ORIGINAL ARTICLE

Mechanism of Formed-reinforcement in Last Roadway for Pillar in the Fully-mechanized Gob-side Entry

Zhang Hongwei,Wan Zhijun,Zhang Yuan

(Key Laboratory of Deep Coal Resource Mining,Ministry of Education,School of Mines,China University of Mining & Technology,Xuzhou,Jiangsu 221116,China)

Abstract: In order to study the mechanism of the stability control of pillar by growing in the lastRoadway, methods involved the in-situ test and numerical simulation are employed. the ease of growth and the impact of filling ratio to formation of pillar are analyzed. results show that the Ru-in roadway besides pillar is filled with crushed rocks, which is relaxing for growing. further, under varied fill rates, the pillar experiences three formation stages, namely, 0-10% (marked increase), 20%-20% (slightly increase) and 25%-10% (stable). the reasonable filling ratio locator in 20%.

KeyWords: Unstable overselling Strata;Narrow Coal Pillar;Working Face ends;Caving characteristics;Growing information;Infill Ratio

The traditional gob-side roadway is They are affected by the movement of key blocks. Research[6]Pointed out that in Tunneling[2]In order to alleviate the tension of production connection in mining area, under the underfully stable overburden, the law of lateral roof breaking and Working Face Advancing under the stable overburden rock along the goaf is gradually applied in the eastern mining area of China.[3-5]. The law of directional roof breaking is basically the same.

It is suitable for the analysis of underfully stable overlying strata structure.[7]And the coal pillar is close to one side of the goaf.(Side of roadway along goaf)Most of the supporting structures[8]It is easy to cause partial instability of coal pillar. It is of great significance to control the overall stability of the coal pillar and to prevent and extinguish the fire in the goaf by Grouting and filling one side of the roadway along the goaf to reduce the lateral deformation of the coal pillar.

The key of grouting filling beside the roadway is to determine the collapse and accumulation form and grouting parameters of coal and rock mass beside the roadway. Since most of the fully mechanized Caving Faces in China adopt the method of no coal caving or less coal caving[9]Top Coal is loose and broken, and collapse and pile up with the working face. After the roadway of the lagging Working Face is abandoned, the top coal will collapse, piled up in the roadway. These collapsed coal and rock mass provide aggregate foundation for grouting reinforcement. However, the domestic and foreign researches on top coal mostly focus on top coal mining, the Study on Stability Control of Narrow Coal Pillar mainly focus on the coal pillar deformation mechanism, coal pillar width design and support parameters.[10-11]Therefore, there is little research on grouting reinforcement mechanism of Narrow Coal Pillar roadway. Based on the grouting reinforcement mechanism of Narrow Coal Pillar roadway as the core6302Collapse and accumulation of coal and rock mass beside Narrow Coal Pillar Roadway in working face

Numerical simulation is used to analyze the influence of grouting parameters on the deformation law of Narrow Coal Pillar; this paper discusses the grouting reinforcement Mechanism and Technology of Narrow Coal Pillar roadway along gob-side roadway under Partially stable overburden rock.

1. Geological and production conditions of Surrounding Rock

Baodian coal mine is divided6.Main Mining Area3.Coal Seam No. The research object is liucai district, West Wing6302Fully Mechanized Working Face(Figure1a). Working Face towards about long1 000 m, Tendency about200 mDepth of Coal Seam

340 m, Average thickness8.58 m, Average inclination6 °.3.Coal is easily spontaneous combustion coal seam, ignition Period3.~6.Month, the level of Spontaneous Combustion2.Level. Figure1BComprehensive columnar schematic diagram of six mining areas.

Fully mechanized top coal caving mining technology is used in the working face of six mining areas.

Height3.0 mCoal height5.58 mDuantou District6 ~ 8 mNo coal. Adopt Narrow Coal Pillar(3 m)Roadway layout along the empty way. As shown in Fig.1cAs shown in the above, a working face is prepared by using the undercutting Roadway Driving Technology under the underfully stable overburden rock, that is, the upper section is6301Continuous working face is adjacent to6302Working Face, Narrow Coal Pillar goaf side called roadway side.

2. Scene Detection of roadway collapse

2.1 Observation method and construction parameters

The most direct observation method is to take real-time video of the collapse form along the roadway. However, after the working face is advanced, the roof collapse after the frame, and then the "coal wall" plugging wind will be erected in the rear of the end bracket, therefore, it is difficult to observe roof collapse by real-time camera. To this end, the method of combining direct camera with indirect borehole peeping is adopted.

Direct camera observation

Select Section6302Coal Caving and roadway roof above the end supports of the working face were taken as the research objects, through Indirect analysis of coal and rock mass accumulation form beside roadway, and compared with borehole observation, the caving height and compaction of coal and rock mass are obtained, so as to analyze the feasibility of grouting reinforcement.

Indirect drilling peep

6302Track Lane(Gob Lane)The observation station is set up to drill holes in abandoned roadway of upper section working face. Drill through the coal pillar, and finally reach the position beside the roadway. Construction drilling site selection at distance of work

Minami Yoo170 mLocation. Observation StationA,BTwo groups apart10 m. Construction at two stations4.A drill hole in which3.Because of the failure of several drilling holes, such as hole-breaking and barbed wire sticking in Mined-out areas. Drill Hole

Then the explosion-proof Industrial Electronic peep meter is used to drill the hole.

ZK1.~ ZK5.Camera observation. Drilling location as shown in Figure2.As shown in the table, drilling construction parameters1..

2.2 Lane the coal rock mass down the forms and filling grouting Feasibility Analysis

Direct camera observation results

End support above the coal rock mass in caving Accumulation Process in and

Will to on both sides of the sliding gradually filling roadway. As shown in figure3AAndBShown in for preventing instability the Pai Tau support shop net of style but observation found Pai Tau support after the net not is located in caving Top Coal Bottom, but was roll-in roadway of coal extrusion. This (in Pai Tau support upper coal caving accumulation of at the same time also will to roadway side rolling eventually lead to Pai Tau support net was "extrusion

".

Due to end support above coal rock mass after more times disturbance coal broken degree is high support mobile promote Central back vertex power coal caving accumulation. As shown in figure3cShown in end support not mobile when along the empty roadway compare the complete; end support mobile a time after along the empty roadway basic was caving of Coal Rock Mass filling tight(Figure3d).

Indirect drilling observation results

The constructionZK1~ ZK5Drilling Hole the end of were is located in lane the Location Hole Drilling peep results(Figure4)Display in the whole drilling observation process in were not expose big range holes; drilling hole the end of are broken coal.

DrillingZK5In hole the end of expose upper Working Face End coal wall. DrillingZK1Has certain of Elevation(18 °)And drilling depth460For the deepest Drilling Hole its level depth up437Has been first area section Roadway Width137The about upper abandoned Roadway Width30.4%. (Upper roadway30.4%Width range in and height302Range in are have caving of coal rock mass.

To sum up, the upper part of the CAP bracket has a thick5.58 m, Wide6 ~ 8.

Loose float coal, collapse backward will fill the inner roadway. With the Working Face Advancing and Basic roof rotation, the thickness of the roof is about6 mCoal seam, collapse backward will also fall into the roadway. Therefore, the coal and rock mass inside the abandoned Roadway in the upper section will be filled strictly, which provides cohesive aggregate for the later grouting reinforcement, to rebuild the fractured coal and rock mass, to a certain extent, limit the deformation and collapse of the coal pillar to the goaf side, and make full use of the location advantages of the caving coal and rock mass to improve the stability of the coal pillar, at the same time, it realizes the function of plugging and preventing fire.

3. Simulation Study on deformation law of coal pillar after grouting and filling beside Roadway

3.1 Model Establishment

Based on the actual geological conditions of baodian coal mine, the finite difference soft

FLAC^{3D}The Influence of roadway driving along goaf, Fully Mechanized Caving Mining and grouting process on Coal Pillar deformation is studied.Mohr-CoulombCriterion description rock

Body yield damage.

Model Length(Y) XKuan(X) XGao(Z)For152 m x 100 m x 62 m,

Occurrence6.Physical and Mechanical Parameters of rock formations2.. Simulation of roadway excavation in the upper section, mining in the upper section, roadway excavation along the goaf, roadway Filling Reinforcement and mining5.Monitoring the dynamic change law of the internal displacement of Narrow Coal Pillar. As shown in Fig.5.As shown, the central part of the model is the coal pillar, and the two sides are the gob-side roadway and the upper section roadway. Lane-side filling body width2.5 mHeight is3 m, In the direction of roadway Length(YDirection)Continuous filling. In the coal pillar, alongYDirection Interval20 mSet up monitoring points7.Group. Coal Pillar cross section(TibetNoodle)The distribution of monitoring points on the map5.As shown,G1.,G2.,G3.AndG4.Of

Coordinates are(0),1.5),(1),1.5),(2),1.5)And(3),1.5).

Type:μFor Poisson's ratio, take0.3;SigmaHFor transverse stress,MPa;SigmaTFor vertical stress,MPa.

The maximum stress at the top of the narrow coal pillar is about13 MPa, According(1)Transverse StressSigmaHMax5.57 MPa. Considering that the coal pillar is affected by dynamic pressure under the condition of insufficient stability overlying strata6.[13], Select average landscape should

10 MPaOf grouting parameters study.

By goaf Caving Coal Rock Mass filling rate and its and filling body

Stress Strain Relation[14]Filling body compression should be force10 MPaAn arcane of secant modulusEGAnd filling rateRAbout(Figure7).

Table 2 Physical, mechanical parameters. rocks

3.2 Lane the grouting parameters of determine

Lane the grouting after to Caving Coal Rock Mass Based of filling body will cementation for unified of overall and filling body mechanical parameters and material style, cementation strength, grouting of, filling rate and other factors about[12-13].

Related Research[14]Pointed out that goaf filling body deformation with force about filling rate the greater the its late deformation the small. Filling Rate

For grouting filling body volume and Lane the space volume ratio. Assume that different filling rate under filling body Poisson's ratio, cohesion and in friction angle certain; volume modulus and shear modulus of with the elastic modulus change and change. Based on this analysis filling rate of Narrow Coal Column Deformation Characteristics of influence.

Filling grouting after coal column of deformation by filling body constraint same filling in due to coal column deformation and cross-StressSigmaH. Assume that coal column was ideal state under the filling of the full surrounded by at this time coal column in Side Displacement limit state according to generalized Hook law for coal column deformation of horizontal stressSigmaHAnd Coal Column Vertical StressSigmaTBetween the relationship

3.3 Influence of grouting reinforcement on Deformation of coal pillar Roadway

Monitoring After roadway FillingG4.Transverse deformation of position(Figure5., AlongXAxis Deformation). Figure8.The filling rate of different monitoring points corresponding to different distance of lagging and advanced working face is different.RHorizontal Deformation under."#"Indicates the monitoring point, followed by the number of distance from the working face,"-"Indicates lag,"+"Advanced. The results show that when the coal and rock mass collapse beside the roadway is not considered, the deformation of the roadway is corresponding to the maximum value in the curve. Under the same filling conditions, the more backward the working face is, the larger the corresponding deformation is. Filling Rate in20%Above, the deformation tends to be stable, and the control effect reaches an ideal state.

The higher the filling rate is, the smaller the transverse deformation of coal pillar is, but the decrease is different. For lagging Working Face monitoring points, filling rate is0 ~ 0 ~ 10%SCOPE has little effect on the deformation of coal pillar.

For coal column surface monitoring pointsG1Filling Reinforcement for lag Working Face of coal column almost no influence because coal column is located in goaf deformation the most serious deformation value were is big. But for advanced working face of coal column same filling conditions under the away from working face its control effect better. AndG1Point similar for coal column in monitoring pointsG2Grouting filling the lag Working Face of location deformation influence is small and for advanced working face of location influence is big.

For coal column internal monitoring pointsG3And Lane the side monitoring pointsG4Grouting filling the Narrow Coal Column lateral displacement control role is big. Overall with the filling rate increase deformation reduce rate increase; but during experience.3A stage: The the first1Stage(0 ~ 10%)With the grouting of increase control effect not obvious deformation reduce rate not. ② The first

2. Stage(10% ~ 20%)With the grouting of increase displacement get effective control; for advanced working face of coal column its control effect respectively

To37%And32%. Due to advanced working face coal column itself displacement it is small so control30% ~ 40%Have In is high level. The the first3Stage(20%After)Deformation reduce rate tends to be gentle (control effect change not the coal column deformation tends to be stable.

Even though the lane the filling grouting has feasibility and filling rate the greater the effect better but comprehensive consider time cost and economic cost control coal column deformation of filling rate maintain in20%About more reasonable.

4. Lane the grouting and Narrow Coal Column Stability Control Technology investigate

Long-term since Fully Mechanized Working Face Advancing after end area coal of caving of the Subventricular Zone section Working Face Narrow Coal Column stability of influence is was

Ignore the research object. Even though the have the lane the grouting of practice but the lane the down the forms and grouting parameters of know insufficient lead to construction lack of guidance basis. Control Narrow Coal Column stability more concentrated in the support style of study formation many effective of Support Methods[15-16]; But in non-full stability cladding Rock Conditions under Narrow Coal Column mechanical environment more complex in reasonable improve support strength of the same time should the lane the grouting reinforcement, to prevent coal column for local instability lead to the system instability to "plugging wind, resistance deformation, can bearing" of control effect.

Plugging wind: field observation show that lane the location are caving of coal rock mass but air leakage channel still in through state. Lane the grouting formation of filling body can effectively block the air leakage channel even if coal column internal fracture development also very difficult to air leakage this in very big degree on reduce the spontaneous combustion of risk. Lane the filling body height should be and coal column height same grouting radius visual with Lane the drilling results and set if holes more the need to Queen grouting radius and shorten the slurry condensation time.

Resistance Deformation: because more times engineering disturbance and lack of maintenance Narrow Coal Column lane the side of bolt most failure support role is small. If abandoned roadway not filling the Narrow Coal Column compression will appear stripping or collapse on the whole coal column of stability threat. If Lane the caving coal rock mass overall stiffness not enough don't can for coal column provide enough of binding also will cause coal column instability. To Caving Coal Rock Mass Based on the grouting cemented formation has certain stiffness of filling body can in certain degree for coal column provide binding to prevent coal column by the influence of the dynamic pressure on the and deformation is too large.

Can bearing: Lane the grouting after the coal column in three-way force state its residual bearing ability get enhanced in by the influence of the dynamic pressure on the process in more keep their own stability. At the same time coal column bearing ability of enhanced also can along the empty roadway provide good of stress environment this the coal column and along the empty roadway stability control are has important significance.

5 Of On

Baodian Coal Mine6302Working Face drilling detection show that its lane the basic was roadway fall of top coal and Pai Tau support down behind in the loose coal rock mass filling and compaction, so to Caving Coal Rock Mass Based on the grouting filling has feasibility.

Coal Column deformation with the filling rate increase can be divided3A stage: filling rate in0 ~ 10%Filling control effect is not obvious; filling rate in10% ~ 20%Filling control effect get improve; filling rate

20% ~ 25%Filling control effect obvious and coal column Deformation Trend

In stability. Consider economic cost filling rate maintain in20%More reasonable.

Lane the grouting reinforcement of coal column overall stability and security mining were has important significance. In non-full stability cladding Rock Conditions under in reasonable improve support strength of the same time should the lane the grouting reinforcement-

The coal column local instability lead to the system instability to "plugging wind, resistance deformation, can bearing" of objective.

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