Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 4, No. 11, November, 2018

Numerical Verification of Empirically Designed Support for a Headrace Tunnel

Mian Sohail Akram [a], Luqman Ahmed [a], Muhammad Fahad Ullah [b], Faisal Rehman [b*], Muhammad Ali [c]

[a] *Institute of Geology, University of the Punjab, Lahore, Pakistan.*

[b] *Department of Earth Sciences, University of Sargodha, Sargodha, Pakistan.*

[c] *Geological Survey of Pakistan, Pakistan.*

Received 16 August 2018; Accepted 15 October 2018

Abstract

In this paper, we used two empirical rock classification systems of rock mass rating (RMR) and rock quality tunnelling index (Q-system) for the support design of a tunnel in District Battagram, Khyber Pakhtunkhwa, Pakistan. Along the tunnel route, the rocks of Precambrian namely Gandaf Formation, Karora Formation and Besham Complex were exposed. During the field investigations, two shear zones were marked in the schist of Karora Formation. The discontinuities parameters collected during the field investigations, results of laboratory testing and material constants determined from RocData version 5.0 software were used during the empirical classification and numerical modelling. The support was designed for the rock mass units from RMR and Q. The quantification of the thickness of plastic zone and total displacement around the tunnel were achieved by the numerical modelling of RS2 9.0 software in both unsupported and supported conditions. The empirically designed support was installed in the model prepared in the RS2 software. According to the results, the empirically designed support when installed in models prepared in RS2 significantly reduced the plastic zone around the tunnel. The reduction in the plastic zone and displacement around the tunnel verified the support design by empirical methods. The present research concludes that empirical designed support can be used for the complex geology of Pakistan.

Keywords: Engineering Geology; Rock Mass Classification; Numerical Modeling; Ground Conditions.

1. Introduction

Empirical methods are designed for the determination of qualities of the rock mass and support design for underground excavations. These classification systems are based on a number of case histories and are being used at various stages of the construction of the project for decades. The predefined parameters and easy tabular rating system for rock classification make these approaches popular among geoscientist and engineers [1]. Empirical rock classification systems such as Terzaghi rock quality designation and classification system [2-4], Rock Structure Rating [5], Rock Mass Rating [6, 7] and Rock Quality Tunneling Index [8, 9] were developed for tunnels and underground excavations. Among these systems, RMR and Q systems have been updated in recent years and are still in use in the tunneling industry while others are out dated and are not in use. In recent times,Palmstrom and Stille [10], Genis, Basarir [11], and Palmström [1] discussed that these classification systems have some shortcomings and emphasized upon the verification of the empiricaly design support by using any of the observational, analytical, kinematical and numerical modeling techniques. Recently, different researchers like Ozsan et al. [12]; Genis et al. [11]; Rasouli [13]; Krishna and Panthi [14]; Kaya, Bulut [15]; Panda et al. [16]; Akgün et al. [17]; Elarabi and Mustafa [18] and others in different

* Corresponding author: faisal.rehman@uos.edu.pk

http://dx.doi.org/10.28991/cej-03091182