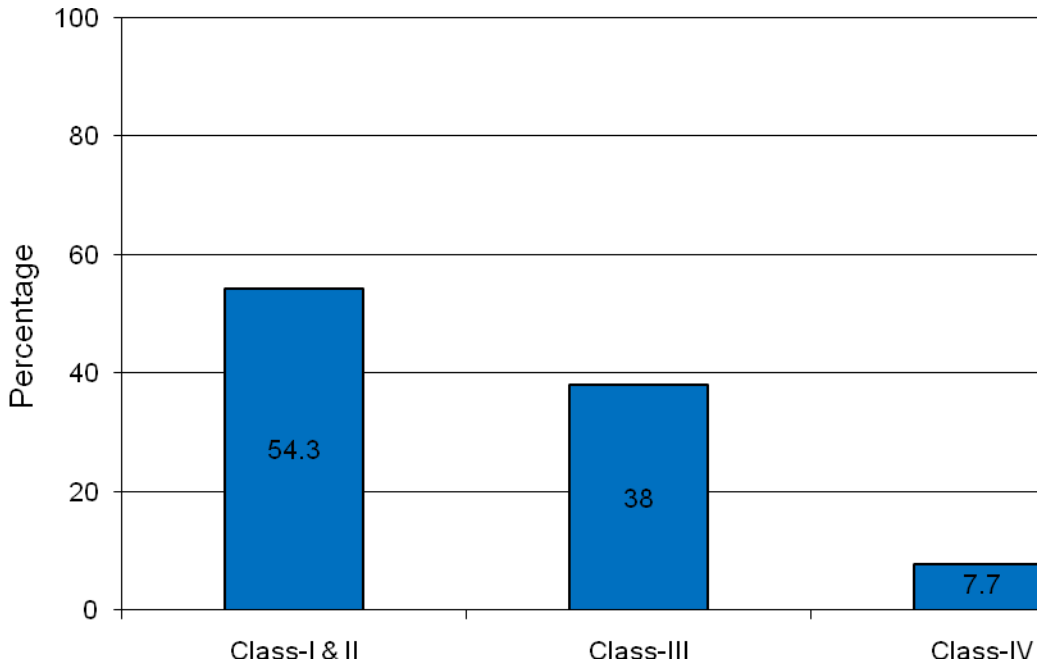

Figure 1 Percentage of Rock Class Encountered During Excavation in HRT.

Tunnel seismic prediction (TSP) an emerging state of the art non destructive geophysical technique, is fast becoming one of the most preferred predictive forecasting tool vis-à-vis conventional methods and being use to predict media ahead of construction, plan drainage measures, assess weakness within the media and thereby employ support measures.

The tunnel seismic prediction (TSP) detects changes in rock mass such as irregular bodies, discontinuities, faults and fracture zones ahead of the tunnel face. This test was conducted in Face-IV (Adit-II U/S), Face-V (Adit-III U/S), Face-VI (Adit-III D/S) and Face-VII (Adit-IV U/S) of HRT. The test results of TSP were compared with the RMR classification for characterizing the rock mass of the HRT.

The TSP results indicated that the method give a good picture in terms of rock strength and presence of groundwater. Moreover, presence of shear seams and filling does reduces the overall strength of rock mass. Therefore, such zones were known in advance and necessary arrangements were made for fast and safe excavation. This is additional advantage of TSP apart from giving prediction of weak discontinuities. In two faces i.e. in Face-IV and Face-VII the predictive range was for 247m and 59m respectively. During excavation more or less similar conditions were met especially identification of water bearing zones and poor strength rock mass condition. It was useful as necessary precautionary measures were taken for dewatering the groundwater and placing of pressure relief holes for easing of hydrostatic pressure. Further, after TSP test the low strength zones were also known, therefore, it was possible to reduce the powder factor and optimize the excavation process. In Face-V & VI decrease and increase rock strength zone as predicted were also met.

The paper deals with rock mass characterization of underground structures specially HRT using RMR classification and TSP technique.

Keywords: Head Race Tunnel, Geology, Rock Mass Rating, Tunnel Seismic Prediction (TSP).