JUNCTION C2 ROOF RATING BY USING CMRR 2009

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ABSTRACT

CMRR is the most applicable method to assess rock behavior and determine rock fall quality in coal mines The data required for the CMRR can be determined either from underground exposures such as roof falls and overcasts, or from exploratory drill core. In either case, the main parameters measured are.

1. The uniaxial compressive strength (UCS)

2. The intensity (spacing and persistence).

3. The shear strength (cohesion and roughness).

4. The moisture sensitivity of the rock.

5. The presence of a strong bed in the bolted interval.

The objective of this study is determined of Tabas coal mine No: 1 roof rating with CMRR. Tabas Coal Mine No: 1 is located a remote rugged desert environment approximately 75 Km south of oasis town of Tabas in Yazd province in mid eastern of Iran. The thickness of coal seam is about 2.0 m which is mined using longwall method. The underground exposures are used to classify mine roof. The results are used in CMRR 2009 and CMRR= 55 are calculated, with adjustment the CMRR will be 48. Therefore, it can be said that Tabas coal mine roof is classified as moderate roof.

Keywords: CMRR, UCS, Longwall

چکیده

پر کاربردترین روش برای ارزیابی رفتار و تعیین قابلیت تخریب سنگ در معادن زغال سنگ، روش *CMRR* می باشد که اطلاعات مورد نیاز در روش *CMRR* توسط فضاهایی که در زیرزمین در معرض دید قرار دارند و یا از طریق مغزه های اکتشافی می تواند جمع آوری شود.

در هر دو حالت پارامترهای مهم مورد اندازه گیری عبارتند از :

۱- مقاومت فشاری تک محوره سنگ بکر

۲- شدت (فاصله داری و تداوم) لایه بندی و سایر ناپیوستگی ها

۳- مقاومت برشی (چسبندگی و زبری) سطوح لایه بندی و سایر ناپیوستگی ها

۴- حساسیت سنگ نسبت به رطوبت

۵- وجود یک لایه مقاوم در فاصله پیچ سنگ گذاری شده

هدف از این تحقیق طبقه بندی سقف تقاطع C_2 معدن شماره یک معدن زغال سنگ طبس می باشد. معدن شماره یک معادن زغال سنگ پروده طبس در ۷۵ کیلومتری شهرستان طبس استان یزد واقع شده است. لایه مورد استخراج در این معدن لایه C_1 به ضخامت ۲ متر می باشد که به روش جبهه کار طولانی استخراج می گردد. اطلاعات مورد نیاز جهت محاسبه *CMRR* از فضاهای باز زیر زمینی جمع آوری شده است و داده ها توسط نرم افزار *CMRR 2009* مورد تحلیل قرار گرفته و در نتیجه *CMRR*=۵۵ و با در نظر گرفتن تعدیلات *CMRR* =۴۸ محاسبه شده است. بنابراین سقف تقاطع C_2 معدن شماره یک در ردیف سقفهای ضعیف بشماره می رود.

کلمات کلیدی: UCS، CMRR و جبهه کار طولانی

1. INTRODUCTION

Tabas Coalfield has 30000 Km^2 area which includes for districts namely Parvadeh, Nayband, Mazinoo and Abdooghi. Central Mine is located in the Parvadeh Coalfield. Parvadeh has 1200 Km^2 area and located at 75 Km for from tabas town. Parvadeh is divided in to five zones namely Parvadeh 1,2,3,4 and Parvadeh East. [10] The Coal Parvadeh bearing sequence is of Triassic age, and the coals associated

mostly with mudstone, with coarsening up to siltstone/ sandstone sequences. Localized thin marine limestone also occurs in the area. [11] The coal seam on the parvadeh 1 district are B1, B2, C1, C2 & D. Seam C1 is the most attractive seam in this area. It has a thickness if close to 2.0 m which is mined using long wall method. Roof and floor conditions are moderate to good, and the seam is largely without stone bands. [12]

2. Data Collection and Classification

The data required for the CMRR can be determined either from underground exposures such as roof falls and overcasts, or from exploratory drill core. In either case, the main parameters measured are:

1- The uniaxial compressive strength (UCS) of the intact rock.

2- The intensity (spacing and persistence) of bedding and other discontinuities.

3- The shear strength (cohesion and roughness) of bedding and other discontinuities.

4- The moisture sensitivity of the rock, and;

5- The presence of a strong bed in the in the bolted interval.

Other, secondary, factors include the number of layers, the presence of groundwater, and surcharge from overlying weak beds. [1]

The CMRR is calculated in a two- step process. First, the mine roof is divided in to lithologic/ structural unit Ratings are determined for each. When using underground data, the equation for calculating the Unit rating is:

Unit Rating = UCS Rating + Discontinuity Intensity Rating + Discontinuity Shear Strength Rating + Multiple Discontinuity Adjustment + Moisture Sensitivity Deduction. [2]

For drill core data, the equation is even simpler:

***Unit Rating = UCS Rating + Discontinuity Rating + Moisture Sensitivity Deduction.** [1]*

Once the Unit rating has been determined, the CMRR is calculated by averaging all the unit ratings within the bolted interval (with the contribution of each unit weighted by its thickness) and applying appropriate adjustment factors. This second step is the same regardless of whether the Unit rating was from data collected underground or from core. Figure 1 illustrates the process. [22]

3. Unit Compressive Strength

The UCS of the rock material affects roof strength in several ways. First, it determines the ease with which new fracturing (as opposed to movement along pre-existing discontinuities) will take place. Second, the compressive strength of the rock is a factor in the shear strength of discontinuities. Approximately twice the weight given to the UCS in the original RMR. [17] Laboratory testing is generally considered the standard method of determining the UCS. Unfortunately, laboratory in the results is also high, with the standard deviation typically about one- third of the mean for coal measure rocks.

4. Discontinuity Intensity (Spacing and Persistence)

Intensity is determined by the spacing between bedding planes or other Discontinuities, and the persistence, or extent, of each individual discontinuity. The more closely spaced a set of discontinuities, the greater weakening effect it has on the rock mass. Persistence is more important for discontinuities that widely spaced. Like UCS, Intensity accounts for about 1/3 of the total CMRR. [22] Underground, both spacing and persistence can be measured, using the standard methods for rock mass characterization (ISRM, 1982). Table 1 shows the Bedding/ Discontinuity Rating Scale for underground data. The matrix shows what point value is added for each combination of spacing and persistence of discontinuities. [21]

5. Discontinuity Spacing Rating

Bedding plan shear strength is a critical parameter for coal mine ground control, because the more severe loading applied to coal mine roof is normally lateral, caused by horizontal stress. Molinda and Mark (1996) found that the lateral strength of some shales are just one-sixth of their axial strength. Two common examples are weak laminations in shale and thinly interceded sandstone and shale (stack rock). In both examples, it is not just that the bedding planes are closely spaced, but also that the bedding surfaces are very weak. [4, 6] Underground, the cohesion of bedding surfaces is evaluated by using a 3.5 in (9 cm) mason chisel and a hammer to split hand samples of rock. Weaker, less cohesive surfaces require fewer chisel blows to split. Cohesion can also be estimated by observing the nature of the fractured wall of a roof fall. [7] The roughness along a discontinuity surface is the other component if the surface's shear strength. In the CMRR, roughness of a surface is estimated visually and classified in to "jagged", "wavy", or "planar" using the system proposed by Barton (1974). This measure is to be applied on a scale which ranges from hand sample size to several feet across a fall exposure. The CMRR assumes that roughness significantly affects shear strength only when cohesion is in the middle range. [4]

6. OTHER MODIFICATION THE CMRR

6.1. Moisture Sensitivity Deduction

Moisture Sensitivity can affect roof stability in several ways. The rock itself may weakened, or may slake or sought. In extreme cases, rock may disintegrate completely and turn to mud when exposed to grounder water. Clay mineral also expands, causing swelling pressures in the roof. In the original CMRR, the maximum deduction for moisture sensitivity was 25 points. In practice, this deduction proved to be too large. The new maximum deduction is 15 points the moisture sensitivity ratings then determined using table 3. If immersion results are not available, moisture sensitivity can sometimes be estimated visually in underground exposures. [15] Usually, some time is required for contact with humid mine air to affect rock strength. In short-term application, there, it may not be appropriate to apply the moisture sensitivity deduction. The CMRR program now reports both the Unit rating and the CMRR with and without the moisture sensitivity deduction. [16]

6.2. Relationship between Immersion and Slake Durability Tests

The CMRR employ the simple immersion test to measure moisture sensitivity. While numerous other tests have been proposed, the closest thing a standard moisture sensitivity index is probably the Slake Durability Test (SDT). Hock recommended the SDT as a basic geotechnical test, ISRM standard procedures have been developed for it, and it is an integral part of Bieniawski`s Rock Mass Rating (RMR). [18, 19] The SDT is intended for use in establishing the rate of breakdown in a rock mass in which stability is suspected to very with time. To perform the test, 10 lumps of rock, each weighing about 0.1 lbs, are oven dried, weighted, and then rotated through a water bath for 10 minutes. The repeated wetting and drying, together with the mild abrasion that takes place during the test, causes moisture sensitive rocks to break down. The slake durability index is the final dry weight of the sample expressed as a percentage of the original dry weight.

Research was conducted to explore the relationship between the SDT and the immersion test. Rock samples were collected underground from a variety of mine setting, carefully wrapped to maintain in situ moisture content, and tested in the laboratory. A total of 96 tests were run on 16 distinct rock types 9 mines. The result shown in figure 2. Table 4 indicates how the results from either test can be used for input to the CMRR. [9, 18] From the testing conducted to date, there is a good correlation between the two tests for the Not Sensitivity and Slightly Sensitivity classes. The correlation is less reliable for distinguishing "moderately sensitivity" rocks from "Severely Sensitivity" rocks. [16]

6.3. Relation between Ball Peen Hammer Test and UCS/Axial PLT

The Ball Peen Hammer Test, originally proposed by Williamson, has been the CMRR standard test for underground data collection. Mark and Molinda compared results for both tests, and found a good correlation. In that comparison, however, the PLT results were converted to UCS using the Vallejo conversion factors. Figure 6 shows the comparison between the two tests, using an expanded data set and converting the PLT data UCS with K=21. In 17 of the total of 21 pairs (or 81% of the cases), the difference between the two measurements was 4 points or less. To account for the changed K, the original Willamson rock classes have been slightly adjusted, as shown in table 3. [3]

6.4. Strong Bed Adjustment

One of the most important concepts in the CMRR is that the strongest bed within the bolted interval often determines the performance of mine roof. The strong bed adjustment (SBADJ) in the CMRR depends upon:

- The Strong Bed Difference (SBD), which is the difference between the strong bed's Unit Rating and the thickness- weighted average of all the Unit Rating within the bolted interval;

The thickness of the strong bed (THSB, ft),

- The thickness of the weak rock suspended from the strong bed (THWR, ft).

In the original CMRR, the SBADJ was determined using a table. For improved accuracy and to facilitate implementation of the table in the computer program, equation 2 was derived using multiple regressions:

$$SBADJ = [2.5B(0.72SBD \times THSB)] \times [B(0.33(THWR - 0.5))] \quad (2)$$

The SBADJ ranges from 0 up to 90% of the SBD. The rules that apply are that the maximum THSB that can be entered into the equation is 4 ft, and the allowable range of the THWR is 1.7-8.5 ft. The THSB must also be at least 1 ft, because experience has shown that thinner units cannot be counted on to reinforce the roof, and may actually weaken it because they can concentrate horizontal stress. [22]

7. The CMRR Computer program

The CMRR program is designed to designed facilitate the entry, storage and processing of field data. Either core or underground data can be entered, and calculations are updated instantly when a change is length, to see their effect on the final CMRR. [14] Shown CMRR class for underground data table 4.

8. Exposures of roof strata

These exposures were located at junctions being constructed in the No.1 Mine Access Drifts. The exposed roof was composed of a stronger, more competent siltstone (2.2m) above an immediate 0.2m to 0.4m of mudstone, figure 5. [12] The exposures were assessed and rated using the Coal Mine Rock Rating System (CMRR) described by Molina and Mark. The exposures examined were dry as were most of the working seen, but groundwater was encountered in places, most notably associated with faults , the ratings are given for dry conditions as seen and on the basis of a slight flow of groundwater. The ratings are summarized in table 7. [22]

Result CMRR for Tabas Central Mine by using CMRR 2009

Location ID: Mine NO: 1 Tabas Project

Depth to Top of Seam: 100

Location Type : Underground Exposure

Number of Units: 2

Bolt Length: 1.8 m

Ground Water adjustment: 3. Light Drip

Surcharge adjustment 1. Unit above bolted is equal in strength to the bolted unit

	Location 1: Start Underground Unit 1/2	Location 1: Start Underground Unit 2/2
Unit Description	**Mudstone**	**Siltstone**
Thickness	0.3 m	2.2 m
Depth to Unit	99.7 m	147.5
Strength	3.5	2.5

Moisture	*4. Severely Sensitive*	*2.0 Slightly Sensitive*
Number of Discontinuities	*2*	*2*
Type of Contact	*Weak*	*Strong*
Contact Description		
Unit Rating (Unadjusted)	*35*	*52*
Unit Rating (Unadjusted)	*20*	*49*
Discontinuity Information	*Underground Unit 1/2*	*Underground Unit 2/2*
Discontinuity Description	*Bedding*	*Bedding*
Discontinuity Cohesion	*3.5 Weak- Slickenside*	*3 Weak- Slickenside*
Discontinuity Roughness	*2.0 Wavy*	*2.5 Planar*
Discontinuity Spacing	*5.0 <6cm*	*2.5*
Discontinuity Persistence	*2.0 0.9-3m*	*2.5*
Discontinuity Description		
Discontinuity Cohesion	*2.0 Moderate*	
Discontinuity Roughness	*3.0 Planar*	
Discontinuity Spacing	*3.0 20-60 cm*	
Discontinuity Persistence	*2.5*	

9. CONCLUSIONS

Tabas Coal Mine No: 1 mined using longwall method. The underground exposures are used to classify junction C_2 roof. The result are used in CMRR 2009 and CMRR = 55 is calculated, with adjustment the CMRR will be 48 Therefore, it can be said that Tabas Coal Mine roof is classified as moderate roof.

10. REFERENCES

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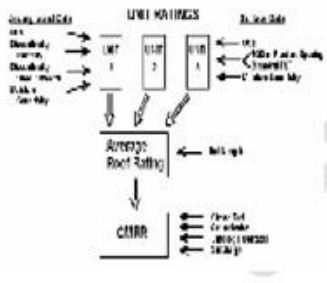

Figure 1. Flow Chart for the CMRR [3]

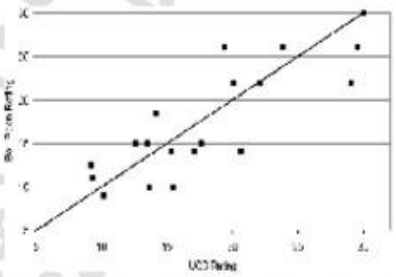

Figure 2. Comparison of the Slake Durability and Immersion[18]

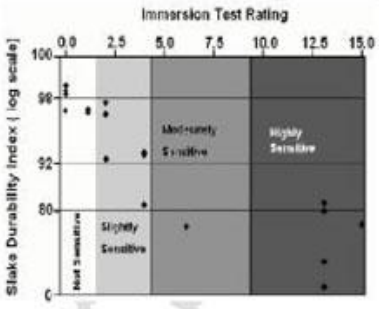

Figure 3. Comparison of Axial Point Load and Ball peen Tests. [3]

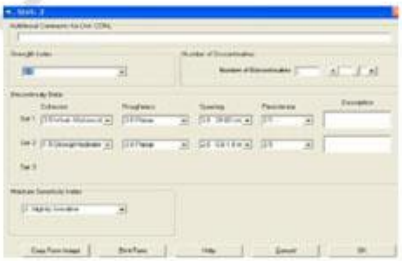

Figure 4 .Underground data entry screen from the CMRR Program. [14]

Figure 5. The exposed roof Junction C_2 [22]

Table 1.Bedding/ Discontinuity Intensity Rating Table for underground data. [21]

Persistence	spacing				
	>1.8 (m)	0.6-1.8 (m)	0.2-0.6 (m)	60-200 (m)	<60 (mm)
0-1 (m)	35	30	24	17	9
1-3 (m)	32	27	21	15	9
3-10 (m)	30	25	20	13	9
> 10 (m)					

Table 2. Bedding/ Discontinuity Shear Strength Rating Table for underground data. [4]

Roughness	Cohesion			
	Strong	Moderate	Weak	Slickenside
Jagged	35	29	24	10
Wavy	35	27	20	10
Planar	35	25	16	10

Table 3. Moisture Sensitivity Ratings [15]

Moisture Sensitivity	Immersion Index	Rating
Not Sensitivity	0-1	0
Slightly Sensitivity	2-4	-3
Moderately Sensitivity	5-9	-7
Severely Sensitivity	> 9	-15

Table 4. Moisture Sensitivity Classes from Immersion and Slake Durability Tests. [18]

Moisture Sensitivity Class	Immersion Index	Slake Durability Index
Not Sensitivity	0-1	100-98
Slightly Sensitivity	2-4	98-92
Moderately Sensitivity	5-9	92-80
Severely Sensitivity	> 9	< 80

Table 5. Approximate UCS Ranges from Ball Peen Hammer Tests. [3]

Ball Peen Hammer Class	Williamson UCS Range (psi)	CMRR UCS Range (psi)
Molds	< 1,000	< 2,000
Craters	1,000-3,000	2,000-5,000
Dents	3,000-8,000	5,000-10,000
Pits	8,000-15,000	10,000-17,000
Rebounds	> 15,000	> 17,000

Table 6. CMRR class for underground data [9]

CMRR Rating	Poor	Moderate	strong
CMRR class	0-45	45-65	65-100

Table 7. Rating of C1 seam roof from underground exposures

Location	CMRR	
	Dry	Slight drip
Central Mine face of conveyor drift	55	48