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Evaluation of Stoping Parameters Through Instrumentation and Numerical Modelling in Manganese Mine in India: a Case Study

M.N. Bagde*, A.G. Sangode, J.C. Jhanwar

CSIR-Central Institute of Mining & Fuel Research, Nagpur Research Center, MECL Bhavan, Seminary Hills, Nagpur 440 006 India

Abstract

This paper deals with the study of stoping parameters vis-à-vis rock mass behavior in an underground manganese mine situated in central India. Strain bars are installed at various locations in the mine as part of rock mechanics instrumentation programme to monitor rock mass movement. The effect of change in stope height from 30 to 45 m with varying stope widths up to 20 m is evaluated through empirical approaches and numerical modeling. The instrumentation monitoring data is analyzed and results are corroborated with those from empirical and numerical modeling approaches. It is observed that an increase in stope height from 30 to 45 m do not adversely affect the stability of stope, cross-cuts and haulage roadway at this mine.

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Keywords: Stope height; Cut and fill stoping; Numerical modelling; Rock mechanics instrumentation; Wall Convergence Ratio (WCR) etc.

1. Introduction

In the case of manganese mine reported in this paper, haulage roadways and cross-cut drifts serve a crucial purpose of transporting blasted ore from the working stopes. The haulage roadways and cross-cut drifts are driven in the hangwall rock mass at this mine. The mine management plans to increase stope interval from 30 to 45 m between 12th Level and 13.5th Level (Fig. 1). The mine management in association with CSIR-CIMFR, India has conducted the rock mass deformation monitoring through rock mechanics instrumentation programme. The programme involves installation and monitoring of strain bars at various cross-cuts in 10th, 11th and 12th levels with a view to study the stability. The numerical modeling studies are conducted to assess the influence of various stoping parameters in terms of the strength factors, stresses and displacement developed around the stope excavation

* Corresponding author. Tel.: +91-712-2510604; fax: +91-712-2510604.
E-mail address: mn_bagde@yahoo.com; mnbagde@cimfr.res.in

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boundary. Parametric study is conducted through different numerical models to study the response of excavation geometry on the mining-induced stresses and displacements, strength factors (SF) within and around excavation boundary as well as surrounding rock mass etc. Instrumentation monitoring data is obtained and analyzed for evaluation of rock mass deformation. The results so obtained are compared with those obtained from the numerical modelling studies. The ultimate aim of this study is to achieve safer stoping environment with an increase in stope interval from 30 to 45 m to enhance production and productivity with safety.

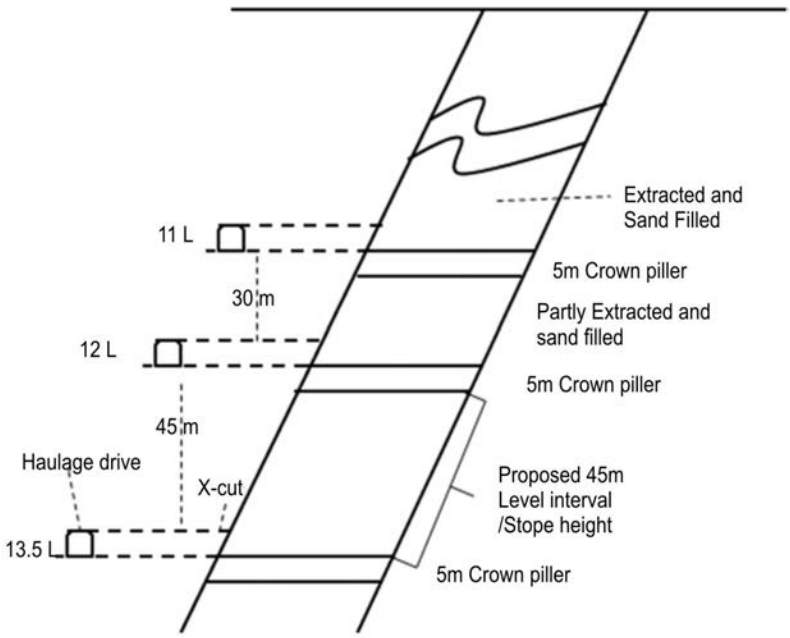

Fig. 1. Vertical cross-section showing the proposed 13.5th level with 45 m stope height planned.

2. Geo-mining details

The mine is located at Bharweli very near to the district place of Balaghat in the state of Madhya Pradesh (MP) in Central India. The Sausar Group rock traverses a large area representing Balaghat and Chhindwara districts in MP, and, Nagpur and Bhandara in the state of Maharashtra. The Sausar Group of meta-sediments extends from Balaghat district in east to Chhindwara district and has a strike length of about 210 km with a width of about 25 km. The Manganese belt of Madhya Pradesh and the adjoining parts of Maharashtra form an arcuate belt. The major structural features, which affect the mineralization in and around this mine, are as follows: over thrust, faults, recumbent folds, joints along with planar and linear structures like bedding and lineation.

Manganese ores in India are being exploited well over the past 100 yrs. These ore are mainly of secondary origin and are associated with the older Achaean meta-sedimentary. The deposits in India were originally classified as threefold, which were subsequently modified as fourfold. They are as follows:

- Syngenetic Gonditic deposits associated with highly metamorphosed Sauser Series of Rocks as in Central and Western India.
- Syngenetic reef deposits associated with the Khondalite sequences of Eastern Ghats.
- Replacement deposits in the Banded Iron Formations as in Singbhum, Karnataka and Goa regions.
- Lateritic deposits and supergene enrichments associated with all the above three.