STUDY OF SUPPORT SYSTEM IN BOARD AND PILLAR METHOD OF MINING

D. VISHNU VARDHAN REDDY[1], Y. SAINATH REDDY[2], D. TANUJ RAVI KIRAN REDDY[3], D. RAMU VENKATA DURGA REDDY[4]

GIET COLLEGE, RAJAHMUNDRY

*[5]Guide: **Niraj Kumar**, Dept. of Mining Engineering, GIET College, ANDHRA PRADESH, INDIA*

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Abstract

In Support system the stability of the workings carried by supports of different types and capacities. These approaches can be followed for many mines and the performance of the support system can be monitored with load cells, and the models can be calibrated accordingly. This will improve the dependability and applicability of the numerical models as a solution for design of support system

For study of supporting in underground mines, CMRI-RMR 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 CMRI-RMR 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.

***Key Words*: NGI- (0r) Q- SYSTEM, ROCK MASS RATING (RMR), CMRI**

1 .INTRODUCTION

For stability of any excavation, design of support is very essential. A very common practice in underground is to make estimation of rock load from the strata and its distribution over the underground mine workings is of prime importance. In Indian coalmines,[2] CMRI- RMR and NGI-Q Systems are mostly used for formulating design of support in rock engineering. Support systems are also designed with the help of numerical modelling

The primary objective of a support system is to improve and conserve the inherent strength of the rock strata so that it becomes self-supporting. Rock support generally combines the effects of reinforcement,[4] by such elements as, tensioned rock bolts and cable , and support with shot-Crete, mesh and steel sets which carry loads from individual rock blocks isolated by structural discontinuities or zones of loosened rock. The choice of the type of support installed in a particular underground excavation depends upon the extent of the zone of loosened or fractured rock surrounding that excavation.

2. METHODOLOGY

Calculation of support resistance for Trunk roads and Split levels based on RMR:

The support requirements for drivage of Gate roads and Split levels are estimated based on RMR method.

1. Calculation for estimation of Rock Load:

Expected rock load (P) in tones/m^2 is estimated by using the following empirical formula

$P = W \times \gamma \times (1.7 - 0.037\ RMR + 0.0002\ RMR^{2)}$

Where W = Span of the gallery in meters

γ = mean rock density in t/m^3

RMR = Rock Mass Rating.

2. Bolt Capacity

Bolt Capacity is taken as 18 T in case of 2.4 m length bolt, 12 T in case of 1.8m length bolt and 10 T in case of 1.2m length bolt.

3. Support resistance is estimated as follows:

Generally Support Resistance is calculated based on

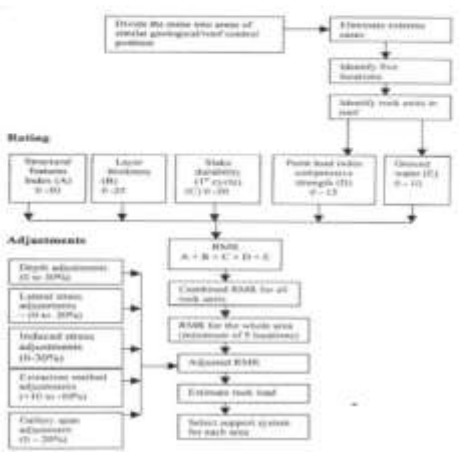


FIG-1: Flow sheets for deriving RMR

The following formula.

Support Resistance = Support Density

Area supported by one row of support

4. Factor of safety is estimated as follows:

F.S = Support resistance

Rock load

2.1SUPPORT SYSTEM

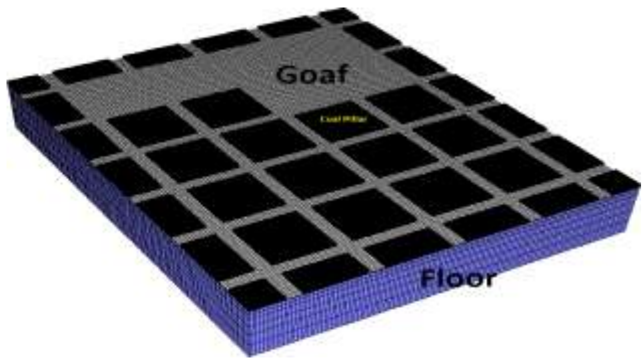
- For the support of roof , roof bolts are used which is used to bind the coal to hard rock
- For side support , glass reinforced fiber plastic bolts are used which can be cut by continuous miner whose picks are made up of tungsten carbide which will be damaged by iron bolts
- If height of the gallery is more than 3.5mthan 3bolts are used otherwise 2 bolts are used in staggering position.
- Length of iron bolts and rigid bolts are 1.8 or 2.4m depending on the location and diameter is 22m
- At junction higher stress are there so more bolts used
- Capacity of rigid bolts are 6 tones
- Tiscog is used in junction in development whose base is iron and top is wooden sleeper

3 .Mechanism of Roof Bolting

Suspension mechanism

Suspension mechanism (Figure15) is the most easily understood roof bolting mechanism. While the majority of roof bolts used are resin point anchors, mechanical anchors are also uncommonly used (2percent only, Henson,2005).Thedesignofroofboltsystemsbasedon thesuspensionprinciplehastosatisfy

3.1. Support Design during Depillaring Operation in Bord and Pillar Panel Using Numerical



Simulation Method:

In an underground coal mine, most successful and economical approach to support the underground structure is roof bolting technology. The most preferred method of working in Indian coal mine is Bord and Pillar. It has been observed from the past histories that, the maximum number of accidents happens duringdepillaringoperation.Inthispaper,theprimary focusistounderstandandanalysetheroofbehavior with roof bolting system in underground coal mine using numerical simulation approach. A three-dimensional (3D) model of the depillaring panel with support design using roof bolt technology is complicated to simulate.

Therefore, the simulation is done near the goaf edge, where maximum chances of roof failure have beenobserved.Onanotherword,itcansaythatsimulati onisdonebeforethemainfall.Anelasto–plastic model has been taken for study considering physio – mechanical properties, geo - mining condition, roof bolt and grout properties as an input parameter. A case of a depillaring panel of underground coal mine has been chosen for study.

Numerical modelling Methodology*:*

Ithasbeenobservedbyfieldobservationandnumericals imulationthattheinducedstressonthepillar increases with the advancement of goaf. In the case of depillaring operation, three – dimensional simulation of the whole panel with rock bolting is complicated because it has taken 353 more computational time to solve. So, to overcome such problem, an analogy has been developed to replicate three-dimensional depillaring panel into a three-dimension section of the panel. The three – dimension sectional view of the panel is shown in the Fig.30. The plan view of the area, where the study has been carried out near goaf edge as shown in Fig. 31. Three – dimensional discretizational view of the model

Field assessment for Roof Bolting System:

Mostfieldassessmentsinvolvemeasuringtheforcepro filealongtheboltsothatacompleteloadtransfer historyduringdifferentminingstagesisdeterminedan dtheperformanceoftheroofboltscanbeevaluated.

Pullouttest-

Thepullouttestisapopulartechniquefortestingtheres istanceofthebolttoaxiallyapplied downward load. The pull out test is considered a valuable test for the fully-grouted roof bolt to test the bond strength between bolt, resin and hole. The tested bolt is installed in the same way and by the same material as its intended use. The bolt is pulled out hydraulically and the displacement at the bolt head is measured at each pre-determined step of load. The bolt is pulled until the bond with the rock fails. From a plot of load verses displacement the ultimate capacity for the bolt can be determined (Figure41).

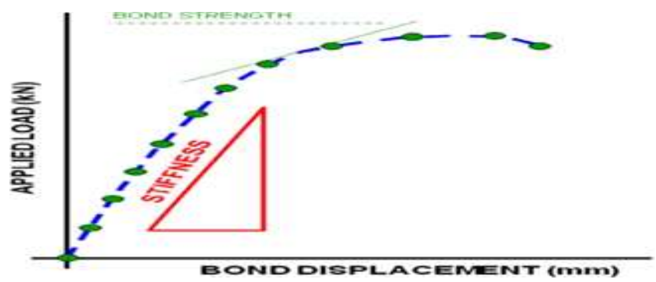
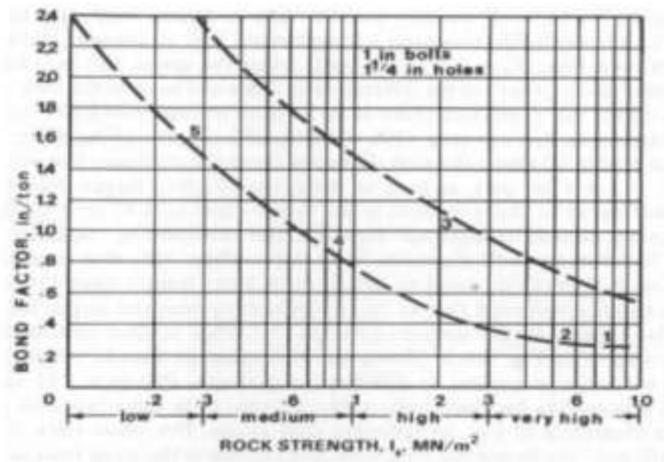


Fig.40. Typical pull-out test results showing "yield point"

Franklin and Woodsfield (1971) conducted pull-out tests on polyester resin anchors installed on different rock types with different strengths such as granite, coal, limestone, chalk… etc. They developed the followingrelationshipbetweentherequiredbondleng thandrocktype,sothat,thestrengthofresinanchor could be adjusted to suit the rock strength by using varying amount of resin:

BL = (BF x L)+ SF

Where BL is the length of bond needed to give less than 5% anchor failures at the design load; L is the required anchor strength; SF is the safety factor, 6 inches in strong rock and 12 inches in weak rock; and BF is the bond factor that can be obtained from Figure below



4. CONCLUSIONS

Based on the critical review and application of various approaches for designing of support system for development and depillaring workings of underground coal mines with a case study, the following are the conclusions and recommendations:

Design of effective systematic support is essential for control of the strata and to provide safe working condition. The roof strata condition of 3AS-5 panel of 3A seam was categorized as fair, as its RMR was 52 Design of systematic support by empirical approach yielded the following conclusions: Factor of safety of galleries, junctions, slices and goaf edges was calculated to be 2.02, 2.33, 1.75 and 1.39 respectively.

- The numeric modeling results were compared and validated with field monitoring data and following conclusions were drawn: Maximum cumulative convergence recorded in the field monitoring was 48mm, when the gallery was at the goaf edge. Results obtained from numerical modeling after implementation of the designed systematic support shows maximum convergence of 58mm in the gallery at the goaf edge.

- Continuous increasing trend of the rate of convergence in the field is an indicator of impending major fall.

- Since the model is practically validated with field results, it can be used to predict the strata behavior of the working in advance.

- Empirical estimates of support requirement for the GDK NO11 INCLINE 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.

- The modified empirical support predictions prescribe 1.8 m for split and 2.4 m long roof bolts for original gallery and point-anchored rebar on 1.5 m centre-to-centre spacing, a design well suited to the roof conditions in GDK NO11 INCLINE mine of S.C.C.L.

- Resin roof bolts are finding more useful applications in underground coal mines, particularly un- tensioned, forged headed rebar, with lengths of 1.5m being the most accepted. Based on Numerical modeling results, the bolting was found efficient at a distance of 0.6m from the side of the pillar and 1.2m distance from the adjacent bolt.

- This thesis 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

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BIOGRAPHIES

D. VISHNU VARDHAN REDDY
STUDET OF MINING ENGG
MINING DEPARTMENT
GIET COLLEGE
RAJAHMUNDRY

D. TANUJ RAVI KIRAN REDDY
STUDET OF MINING ENGG
MINING DEPARTMENT
GIET COLLEGE
RAJAHMUNDRY

Y. SAINATH REDDY
STUDET OF MINING ENGG
MINING DEPARTMENT
GIET COLLEGE
RAJAHMUNDRY

D. RAMU VENKATA DURGA REDDY
STUDET OF MINING ENGG
MINING DEPARTMENT
GIET COLLEGE
RAJAHMUNDRY