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Roof Support System in Underground and Monitoring

Kotte Chandramogili[*1], Mr. Vinay Kumar Patel[*2]
1, Post Graduate Student, Department of Mining, Bhagwant University, Ajmer, Rajasthan, India.
2, Assistant Professor, Department of Nano Technology, Bhagwant University, Ajmer, Rajasthan, India.

ABSTRACT
Field investigations were carried out over a two-year period at NCPH Colliery of S.E.C.L; R-6 Mine site for evaluation of strata behavior during extraction of coal in a 6.5 m thick seam by continuous miner at a depth of 106 m. Numerical and empirical models were also used for modification of existing support system leading to formulation of guidelines for the Strata Management. For the geomining conditions of R-6 mine, maximum of 16 mm roof convergence was observed during widening of galleries. Conventional support system of cement grouted roof bolts of 1.5 m length, 22 mm diameter at a spacing of 1.5 m between rows and 4 bolts in a row. With this conventional support system, widening of galleries up to 6 m has shown no considerable convergence but greater than 6 m wide galleries has resulted in the formation of undulated roof and floor conditions. Based on field observations including convergence of development and depillaring galleries and numerical modeling studies, the support system was modified with resin bolting so as to provide safer working conditions. The modified support system has 1.8 m long resin bolt for split galleries, 2.4 m long resin bolts for original gallery and point-anchored rebar at 1.5 m center-to-center spacing for the roof conditions of NCPH mine. Based on Numerical modeling results, the bolting was found efficient at a distance of 0.6 m from the side of the pillar and 1.5 m distance from the adjacent bolt. Although this work is based on studies carried out for the geomining conditions of the NCPH Colliery; R-6 Mine, it is believed that the findings can be applied to other shallow depth coal mines in similar geological conditions. A significant improvement in safety, productivity, and economy was observed at the NCPH Colliery R-6 Mine by adopting many of the recommendations, and strata management guidelines developed through this work.

INTRODUCTION
General A developing country like India has ever-growing thrust on faster economic development. As energy is the lifeline of all economy, India is genuinely concerned about its energy security. To meet the projected energy demands, Government has declared that fossil fuels, particularly coal, are going to be the mainstay fuel for power generation. Coal provides the single most vital input for the growth of Indian industry. It is the key Contributor to the Indian energy scenario. Out of the four major Indian fuel resources i.e. oil, natural gas, coal, and uranium, coal has the largest domestic reserve base, and the largest share of India's energy production. The most economical method of coal extraction from coal seams depends on the depth and quality of the seams, and the geology and environmental factors. Coal mining processes are differentiated by whether they operate on the surface or underground. Most of coals extracted from both surface and underground mines and it's depending on the techno-economical feasibility. These evaluation are based on the following: regional geologic

conditions; overburden characteristics; coal seam continuity, thickness, structure, quality, and depth; strength of materials above and below the seam for roof and floor conditions; topography (especially altitude and slope); climate; land ownership as it affects the availability of land for mining and access; surface drainage patterns; ground water conditions; availability of labour and materials; coal purchaser requirements in terms of tonnage, quality, and destination; and capital investment requirements. Surface mining and underground mining are the two basic methods of mining. The choice of mining method depends primarily on depth of burial, density of the overburden and thickness of the coal seam. Seams relatively close to the surface, at depths less than approximately 50 m, are usually surface mined

LITERATURE REVIEW

General Strata control is the science (some would suggest art) of utilizing various techniques to prevent or control failure of the strata around mine openings at least for the period where access is required. For different locations in the mine this period may be for the life of the mine (which can be considered as permanent), such as the main mine accesses from the surface, or for a matter of less than an hour, such as a lift off a coal pillar with a continuous miner. Strata refers to rock in all the possible forms that it may take from a high strength material to an extremely weathered, very low strength, essentially soil like material. Strata control refers to the methods applied to manage the risks associated with various forms of strata instability in underground coal mines. The aim of this aspect of strata control is to make the strata self supporting as far as possible, or if not, to minimize the extra support work required. With regard to opening size, this involves designing minimum practical widths for whatever operations are carried out and could involve modifying the design of equipment to fit into smaller openings. It is perhaps more common to install extra support to stabilize an opening that is suited to available equipment rather than design and manufacture equipment to suit the opening. It is likely that the economics of the latter alternative are seldom examined closely. Mining sequences can be designed to allow intersections to be mined across existing roadways and minimize breakaways which are always bigger excavations. Equipment still needs to be able to turn the corners however. Opening size is always going to be a compromise between a desire to minimise excavation and maximize stability versus minimizing ventilation resistance and maximizing the available work space. The height of excavations also needs to be considered – is it better initially to mine less than the final working height in a thick seam for the benefit of more stable ribs? In the event of rib failure openings effectively become wider to the depth that the failure extends into the rib. With regard to pillar design, the aim is usually to design pillars large enough to remain stable under increased vertical load caused by redistribution of the load previously carried by the extracted coal. Note that there may be several stages to this load redistribution as first and second workings are undertaken.

General

This thesis aims to be a logical design methodology for coal mine extraction optimization under competent sandstone mine roof, illustrated by a comprehensive investigation and optimization study of the NCPH Colliery, R-6 mine, a shallow underground bord and pillar mine with a massive sandstone roof. This research is intended to guide mass exploitation of Coal in the mine and other coal mines globally in efforts to develop or optimize coal extraction and address the geo-mechanical challenges presented by massive sandstone roof. The key aspects and tools required to facilitate effective site characterization, ground support design, excavation stability, pillar design, environmental risk management and mining method optimization have been presented, as part of the design methodology. The field work

for this thesis was conducted at the NCPH Colliery, R-6 mine site, Chirimiri Area, M/s S.E.C.L. between July 2010 and December 2011. Rock mechanical properties test work and produce of extensometers, convergence recorder, Load cell & stress meter for this study was conducted at the Geo-mechanics data collected at the company laboratory and CMRI. The objective of this thesis was to advance the design methods used to develop ground support systems, stable excavation spans and coal pillars and optimized coal extraction methods at shallow underground coal mines characterized by a massive sandstone roof. Current design methodologies do not give adequate treatment of sandstone roof geology in the design of safe mining conditions for coal extraction, where significant engineering design input is required to address the complexities of this category of mine roof behavior. The importance of safety risk management is also not given adequate treatment in design methodologies at a time when neglect of this issue can severely undermine the credibility of a new project proposal in same area. This thesis critiqued available design methods. It defined the geo-mechanical and working considerations important to design and then applied analytical, empirical and numerical methods to support the final design of a ground support system, coal pillars and pillar extraction method for the R-6 mine. It is hoped that this research will be particularly valuable to the R-6 mine in its efforts to develop future coal mines with massive sandstone roof conditions. 159 Furthermore, this thesis is expected to benefit coal mine projects globally where similar geotechnical, geological and environmental risks are present, yet not adequately addressed with available tools and references. This chapter will review the important conclusions and recommendations as they relate to the study questions outlined in chapter 1. Contributions to the advancement of the state-of-the-art are also presented, followed by recommendations for future work.

CONCLUSIONS

Field studies have been conducted on strata behavior with respect to convergence during extraction of coal in a thick seam (4-6.5m) by continuous miner with diagonal slicing method at NCPH colliery, R-6 mine. In this method during depillaring operation no additional support installed (except break line support) as per our existing strata control technology. But operation of depillaring in thick seam (4-6.5m) is crucial as strata management because so many other factors influencing the mechanism of stability excavated area. Such as geo-mining parameters has variable due to extraction height and width changes in sequential manner. Our studies also concluded with reference to existing support system verification for ensuring safety. Based on the results of the above mention field investigation and verification of numerical models with compare to empirical designed Roof bolt support system our study drawn following concluding remark:- • During widening of galleries, a maximum of 16mm roof convergence is observed in NCPH Mine. • Widening of galleries upto 6m has shown no considerable deformation or convergence but greater than 6m wide galleries has resulted in the formation of undulated roof and floor conditions in before modification of support system. • Before this study, there was use of quick setting cement capsule in roof bolting. Based on Field observations, it has been modified to resin bolting so as to provide safer working conditions. • Empirical estimates of support requirement for the NCPH mine roof suggest a conservative range of rock bolt lengths and pattern of support spacing, and a greater support load density and anchorage depth that have successfully been provided by the current installed ground support. 160 • The modified empirical support prediction

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