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The causes analysis and control measures about rapid floor heave in deep mine

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Abstract: With the depth of coal mine increasing, it appeared a phenomenon of rapid floor heave in some roadways in a short time, which threaten greatly to the normal mine production and the lives safety of workers. The causes and control measures about rapid floor heave are analyzed in this paper. Which has a certain reference values for preventing and controlling rapid floor heave in deep mine.

Introduction

At present, the depth of coal mine has been increasing with the rate of 8 ~ 12m a year. According to coal resource development and resource conservation research, less than expected in the next 20 years, a lot of coal mine will enter into the 1000 ~ 1500m depth[1]. Roadway excavated lead to the destruction of the original rock stress state, causing the surrounding rock stress of roadway realignment and the surrounding rock deformation. The floor heave is a major form of damage deformation in deep mining roadway. Usually the floor heave speed is relatively slow, but because of keeping long duration deformation, in two months or even one year after the tunneling, the floor heave phenomena has still been occurred, so the total amount of floor heave could reach one or two times of the roadway height. Generally, the extent of floor heave is judged by the accumulated displacement, however, with the mine depth increasing, the accumulation degree of floor heave in deep mine is not enough to describe because of rapid floor heave occurred. For example, it happened more than one meter floor heave in just a few hours in some roadways. This phenomenon is called rapid floor heave. Currently, there is no research literature about it. In this paper, some rapid floor heave emerging phenomenon will be introduced, and its causes and mechanism will be analyzed, which provide reference basis for controlling the rapid floor heave.

Some descriptions about some typical of rapid floor heave

According to the existing data, there are no relevant reports for the phenomenon of rapid floor heave in the literature, even no related definitions. The following description is typical of rapid floor heave.

(1)In Ruhr mining in Germany, the roadway depth was less than 1100m, and the width was above 6m. The rapid floor heave occurred there, and the floor deformation value was 0.8 m within 24 hours.

(2) In the development roadway of No.1 mine in Zhaogu of Jiaozuo Coal Group in China, the roadway depth was less than 608m, and the width was above 3.8m. There had been seven times of rapid floor heave in different roadway. Among which, the cumulative value of the most serious floor heave actually was 1.5 m in 3 hours (average of 0.5m / h), and the value was 2 m in 6 hours. People who stay at the scene could feel the rising rock around their feet obviously. A similar situation is also happened in some of Xingtai Mining Bureau of Mine.

(3)In the mine of Mengjin of Yima Coal Industry Group, when the auxiliary shaft empty wagon track was being constructed, shooting caused that the no construction of the main shaft temporary detour happened rapid floor heave. Two of constructed the main shaft temporary detour gas release holes can occur suddenly to spray, and accompanied by muffled thunder-like sound[2].

(4)In -300 level east roadway of Shuijingtou mine of Niuma Industry Co., Ltd., the rate of floor heave was more than 30mm / d in a few days after tunneling. Usually, a strong floor showed “w” shape [3].

Over the years, roadway floor heave has been one of difficult problems for the coal mining and other underground project. Intensive floor heave brought a lot of repair work, and greatly increased the roadway support costs, while transport of roadway and pedestrian caused great difficulties, the sharp narrow roadway severely affected the mine ventilation normal production workers safety. Particularly it should be concerned about the rapid floor heave, because of its bringing sudden disaster. So, it is necessary to research about it.

Definition of rapid floor heave

About how to distinguish between ordinary and rapid floor heave, we give the definitions qualitative and quantitative description. The definition of general floor heave by Baidu encyclopedia is that it is a phenomenon that floor heave occurred because of the impact of the pressure or water pressure and so on..

However, rapid floor heave is a very rare phenomenon and has greater hazards, no one has yet been defined for this existing natural phenomenon, we give the following definition that rapid floor heave is a phenomenon that the floor heave suddenly occurred because of the impact of the pressure, gas pressure or floor hydraulic pressure in a short period of time.

According to the roadway floor cumulative deformation value and floor heave rate, the different types of roadway floor are shown in Table 1.

From Table 1 it can be judged, when the maximum floor heave rate is less than 0.5mm / d, the floor heave was slightly, there are little effect on the stability of the roadway. However , when the floor heave deformation reach the maximum rate of floor heave of 30mm / d above, the cumulative values of the floor heave are above 500~2000m. In this case, the floor heave may be rapid floor heave, and the floor in roadway must be controlled.

Table 1 Classification of roadway floor

level	Classification	mount (mm)	maximum rate (mm/d)	deformation describe	Extent of impact	Control measures
1	Minor floor heave	100~200	<0.5	Two sides have no apparent movement, and floor is slightly uneven.	Don’t affect to use.	Don’t need to deal.
2	Obvious floor heave	200~300	0.5~10	Floor heave accelerates obviously, floor changes obviously, rail is skewed, ditch is pushed, the roof downs, two sides have a little movement.	Production and safety have been a certain degree influence.	It should timely Service and deal.
3	Strong floor heave	300~500	10~30	Deviate the rail, ditch is badly pushed, roof downs, crazes and crumbles, two sides have more movement.	Impact on production, and threaten security transportation seriously	It must be cleaned, expanded and renovated.
4	Rapid floor heave	500~2000	>30	Floor heave rapidly, roof and two sides are damage greatly.	Roadway is in a semi-closed state, and difficult for ventilation and pedestrian.	It must be thoroughly renovated, and the floor can be supported for using.

Analysis of causes and mechanism for the rapid floor heave

The main factors of floor heave based on similar simulation experiment obtained by Jiang Yao-dong et. are floor rock, rock stress, water, and support strength [4~6]. According to the analysis of available information we summarize the causes on rapid floor heave are mainly as following.

(1) The weakening of surrounding rock. Firstly, with the mine depth increasing, geothermal also will be increased, high temperature causes the rock to the plastic transition from brittle, the plastic deformation of the rock; Secondly, the increase of mining depth and stress pressure, make the rock show significant plasticity; Thirdly, if the surrounding rocks are clay minerals, by water penetration, it will reduce the strength of the rock and prone to deformation.

(2) Affect by the stress concentration. Near the chamber construction, the excavation process spread stress and underground pressure after blowing continuously increasing, easily making the section of floor heave round way instant release stress, the floor with sever and deformation.

(3) Affect by the gas pressure and floor water pressure. In high-gas coal mine, coal seam gas contained in pressure, when the roadway is tunneled for a certain distance to the coal seam, gas pressure exceeds the critical value of emission, and gas breaks through the rock to crack and gushes boring space, the rock of the honeycomb structure of the gap. Leave the water or steam, rock strength decreases. In the coal and gas outburst mine, if the roadway floor away from the high content and pressure gas roof is less than two meters of the roadway, with the heading face forward, facing faults or fracture in a geological structure. It is easy because of the stress spreading led to the rapid floor heave or even the coal and gas outburst happen. In recent years, water inrush accidents occurred frequently. Within a few hours before the accident, because the water pressure makes floor deformation and rapid floor heave, the floor starts to leak the water from the heave location, followed by a sharp increase of water. Therefore, rapid floor heave is one of the important sign for gas and water outburst accident.

(4) Affect of support situation. General roadway floor is in no support state, it is main reason that two sides and roof support are easier, for the ordinary floor heave is cleaned; In addition, the anchor floor construction is difficult, a large amount of gangue work; if it is unable to support to control floor heave, clean will be heavy workload. In the view that mine happened rapid floor heave, first supporting only support roof and sides with bolt-net-anchor, while the roadway floor is no supported, so we can see that before second the roadway excavated, the surrounding high stress balance is broken, the rapid weakening of rock strength with water, together with superposition effect of the level of tectonic stress, floor water pressure and supporting stress, leading to the rapid floor heave.

The mechanism of rapid floor heave is very complex. After roadway excavation process is completed, the high-stress balance of surrounding rock is damaged. In addition, floor may subject the penetrative water from the roof and floor, which make rock strength weak rapidly. The tectonic stress level and the additive effect of influence to mine and supporting pressure, are also deal with the rapid floor heave. Shortly after the excavation, the roof and two sides are only considered to support, and no support floor, under the effect of abutment pressure, two sides are sink and plastic deformation that floor tensile strain unload produce to heave, leading to floor heave. Therefore, high stress, soft surrounding rock, bad effect of water, the additive effect of influence to mine and supporting pressure and other factors were superimposed on varying degrees for speeding to floor heave, thus rapid floor heave is occurred.

Control measures

For control deep mining conventional floor heave problem, He Man-chao et al [6] who presented the classic three control floor heave theory, namely through the surrounding rock roof, two sides, floor corner three positions take control, change the three parts of the stress state and deformation to achieve the floor of the control, to achieve to reduce the extent of floor heave. In terms of concrete construction, Wang Wei-jun Hou Chao-Jiong summarized that floor heave control measures at home and abroad, summarize the methods of floor heave control [7].

Strengthening method, removing pressure method, combining method, filling method should be used. For the rapid floor heave to say, “An ounce of prevention is worth a pound of cure”. Generally speaking, the roof is enhanced the strength of support, while the floor is used on strengthening method, removing pressure method for control. Strengthening method mainly include, floor bolt, application of floor grouting floor grouting, closed metal stents, concrete inverted arch; Removing pressure method mainly include, floor kerfs, floor drilling, floor loose blasting, two sides notch, top of the pressure relief grooves .

In controlling for rapid floor heave of Zhaogu in Jiaozuo Coal Mining Group Co. ,Ltd, at first, used a high-strength bolt-net-anchor for first support, and then used a long ring-type support for supporting, at last used grouting and anchor supporting for reinforcement. Through this control program is used, rapid floor heave is basically eliminated, the effect of control is obvious [7]. Occur rapid floor heave in high-gas coal mine, Mengjin mine in Jiaozuo Coal Mining Group Co. ,Ltd analyzed the zone of the gas content and pressure high is in fracture, because of stress spreading, it easily leads to floor heave even coal and gas outburst accident, so grouting techniques is used to cut off the stress transmission, to control rapid floor heave. For occurrence of the rapid floor heave in loose broken rock, it must strengthen the roof and two sides support, and control air and water to prevent the deterioration of the surrounding nature.

Of course, for the rapid floor heave, we should do for the prevention:

(1) Strengthen the underground geological prospecting, probe the detailed litho logy and structure of roof and floor, change the mechanical properties of rock and improve the strength of surrounding rock. From design consideration, the roadway is arranged as far as possible away from the geological tectonic belt or stress concentration area, or adjust the angle of axial direction with the maximum principal stress, to minimize the impact of the level of tectonic stress;

(2) Enhance hydrogeology exploration and control surround rock and floor water. Strengthen construction management. After roadway excavation, immediately shot concrete for closure of surround rock, reduce the water (including steam) effect of the surrounding rock weathering and weakening;

(3) Alternate operation. Avoid constructing on many sites and reduce superposition of mining influence;

(4) In first construction, ensure the construction quality of supporting roof and two sides, reduce the surrounding plastic zone, to avoid the deformation of the roof and the two sides, lead to the increased damage of floor heave;

(5) The selected Support method must maximally keep increasing the integrity of roadway floor, early use of the long-loop support for closing support.

Conclusions

(1) Rapid floor heave is a very rare phenomenon and has greater hazards, which is a phenomenon that the floor heave suddenly occurred because of the impact of the pressure, gas pressure or floor hydraulic pressure in a short period of time.

(2) The causes on rapid floor heave are mainly four factors including the weakening of surrounding, affect by the stress concentration, affect by the gas pressure and floor water pressure rock, and affect of support situation and so on.

(3) The mechanism of rapid floor heave is very complex. After roadway excavation processes are completed, the high-stress balance of surrounding rock is damaged. In addition, floor may subject the penetrative water from the roof and floor, which make rock strength weak rapidly. The tectonic stress level and the additive effect of influence to mine and supporting pressure, are also deal with the rapid floor heave. Shortly after the excavation, the roof and two sides are only considered to support, and no support floor, under the effect of abutment pressure, two sides are sink and plastic deformation that floor tensile strain unload produce to heave, leading to floor heave. Therefore, high stress, soft

surrounding rock, bad effect of water, the additive effect of influence to mine and supporting pressure and other factors were superimposed on varying degrees for speeding to floor heave, thus rapid floor heave is occurred.

(4) In deep mine, it need do something to strengthen the support strength of the floor the roof and two sides in the roadway, to avoid the damage aggravating caused by some phenomenon of floor heave. For controlling rapid floor heave, we should strengthen geology exploration, including nature of rock, structure and hydrologic exploration about surrounding rock.

Currently, rapid floor heave haven't enough to be researched. It should strengthen the mechanism research work of the rapid floor heave in future, so as to avoid the roadway due to rapid floor heave brought unexpected disasters. This article provides a theoretical basis to take reasonable prevention and control measures for some deep roadways in which rapid floor heave happened. In mine safety, it has important theoretical and practical significance.

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References

[1] Lan Yong-wei, Zhang Yongji, Gao Hongmei. Research on the Mechanism of Floor Heave of Roadway in Deep Mining [J].Ming Research and Development.2004, 25(1):34-36.

[2] Sun Chang-qing. Tunnel Bottom Drum Government for Coal and Gas Outburst Mine[J].Coal Technology.2008,27(11):5-6.

[3] He Manchao, Zhang Guo-feng, Wang Gui-lian, Xu Yun-liang,Wu Chuang-zhou,Tang Qiang-da. Research on Mechanism and Application to Floor Heave Control of Deep Gateway [J].Chinese Journal of Rock Mechanics and Engineering.2009, 28(1):2593-2598.

[4] Jiang Yaodong, Zhao Yixin,Liu Wengang, Li Qi. Research on Floor Heave of Roadway in Deep Mining [J].Chinese Journal of Rock Mechanics and Engineering. 2004(7):2396-2401.

[5] Sun xiao-yan, Sun Yu-ning, Zhou Hong-chao, Zhou Jian-rong. Simulation of Similar Materials ofFloor Heave Control of Roadway [J].Energy Technology and Management. 2007(6):3-5.

[6] Wang Wei-jun, Hou Chao-jiong. New Development of Mechanism and Control Technique Study of Extraction Opening Floor Heave [J]. Jounal of Xiangtan Mining Institute, 2003, 18 (1):1-6.

[7] Hu Gong-quan,Guo Da-tao. Reinforced Technology on the Tram Operation Foundation Floor of the Auxiliary Shaft Horsehead in Zhaogu NO.1 Mine [J].Mine Construction Technolegy, 2007, 28(6):16-17.