The Evaluation of Lesser Himalayan Rocks for Ballast in the Nijgadh-Hetauda-Bharatpur Section of Proposed Electrified Mechi-Mahakali Railway, Nepal

Ramesh Pudasaini[1], Chhabilal Pokhrel[2*], Mukunda Raj Paudel[1] and Basant Bhandari[1]

[1]Department of Geology, Tri-Chandra Multiple Campus, Kathmandu, Nepal
[2]Department of Geology, Prithvi Narayan Campus, Bagar, Pokhara, Nepal

(*Corresponding E-mail: pchhabilal46@gmail.com)

Abstract: **Railway have been important for the development of mountainous country like Nepal. The Government of Nepal has planned to establish various railway networks within the country such as the East-West Railway Project which is expected to play important role in connecting the eastern to western regions of Nepal to contribute socio-economic development of country. To construct a sustainable railway, highly durable and strong ballast material is required. The study area includes the Lower Nuwakot Group and Upper Nawakot Group of Nawakot Complex and the Bhimphedi Group of the Kathmandu Complex.**

According to current standards (Indian Standards (I.S.)-1963, American Society for Testing and Materials (A.S.T.M.)-2015 and British Standards (B.S.)-2008), the various physical, strength, and durability properties were found to range as follows; the Flakiness Index from 1.58% to 10.62%, and the Elongation Index from 30.86% to 91,73%. The specific gravity ranged from 2224.43 kg/m^3 to 2783.03 kg/m^3, and the water absorption ranged from 0.47% to 1.41%. The total porosity and apparent porosity ranged from 16.34% to 27.87% and 12.76% to 25.32%, respectively. The Unconfined Compressive Strength ranged from 68.4 to 206.64MPa. In long term durability tests, the Los Angeles Abrasion value ranged from 13.35% to 46.18%, the Slake Durability Index value ranged from 96.52% to 99.1%, and the Sodium Sulfate Soundness value ranged from 0.095% to 2.10%. These properties show that the material have low porosity, high compactness, durable and shows resistant for weathering with low chemical reactivity which is suitable for railway ballast. For the use of railway ballast, Fagfog Quartzite, Dunga Quartzite from Hetauda and Malekhu area and Pandrang Quartzite of Bhimphedi area are very good and good respectively.

Keywords: ***Ballast, Flakiness Index, Slake Durability Index, Los Angeles Abrasion value.***

Introduction

Railways play crucial roles in the development of many nations of the world, and Nepal Government Railway became the first to connect Amlekhganj and Raxaul across the Nepal-India border. Mechi-Mahakali Railway connects the east and west of Nepal and provides trade and transit. The network of railways will be of significant value to the country's transportation, infrastructure, regional integration, and socio-economic development. In order to build a strong railway track, lots of strength and hard rock are required.

The ballast layer is the principal component of the track, and more than 1600 m^3 and 2500 metric tons are required for one kilometer railway track. Railway ballast aggregates have different sources depending on how expensive it is to build the track. The railway track-bed material supports sleepers, disperses and distributes dynamic loads, absorbs vibrations and impact loadings, prevents lateral movement on curved sections, offers track gradient, and acts as a drainage layer.

The study area is located in Chitwan, Makwanpur and Dhading District, Bagmati Province, Central Nepal (Figure 1). The Government of Nepal is focusing on improving transport efficiency, particularly in Nepal's challenging terrain.

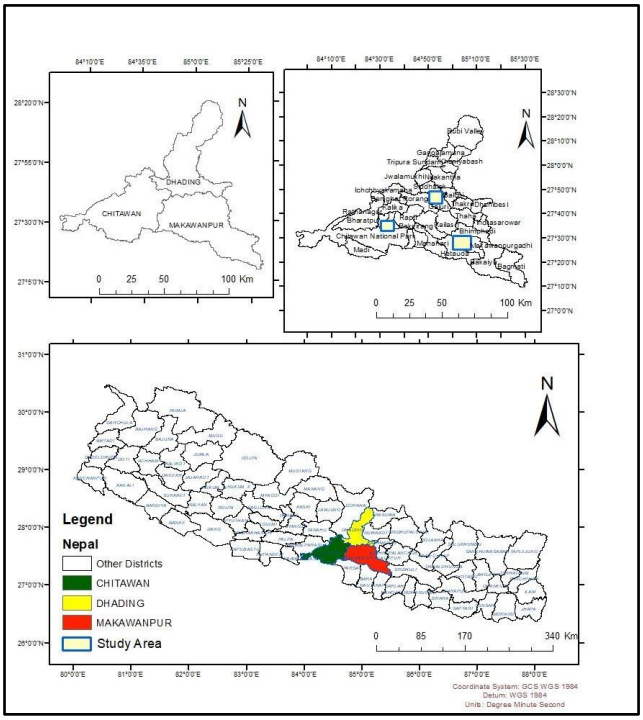

Figure 1, Location Map of Study Area.

Methodology

The research began with a detailed desk study comprising reading published and unpublished documents, field guides, geology maps, and standards such as A.S.T.M., B.S., and I.S. related to rock testing and railway ballast material. Google Earth imagery were analyzed to conclude the topography, geomorphology, and geology of the region of interest. Secondary data from the Department of Mines and Geology were also used to get acquainted with local geology and plan the fieldwork in advance.

Fieldwork was conducted in phases to record geological and engineering geological data. Reconnaissance survey demarcated the study sections, and detailed mapping and sampling on Kathmandu-Kulekhani-Hetauda and Kathmandu-Malekhu-Narayangadh road sections followed. At the field, a Brunton compass, hammer, measuring tape, and topographic maps were employed to document lithological information, quantify bedding orientations, and sample collection. About 30-40 kg of samples of quartzite were gathered from four key sites that characterize various units of quartzite: Dunga Quartzite (Figure 2) (Trikhanni and Malekhu), Fagfog Quartzite (Muglin), and Pandrang Quartzite (Pangan Gaun). Field analyses such as visual inspection (color, texture, fracture), hardness (scratch test), soundness (tapping with a hammer), and reactivity (with diluted HCl) were conducted to analyze the physical properties of the rocks.

Laboratory tests of the study included physical, strength, durability tests and petrographic analysis. The physical properties: Flakiness Index (FI), Elongation Index (EI), density, specific gravity, bulk density, and Water Absorption (WA) were determined using standard tests (ASTM C127, 2011; ASTM C535, 2016; ASTM C29/C29M-07, 2007).

Figure 2, Outcrops showing the Dunga quartzite exposed at Trikhandi temple area.

Acknowledgement

I would like to present my warmest appreciation to the Department of Geology at Tri-Chandra Multiple Campus, Associate Professor Doctor Subodh Dhakal, Associate Professor Mukunda Raj Paudel, and Assistant Lecturer Chabilal Pokhrel for their support and guidance during the research.

I also thank Tribhuvan University Central Department of Geology, Visma Consult Pvt. Ltd., NEA Geotechnical Laboratory, and Sunam Infrastucture Nirman Pvt. Ltd. Laboratory for providing necessary equipment and facilities for laboratory tests and also thanks my colleagues for their assistance and finally I expresses gratitude to my parents, brothers, and sister for their unwavering support.

Conclusion

The study takes into account the utilization of the Lesser Himalayan rocks in the Nijgadh-Hetauda-Bharatpur section of the Electrified Mechi-Mahakali Railway. The rocks are garnetiferous schist, micaceous schist, psammitic schist, quartzite, marble, phyllite, slate, and sandstone. Dunga Quartzite is a massive, milky-white quartzite that is suitable for railway ballast utilization due to it being rigid. Pandrang Quartzite, dark gray micaceous quartzite with thin sericite-chlorite schist, has a blocky texture and metallic luster. Fagfog Quartzite, quartzite with occasional intercalations of grey phyllite.

According to international standards followed, the quality of the samples is graded as good and very good for railway ballast. Recommendations are to use all quartzite units as railway ballast after no additional treatment.

References

ASTM International. (2011). ASTM C127-11: Standard test method for density, relative density (specific gravity), and absorption of coarse aggregate. ASTM International. https://doi.org/10.1520/C0127-11

ASTM International. (2007). ASTM C29/C29M-07: Standard test method for bulk density (unit weight) and voids in aggregate. ASTM International.

ASTM International. (2016). ASTM C535-16: Standard test method for resistance to degradation of large-size coarse aggregate by abrasion and impact in the Los Angeles machine. ASTM International. https://www.astm.org/Standards/C535.htm