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# STUDY OF SUPPORT SYSTEM AND STRATA MONITORING INSTRUMENTS USED IN UNDER GROUND COAL MINES

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## ABSTRACT

In underground coal mines, a number of fatal accidents have been occurred due to roof fall. The roof fall mainly occurs in newly exposed working sections of coal mines during development and final extraction of coal. The main factor which contributes to the roof failure in coal mines is the re distribution of stresses and geotechnical discontinuity. If a proper support system is not provided in time the layers get detached and fall down causing major causalities in the mines. Bord and pillar method is the most widely practiced underground mining method in India.

Nevertheless about 61% of underground coal mining accidents are due to roof and side fall of bord and pillar. Design of systematic support is essential to avoid strata control problem and to provide safe working condition. The primary objective of a support system is to mobilize and conserve the inherent strength of the rock mass so that it becomes self-supporting. The system consists of various structural and non-structural elements that provide stability to the underground workings, such as roof bolts, mesh, shotcrete, and steel arches, steel props, timber props, cogs.

Rock support generally combines the effects of reinforcement, by such elements as dowels, tensioned rock bolts and cables, and support, with shotcrete, mesh and steel sets which carry loads from individual rock blocks isolated by structural discontinuities or zones of loosened rock. For study of supporting in underground mines, CMRI RMR (Central mining research institute Rock mass rating) and NGI-Q Systems are mostly used in rock engineering. Support systems are also designed with the help of numerical modelling.

Rock load at the time of development in the gallery and junction can be found out by CMRIRMR but at the time of depillaring we are using the NGI-Q system for the goaf edges and slices but calculation of NGI-Q system is very time taking. So, we would use a formula that uses CMRI-RMR system giving a result that is very similar to the NGI-Q system and provides very fast result by involving only one parameter RMR so we can find-out the resultant rock load at the time of development and depillaring frequently and easily.

## INTRODUCTION

Underground coal mining in India is predominantly carried by bord and pillar method. It contributes over 90% of the underground coal working today and is expected to prolong in future. Bord and pillar method is popular for flat deposits with thin seam, but its safety and productivity are lower than other modern methods. Roof and side falls are the major hazards in underground bord and pillar mining method in India.

The statistics show that about 61% of underground accidents are due to roof and side fall, accounting for 22% of total fatalities (DGMS Annual report, 2022). Bord and pillar method of working is carried in two stages, development and depillaring with total extraction of 50-60%. 2030% coal is recovered during development of galleries. Design of systematic support system is essential for providing safe working condition and to avoid roof and side fall accident.

The main cause of roof failure in coal mines is generally due to the occurrence of geological discontinuities. The accident due to roof fall constitutes the major challenges faced by field engineer. Thus, proper care should be taken to increase the stability of workings by characterizing the roof fall also execution of proper plan to arrest the movement of layered strata which are liable to fall when the stresses act upon them.

Rock mass classification systems have constituted an integral part of empirical mine design for over 100 years. An important contribution of the RMR is that the system has stimulated the development of a plethora of more specialized system of ground evaluation particularly in mining application. They provide guidelines for stability assessment and also to select appropriate support system. Roof fall generally takes place due to detachment of lower strata since the process of redistribution of stresses takes place around the excavation made. Thus, proper support design for mine openings is considered as a major factor in stability of the roof strata.

The design of support for underground excavations has been described as art as well as science. The design process in rock excavation is considered to be a tedious job due to lack of control over geological and stressed conditions. A research work was carried out is to obtain an optimum and advanced Rock Mass Rating system for underground coal mine. As in situ rock exhibits DIANE behavior (discontinuous, inhomogeneous, anisotropic, and non-linearly elastic) and using the laboratory resulted factors like Uniaxial Compressive Strength and that to at small scale (sample) oversights our estimation.

The estimation of rock load on strata and its distribution over the underground mine working is very important. We are using CMRI- RMR and NGI-Q system for the calculation of strata pressure at the exposed area of underground mine and after calculation of strata pressure we design the support system to estimate the proper economic and safe support.

But in this project, we would only use the CMRI-RMR system to calculate the strata pressure at the different place of mine in development as well as in the depillaring area by using different formula. It will give a very fast and easy calculation so that we can design the support most safely at the danger zone without waiting of the NGI-Q system.

**OBJECTIVE**

Roof and side falls are the major hazards in underground bord and pillar mining method in India. The complexity of geological deposit and variability of mining parameters leads to the occurrences of unwanted roof falls. Bord and pillar method of working is carried in two stages, development and depillaring with total extraction of 5060%. The work carried out by many researchers has been reviewed and their inferences are shown below

Singh et al. (2005): Bord and pillar mining is very much in practice in Indian underground coal mines. Basically, two empirical methods; CMRI-RMR for design of supports during development and Q-System for design of supports during depillaring are being used in India. The supports include full column grouted bolts, props and chocks.

Maiti et al. (2006): Information on magnitude and direction of in-situ and induced stress is critical for safe design of underground workings. Numerical modeling is the preeminent advancement for solving and understanding strata control problems.

Cambulat (2008): Though roof bolting is prominent in use, the roof falls and strata control poses a major challenge. This is due to inherent uncertainties in rock mass and support elements which are not considered in design methodologies.

Palei and Das (2008): Calculation of support safety factor is important for support planning and design of underground coal mines for prediction of roof fall. The study infers that the gallery width is ranked as the first parameter to control the support factor of safety.

Maiti and Khanzode (2009): A relative risk model for roof and side fall accidents was developed by using log linear analysis of two-way contingency table. The application reveals that effectiveness of safety measures across different locations in underground mines varies and focuses mainly in workplaces such as face.

Das et al. (2009): Their work predicts the severity of roof fall accidents. Their work inferred that unsupported or partially supported roofs are more prone to major as well as serious accidents and deep workings have higher risk of major accidents than the shallow workings.

Cambulat (2010): Advanced roof support design based on stochastic modeling technique ensures greater stability of roadways. The input parameters of stochastic modeling are taken as probability distribution rather than single values.

Kushwaha et al. (2010): A comprehensive guideline is developed for depillaring considering split and slice width, rock characterization, depth cover and in-situ stresses. Vibrating wire stress meters and strain gauged rock bolts were proven beneficial for their study in strata behavior and to make the decision of the amount of support to be provided.

Singh et al. (2011): Strong and massive roof strata provide stability c development but poses more problems during depillaring. The problem is more deep workings.

Singh et al.(2011): The assessment of stability of the three basic mining structures, i.e., pillar, roof strata, applied supports at different stages of an underground coal mining is important for optimization of safety and recovery is inferred from the study.

Singh et al. (2011): The in-situ and mining induced stresses has a greater impact on performance of bord and pillar mining. The in-situ stresses are generally static in nature whereas mining induced stress vary over pillar and are highly influenced by strata dynamics during different stage of extraction.

Jayanthu et al.(2012): Reexamination and modification of the norm for design of SSR in development is needed with consideration of life of the roadway. Understanding the strata behavior at critical stages of roof fall is required besides approaches for design of strata control techniques. Instrumentation is required for continuous monitoring of strata behavior in provisions of convergence of openings and stress over pillars and stooks in advance of the extraction line. Formulation of Strata Control Cell for designing Systematic Support Rule (SSR) and monitoring strata control measures in a scientific way is necessary to ensure efficiency.

**STRATA CONTROL AND MONITORING PLAN (SCAMP) REGULATION NO.123**

(1) (a) The owner, agent and manager of every mine shall prepare, formulate and implement a Strata Control and Monitoring Plan (SCAMP) based on scientific study considering the geotechnical data, information and the method of development and extraction of coal or the excavation required therefrom, which also includes a support plan to secure the roof and sides of belowground workplaces, and shall be subject to revision with change in condition, for all workings belowground.

(b) The owner, agent and manager shall submit a copy of the Strata Control and Monitoring Plan (SCAMP) to the Regional Inspector who may, at any time by an order in writing, require such modification as he may specify therein.

(2) The owner, agent and manager of every mine having workings below ground shall, before commencing any operation, frame, in consonance with the Strata Control and Monitoring Plan framed under sub-regulation (1) and with due regard to the engineering classification of strata, local geological conditions, system of work, mechanization, and past experience, and enforce the support plan specifying in relation to each working place the type and specifications of supports and their intervals:

Provided that in respect of a mine where development operations are already in progress, the support plan shall be framed and enforced within thirty days of the date of coming into force of these regulations.

(3) The manager shall, at least thirty days before the commencement of any operation, submit a copy of the support plan framed under sub-regulation (2) to the Regional Inspector who may at any time, by an order in writing, require such modification in the plan as he may specify therein.

(4) The Manager shall hand over copies of the support plan framed under sub-regulation (1) and (2), in English as well as in a local language understood by majority of the persons employed in the mine, together with illustrative sketches, to all supervisory officials concerned including the assistant manager and shall also post such copies at all conspicuous places in the mine.

## CONCLUSION

1. Design of effective systematic support is essential for control of strata and to provide safe working conditions. The roof strata condition of 79 panel of 3 seam Kalyanikhani 5 incline was having the Q value of 11.125.

2. Design of systematic support by empirical approach yielded the following conclusions

Factor of safety for splits =1.95

Factor of safety In slices =2.76

Factor of safety of supports at goaf edges in slices-6.29

3. According to the factor of safety obtained from analysis mostly roof bolting with length of 1.8m long full column grouted bolts placed at 1.5x1.5 grid pattern

4. Additional supports are used in the junction with 4 corner cogs which are supported with

4sides prop

5. Roof bolts of 2.4m length can be used instead of 1.8 in the gallery for providing 25% extra support

## REFERENCE

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