CHAPTER 1.
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1.1 General

Presently, the trend of Indian underground coal mine is going into mechanization using continuous miner technology in Bord and Pillar working. The machine has operated in a wider gallery size up to 6.6 m due to the smooth maneuvering of the machine and fast retreating during depillaring stage. In the conventional method of mining LHD/SDL machine has been used to operate the gallery size up to 4.8 m. Primarily, the design of roof support system is done by empirical expression. The expression uses RMR, width of the gallery and roof density. It was designed for conventional mining operation. RMR has given by many researchers named as (Terzagi, 1946, Bieiawski, 1989 and Barton et al., 1974).

There are two types of support systems used in underground Bord and Pillar mining named as active and passive. Cog, chock, props fall into the category of active support, while rock bolt is a passive type, utilizing the rock strength by applying internal reinforcing stresses.

Numerous efforts were made to develop better support systems and to improve rock stability in underground working. However, for centuries, all support systems were passive. Since the first primitive slot-and-wedge type of rock bolts (active support) has used in 1927 at US metal mine (Bolstad et al., 1987). Rock bolting as a systematic method is proposed for roof support by Weigel in 1943. Rock bolting has become the most important support system in mining industry. Weigel proposed the basic concept of roof bolting as a systematic support design for a weak roof (Weigel, 1943). U.S Bureau of Mines (USBM) adopted the systematic roof bolting technology in 1947. Accidents have considerably reduced after adopting systematic roof bolting technology.

Rock bolting is more economical than other support systems used in underground mine because its installation is very easy as compared to the other. So, it saves material and manpower consumption to improve the productivity of the mine. It also reduces the hindrance for the smooth operation of machinery and manpower in the underground working as compared to other support systems used in mine.

1.2 Statement of Problem

Coal is extracted by opencast and underground mining methods. Thousands of manpower work belowground in the coal mining industries. The major accident causes in Indian coal mines are the failure of roof and side. Experience of the past reveals that roof fall is one of the predominant causes of fatalities in underground coal mines, and that trend continues even today (Mandal, et al., 1999). Strata control is a major problem affecting safety and productivity in underground mines. Experience of the past clearly brings out that roof fall is one of the predominant causes of fatalities in belowground coal mines, and that trend continues even today. There were thirteen accidents due to ground movement involving fifteen fatalities and two serious injuries during the year 2014 (as per DGMS annual report, 2014), out of which ten accidents were due to fall of roof and three accidents were due to fall of side. Roof fall accidents accounted for 17% of all fatal accidents in coal mines. It contributed 50% of all fatal accidents in belowground operations.

Rock mass rating (RMR) plays an important role in the design and selection of support systems. In India, initially, Barton’s Q-system and Bieniawski’s RMR system were tried for support design in coal measure rocks with limited success (First Indian Mining Congress & Technology Exhibition, 2005). Considering the limitations of these two systems, CMRI-ISM Geo-mechanics classifications have been developed for Indian coal mines (Venkateswarlu, et al., 1989). Furthermore, the Paul Committee, in their report in 1990, recommended CMRI-ISM classifications system for roof support density in Bord and Pillar panel. The RMR based support design is successfully implemented and observed good results in the case of conventional mining using LHD/SDL operation. The existing empirical approach for support design has been derived from field observation and is limited for gallery size up to 4.8 m. In the present practice, continuous miners are widely used in mechanized mining operations. This equipment essentially required higher gallery size for easy maneuvering. The above-mentioned reason makes it necessary for optimum support design in mechanized working.

Many researchers have been done in support design in the form of the mathematical, empirical and numerical approach. The three-dimensional numerical simulation gives a reasonable understanding to analyze the complex roof strata and bolt interaction. The numerical model indicates that the roof bolts can significantly affect the vertical stress distribution in the bolted area. So, the development of the three-dimensional roof bolt model can benefit the studies on bolt/rock interaction substantially.

So, in this study, an attempt has been made to analyze the complex behavior of an immediate roof during the development and depillaring stage for wider gallery operation. To fulfill the objective of the research, parametric study has been done using three–dimensional numerical simulation for estimating the rock load height (RLH) and axial load developed on the bolt. The study includes four variable parameters i.e., RMR, depth of working, bolt density and gallery size that play an important role in estimating the required support density during development and depillaring operation.

1.3 Organization of Thesis

- ❖ Chapter 1: Describe the introduction and statement of the problem
- ❖ Chapter 2: Presents the objective of the study.

- Chapter 3: Covers the literature part, which includes different mechanized operations in India, manner of pillar extraction, roof behaviour, approaches for the selection of the rock bolt system.
- Chapter 4: Presents a detailed discussion about the methodology used to achieve the objective of the study.
- Chapter 5: Introduces different case studies include geo – mining condition, support system used, and geo–technical instruments used in the field.
- Chapter 6: Incorporates simulation of case study and its validation using instrumented rock bolt.
- Chapter 7: Discusses numerical modelling techniques and their application. This chapter attempts to derive an idea about the detailed behaviour of roof using different bolt patterns through parametric investigation on numerical modeling. Selection of range for different input parameters affected in the simulation process.
- Chapter 8: Contains research outcomes of field and simulation investigation for qualitative and quantitative evaluation of effects of various geo – mining parameters over rock load height (RLH) during depillaring operation. Establishing a relationship based on the statistical analysis of data observed by simulated model results for required support load density in depillared area.
- Chapter 9: Includes the summary of results, conclusion of the study, and recommendation and scope of future work.