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RESEARCH ARTICLE

ROCK MASS CLASSIFICATION SYSTEMS AND KINEMATIC ANALYSIS OF SLATES FROM DIR GROUP, NW, HIMALAYA, PAKISTAN; IMPLICATION FOR SLOPE STABILITY

Aftab Ur Rahman[1*], Zhang Guangcheng[1], Asghar Khan[3], Mohit Kumar Puniya[2], Sami Ur Rahman[3], Zeng Xin[1]

[1]School of Engineering, China University of Geosciences, Wuhan 430074, China
[2]National Geotechnical Facility, Survey of India, Dehradun, Uttarakhand, India
[3]Shaheed Benazir Bhutto University Shiringal Dir (Upper), Khyber-Pakhtunkhwa, Pakistan
Corresponding Author Email: aftaburrahman1479@gmail.com

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ABSTRACT

Slope stability is an important issue for the construction of roads on hill slopes. 24 slopes cuts have been investigated to determine the slope instability issues and mode of failure along the newly constructed road of Dir-Sheringal Khyber-Pakhtunkhwa, Pakistan. The major rocks are slates and tuffaceous siltstone which are weak to moderately strong in strength. The main objective of this study is to assess the application of rock mass classification systems and kinematic analysis which affects the slopes. The investigation shows that rock mass rating (RMR-basic), and slope mass rating (SMR) values range from 0 to 73 which is poor to normal while geological strength index (GSI) analysis classified the rock mass from poor to good conditions. The Kinematic analysis shows that three types (plane, wedge and topple) of failure mode are present in these slopes. Most of the slopes are unstable and weak where perspective tools and proper installation provide support and prevent future failure. This study shows a good relationship between RMR-basic, SMR, and GSI for different locations.

KEYWORDS

Slope, Kinematic Analysis, Stability RMR, SMR, GSI, Failure mechanism

1. INTRODUCTION

Rock slopes are one of the most important issues of road construction, especially in hilly and mountainous areas. Slopes are more liable to instability problems due to differences in the rock mass conditions, presence of different discontinuities, shear zones, fault, thrusts, unscientific way of slope cutting, heavy rainfall seismic and neo-tectonic activities (Bieniawski et al., 1979; Bieniawski, 1989; Ahmad et al., 2003). However, plane, wedge failures, rock topples, and rockfalls are common slope failures (Evert et al., 1981). A detailed geological investigation of any slope helps the civil engineer to design the proper support system to provide and mitigate the slope failures. A proper slope design not only leads to improvements in slope stability and safety but also reduces costs, extends the life of mines, and decreases the stripping ratio (Bieniawski, 1984; Bye et al., 2001).

Many researchers around the world have a great interest and widely used different classification techniques and methods for slope stability and rock mass classification systems. Rock mass classifications systems are frequently used methods by engineers that provide quantitative data and a good way for engineering purposes to provide original descriptions of rock mass from different structural parameters (Pantelidis, 2009). Rock mass classification systems have been commonly utilized in the field of engineering geology, particularly for the design purpose of the slope. They are widely used due to their simplicity and the limited need for detailed information (Duran et al., 2000). Various classification systems such as Rock Mass Rating; RMR Slope Mass Rating; SMR, Continuous Slope Mass Rating; CoSMR and Geological Strength Index; GSI are extensively used methods for Rock Mass Classification (Bieniawski et al., 1979; Romana, 1985; Tomás et al., 2007; Evert et al., 1997).

In this study, three methods of rock mass classification system have been used which are Rock Mass Rating (RMR), Slope mass rating (SMR), and Geological Strength Index (GSI) (Hoek et al., 2013). Kinematic analysis can explain the possible mode of failure and potential along the slopes.

The current study has focused to investigate the slope cuts along the newly constructed road of Dir-Sheringal valley. Geological studies have been reported by many authors but, no work of engineering assessment is reported from the Dir group (Khan, 1979; Sullivan et al., 1993). Due to the poor blasting and mechanical excavation, many slopes and risky cuts have been generated along the road. Assessment of the selected slope has been conducted through different classification methods which give us different categories and descriptions of the selected slope cuts. Kinematic analysis was aimed to reveal the possible mode of failure and direction. All the results of the slope cut were examined to mark various zones that are prone to instability and determine failure reasons adversely affecting the newly constructed Dir-Sheringal Road.

2. LOCATION AND GEOLOGY OF THE STUDY AREA

Study area is located in northwestern Kohistan Island Arc (KIA), northern Pakistan (Figure 1. b). The selected slopes are located in a highly mountainous zone of (latitude 35°13’ 03.43’’ N and longitude 71°58’25.73’’E, an Elevation of 4220 feet) (Figure . 2)This road stretched specifically along the main road of Dir-Sheringal (N-45), near the village of Doon Payeen village in upper Dir, Khyber-Pakhtunkhwa (KP,), Pakistan,

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