Journal of Thermal and Fluid Science
Volume 4, Issue 2, September 2023, pp 62 - 65
https://doi.org/10.26706/jtfs.4.2.20230904

Strata Control in Mining: A Study of Strata Control in an UG Coal Mine

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Article – Peer Reviewed
Received: 20 June 2023
Accepted: 20 August 2023
Published: 20 September 2023

Cite this article: Chandrashekhar Pathak, Prashant Borkar, Pralay Meshram, Kiran Chavan, "Strata control in mining: A Study of strata control in an ug coal mine ", *Journal of Thermal and Fluid Science*, RAME Publishers, vol. 4, issue 2, pp. 62-65, 2023.
https://doi.org/10.26706/jtfs.4.2.20230904

Abstract— Strata control is a significant issue while mining for underground coal and requires specific consideration. The leading cause of fatal accidents in underground coal mines is still strata control-related mishaps like roof and side falls. Between the development and depillaring phases of underground coal mining, when the pillars are extracted, or when the natural support is removed, the primary threat occurs. The coal mining sector faces a significant problem in properly managing safety concerns during depillaring. Due to the circumstances during depillaring, the stratum control parameters must be continually checked and monitored using increasingly sophisticated and advanced instrumental technology. To ensure the safety of the workers and the workings, strata control studies during depillaring provide information about impending abnormal or hazardous conditions/situations in mine workings, such as roof collapse, mining stress, sole, column/support/rib failure, support yield/failure, etc. The effectiveness of the stratum control research programme during depillaring depends on careful planning, the installation of trustworthy ground movement sensors with a continuous data collecting system, the generation of adequate data, and proper and prompt data interpretation. This essay discusses the necessity of strata control studies, particularly during depillaring, the riskiest step in underground coal mining, as well as other strata control study concerns, such as the parameters to be measured, the types of sensors to be utilised, and the nature of instrumentation and monitoring.

Keywords—RMR, strata control, underground mining, rock load, support density, factor of safety

1. Introduction

Generally speaking, "strata control" connects with managing stratum to preserve a stabilized mine opening or galleries and entrances of underground where mining activities are happening or going to happen in near future [1].

However, stratum management within the goaf is typically of no interest. The need to control layering could include the void area, essentially to the Goaf limit, for a brief distance. The removal of natural support, such as the removal of a pillar during a depillaring operation or the construction of a sizable void during longwall work, caused the nether roof, load, and surface to become unstable, compromising the safety of the employees, the workings, and surface features. Therefore, it is crucial to calculate the support density, rock load, and safety factor in order to stabilize the strata and ensure that people and machinery can operate them safely during the coal mining process [2-5].

The objective of the study is,

a) To study the strata control and management plan in underground coal mine.

b) To calculate the rock load, support density and factor of safety for making of strata control and management plan for the mine gallery and face.

2. Literature Review

Mining sequences can be created to minimise breakaways, which are always deeper excavations, and allow junctions to be mined across existing roads. However, machinery still needs to be able to turn the corners. A balance must always be made between the goals of minimising excavation and maximising stability and maximising work space while minimising ventilation resistance. The height of excavations must also be taken into account; is it preferable to mine beneath the thick seam's final operational height as well in order to produce ribs that are more stable. Openings effectively widen up to the rib's thickness Failure involves as well it in the event of rib failure. When it comes to pillars layout, the goal is often to create coal pillars that are adequate to stay consistent despite an increase in vertical load brought on by the redistribution of the load that the mined coal formerly carried [5-8].

Today, practically every mine uses strata reinforcement to some degree, most frequently in the form of roof bolts. Split Ended Steel rods and a wedge of steel material used inside the holes were the earliest type of roof bolts. The rod was put into a hole that had already been drilled through the roof, and it was pounded into place so that the pointed end pushed the steel rod to grab the hole's tightly. When identical rods were put across and along a roadway and A threaded nut was torqued into a washer plate and a steel plate was put onto the surface of the roof to exert some amount of tensional force, the immediate roof stratum beds were clasped together to create a stronger beam. After increasing the bolting pattern density, the roof became self-supporting [9-11].

The split and wedge bolts subsequently substituted with better roof bolt anchoring techniques that used cartridges of fast-setting, two-part epoxy, the blended resin as the spinning bolt was pushed into the hole. Despite the fact that tensional force was used during setting up, there was a lot of mobility. took place before the bolts fully became efficient since they were first attached at the bolt's end (referred to as "point anchor bolts"). Full column anchors—also known as "full column anchors"), which currently exists invariably employed for the initial roof bolting, were discovered to produce better results when utilised to entirely fill the hole bored safeguard the bolt in the roof throughout its total length [12-14]

Factors that affect that the strata movement are design factor and inherent properties of rock. Design factors include roof span, shape of coal pillar, dimension of coal pillar etc. while inherent properties of rock include physco-mechanical properties, density, dynamic properties. Other factors are natural factors that water seepage, geological disturbances [15,16].

Therefore the support are designed for any underground excavaction are on the basis of Rock Mass Rating (RMR), rock load and support density.

The expected rock load is calculated using the roof strata's RMR and the empirical equation :

Rock load = B x D (1.7 -0.037 x RMR + 0.0002 x RMR^2) where B is the width of galleries/splits, D is the average rock density

While the support density can be calculated as:

S=(No. of bolts or props in a row * Grouted roof bolt capacity) / (Width of the slice * Spacing between two rows)

And the factor of safety can be calculated by on the basis of rock load and support density

For the empanelment of strata control and monitoring plan the following points are to be consider:

1. Scope & applicability
2. Geological technical data
3. Support plan under reg. 123 of the coal mines regulation, 2017
4. Support of the junction including those immediately outbye of development face
5. Support of ledges / sides / fault planes / overhangs / slips/ other geological disturbances/ etc

6. parameters for the design of roof bolt
7. Installation of roof bolts
8. Measurment of roof bolt/rope stitching performance
9. Monitering of strata behaviour
10. Equipment & material used for support
11. Monitoring of support performances
12. Measurement of strata behavior
13. Resetting of supports
14. Provision of temporary support
15. Replacement of old support
16. Withdrawal of support
17. Cleaning of falls of ground
18. Maintenance of record

There is an evident indicator when conventional free standing support, such as props, bears extreme weight; the bigger the load, more severe deformation occurs. Roof bolts, on the other hand, provide no outward evidence of load increase and thus no indication of how close the specific bolts or the entire system are to eventual failure. The Tell tale extensometer will detect any unstable tendencies in the strata so that management can take corrective action as soon as possible.

Extensometer is stratum - tell tale. It provides a forewarning of a roof collapse. The dual-height tell tale delivers a clear warning right away, differentiating from movement both above and below the rock-bolted height.

3. Data Collections

To achieve the set objectives, an underground coal mine located at Nagpur region is chosen. The following details are collected from the mine:

i. Name of Seam: Seam V
ii. Thickness of the Seam: 3.0 to 4.6m
iii. Roof rock Shale & Sand Stone
iv. Floor rock Sand Stone
v. RMR 31.5
vi. Pillar Size 25m X 25m
vii. Gallery Size 3.6m X 2.5 m
viii. Density of Rock 2.22 t / m2

4. Result And Discussion

Calculation for Support Plan of 11LE Dev. Dist. in Seam with Gallery Width size of 3.6 m: -

1. Rock Load = rock density x gallery width (1.7 – 0.037 RMR + 0.0002 RMR^2)
   = 2.22 X 3.6 (1.7 – 0.037 x 31.5 + 0.0002 x 31.52) = 5.86 t/m^2
2. Support Density = (load bearing capacity of each bolt x no. of bolts) / (Span of gallery x row spacing)
   = (12 x 3) / (3.6 x 1.2) = 8.33 t/m^2
3. Factor of Safety = support density/ Rock load
   = 8.33/ 5.86 = 1.42

5. Conclusion

i. Strata control and monitoring plan is a very critical and important factor to study in an underground mine.
ii. The factor of safety determined using rock load and support density is quite good.
iii. Use of dual height tell-tale or any other strata monitoring equipment is essential for early detection of strata in a scientific manner
iv. Strata control equipment’s must be used as prescribed in strata management and monitoring strategy or as per the guidelines prescribed by the DGMS.

Acknowledgment

The authors wish to thank the professors and the HOD of Department of Mining engineering, G.H. Raisoni University Saikheda.

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