Rock characterization and empirical design of support for a hydropower tunnel in Shangla, Khyber Pakhtunkhwa, Pakistan

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Abstract

The study site is located in Shangla District, Khyber Pakhtunkhwa. Geological and engineering geological mapping was undertaken along the tunnel corridor using topographic survey overlaid on satellite image. During engineering geological mapping, soil and rock units were identified and marked based on dominant lithologies. Discontinuity surveys were conducted along the tunnel route to get the information about the distribution, orientation and characteristics of the discontinuities for onward rock characterization using empirical methods; Rock Mass Rating (RMR) and Rock Tunneling Quality Index (Q).

Kinematic analyses were undertaken on discontinuity data in relation to the tunnel alignment using computer program Rock Pack III and DIPS. Possible modes of rock failure were assessed in representative tunnel sections using computer program UNWEDGE. Spot support based on the discontinuity data was suggested. All the discontinuity and subsurface investigations data were used to characterize the rock units for rock mass classification; R1-R4 based on RMR and Q values. Overall, 48% tunnel was found to pass through R1, 09% through R2, 30% through R3 and 13% through R4 of the total tunnel length of 5950m. Corresponding to each rock class, an empirical design of the support was finalized after analyzing the support elements provided by both empirical systems. The support designed for the tunnel comprises the steel ribs, shotcrete and rock bolts for R1-R4 rock classes.