Study on the Quality Classification of Rock Mass in Tectonic Mixed Rock Belt

Ruipeng Hao[1,2,3*], Bowen Zheng[123], and Shengwen Qi[123]

[1] Key Laboratory of Shale Gas and Geological Engineering, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 100029, P. R. China

[2] State Key Laboratory of Lithospheric and Environmental Coevolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 100029, P. R. China

[3] College of Earth and Planetary Sciences, University of Chinese Academy of Sciences, Beijing, 100049, P. R. China

(*Corresponding E-mail: haoruipeng@mail.iggcas.ac.cn)

Abstract: In the field of geological engineering, the complexity and variability of tectonic mixed rock belts in plateau and mountainous areas have brought great challenges to the construction of transportation engineering. In order to reveal the distribution law and engineering effect of rock mass in these areas, this study summarized the geological setting, lithologic assemblage and tectonic development of two typical tectonic mixed rock belts in Jinsha Jiang River and Jiali-Yi gong. Through systematic investigation and analysis, combined with key parameters such as rock saturated uniaxial compressive strength and rock mass integrity index, a set of rock mass quality classification scheme for tectonic mixed rock belts was established, which not only considered the internal structure of the rock mass, but also took into account the influence of external environmental factors such as stress field and groundwater conditions. On this basis, a tunnel and a slope in the two tectonic mixed rock belts were selected as typical cases to carry out rock mass quality classification and engineering geological evaluation, and the results showed that the rock mass quality of the tectonic mixed rock belt was closely related to lithological assemblage and structural development. The rock mass quality classification scheme proposed in this study can accurately reflect the actual condition of rock mass, and can provide a reference for the evaluation of rock mass quality classification in complex engineering geological environment areas such as tectonic mixed rock belts.

Keywords: ***Engineering geomechanics, Traffic corridors, Tectonic mixed rock belts, Rock mass quality classification.***

Introduction

The Sichuan-Tibet Transportation Corridor Project (hereinafter referred to as the “Transportation Corridor”) stretches from Chengdu City in Sichuan Province in the east to Lhasa City in Tibet in the west. It serves as an extremely important strategic transportation artery in southwestern China, holding significant and long-term implications for the nation's long-term stability and the healthy economic development of the Tibetan region. The Transportation Corridor traverses multiple active tectonic zones and geomorphological units, passing through plate suture zones such as the Jinsha River, Lancang River, Nujiang River, and Yarlung Zangbo River, along with a series of associated fault systems. Lithology along the route is complex and variable (Guo et al., 2017), encompassing various rock types that can trigger engineering geological problems, such as ophiolites, cataclasites, ultracataclasites, clastic rocks, and carbonate-magmatic rocks. Research on rock mass quality evaluation for the major tectonic mélange zones crossed by the Transportation Corridor is relatively scarce. Elucidating the distribution characteristics of rock mass quality in this area is crucial for the safe construction of the project (Jiang et al., 2016; Guo et al., 2024; Lu et al., 2023).

Given the complexity of rock masses and their close link to engineering activities, rock mass classification has long been a core focus in rock mechanics research and applications (Wu and Liu, 2012). Before the 1970s, international evaluation methods relied mainly on single-index qualitative or quantitative analyses, such as Deere’s RQD classification (Deere, 1964), which offered limited reliability. Since the 1970s, classification systems have evolved from qualitative to quantitative and from single-factor to multi-factor approaches, including Barton’s Q-system (Barton, 2013), Bieniawski’s RMR system (Bieniawski, 1973), and Hoek’s GSI classification (Hoek and Brown, 1997).

In China, research on rock mass quality evaluation began in the 1960s–1970s. Gu Dezhen and Huang Dingcheng developed the Z-system (Gu, 1979), which laid the foundation for subsequent standards such as the HC classification for underground caverns and the CSMR system (Chen, 1998). The Standard for Engineering Rock Mass Classification (2014) established a national guideline combining qualitative and quantitative methods by determining the basic quality (BQ) and project-specific rock mass grade.

Layered rock masses exhibit anisotropy in strength, deformation, and permeability, which conventional isotropic classifications cannot address. To overcome this, Saroglou et al. (2019) proposed the ARMR system, and Guo et al. (2020) developed the A-BQ classification based on China's BQ standard, enhancing anisotropic rock mass evaluation.

This study integrates field investigations and data analyses to establish a rock mass quality classification scheme for tectonic mélange zones, using parameters such as saturated uniaxial compressive strength and rock mass integrity index to evaluate their engineering quality.

Methodology

This study adopts a technical route of "field investigation-laboratory test-comprehensive evaluation": geological feature analysis systematically combed the lithological assemblages (such as serpentinite, marble, schist, etc.), structural developments (such as Jinshajiang Fault and Jiali Fault) and groundwater conditions of the two mixed rock belts; key parameter acquisition obtained the saturated uniaxial compressive strength (Rc) of rocks through rebound instrument method and laboratory tests, and determined the rock mass integrity index (Kv) by combining the volume joint count (Jv) and rock quality index (RQD); classification system construction established a comprehensive classification model considering lithological assemblages, tectonic stress and groundwater influence based on the national standard BQ and GSI system, and carried out quantitative calculation of rock mass quality through the formula (BQ = 100 + 3Rc + 250Kv) and the GSI-RMR correlation.

Conclusion

Through field investigations and data analysis, this study classified engineering rock masses within the tectonic mélange zones of plateau transportation corridors and derived the following conclusions. Based on the national BQ, GSI, and RMR standards, a multi-method approach for obtaining rock mass quality parameters was developed, leading to a comprehensive qualitative–quantitative classification scheme for tectonic mélange zones. Applying this method to the Jinshajiang and Jiali–Yigong mélange belts revealed that rock mass quality distribution is closely controlled by lithological assemblages and structural development. The proposed classification method provides a valuable reference for evaluating rock mass quality in complex engineering geological environments such as tectonic mélange zones.

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