

Preliminary Analysis of Building Safety and Construction Technology in Mine Goaf

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Abstract: After the mining of coal resources, there are many goaves left underground. The guarantee of mine goaf safety is of considerable significance to the entire mine production. The relevant production enterprises must attach greater importance and take active measures to improve the mine goaf safety and create conditions for achieving the relevant production goals.

1. Introduction

As is known to all, after the mining of coal resources, there are many goaves left underground. The collapse of the mine goaf caused total geological disasters in coal mines. Currently, the mine goaves are relatively common in the Northeast, North, East, Central, Northwest, and Southwest China. Coal mine goaves are threatening miners engaged in underground operations at all times. In the mine production process, along with the continuous advancement of the production process, the relevant mined areas will form goaves. In the production process, if the relevant departments or personnel cannot take appropriate measures to deal with the goaves, the adverse consequences can be immeasurable [2]. The so-called goaf refers to the space left by the mined area after the underground material is mined. Generally, compared with the unmined area, the probability of disasters such as the collapse in the goaf is higher. This is because after the ground surface in the upper part of the goaf loses its support, it creates an imbalance and further induces the deformation and collapse of the ground surface, which is not conducive to the advancement of production [3]. Regarding the current situation of mine goaves in China, there are still many problems during the construction in goaves. Some construction personnel is not aware of the importance of construction in goaves. The focus of production is on the advancement of production, and the treatment of the goaf is ignored, which has a significant impact on the advancement of the entire mine production [4]. In addition, the current phenomenon of goaf collapse in China is more serious, especially in the Northeast, North, and Northwest China. The extent of the goaf collapse is relatively serious, which has a certain negative impact on guaranteeing the safety of human lives [5].

So far, based on the calculations of relevant researchers, the average goaf collapse system in China has exceeded $2400\text{m}^2/10,000\text{t}$, which directly shows the necessity of goaf control in China. It will affect safe production and also restrict the development of the relevant areas to a certain extent. Therefore, relevant departments and enterprises must strengthen their attention and actively take measures to improve the safety and quality of the goaf processing. The realization of production lays the foundation. In this paper, the measures to improve the building safety in mine goaf and the construction technology are analyzed and discussed.

2. Measures to Improve the Safety of Mine Goaves

The goaf survey process is shown in Figure 1.

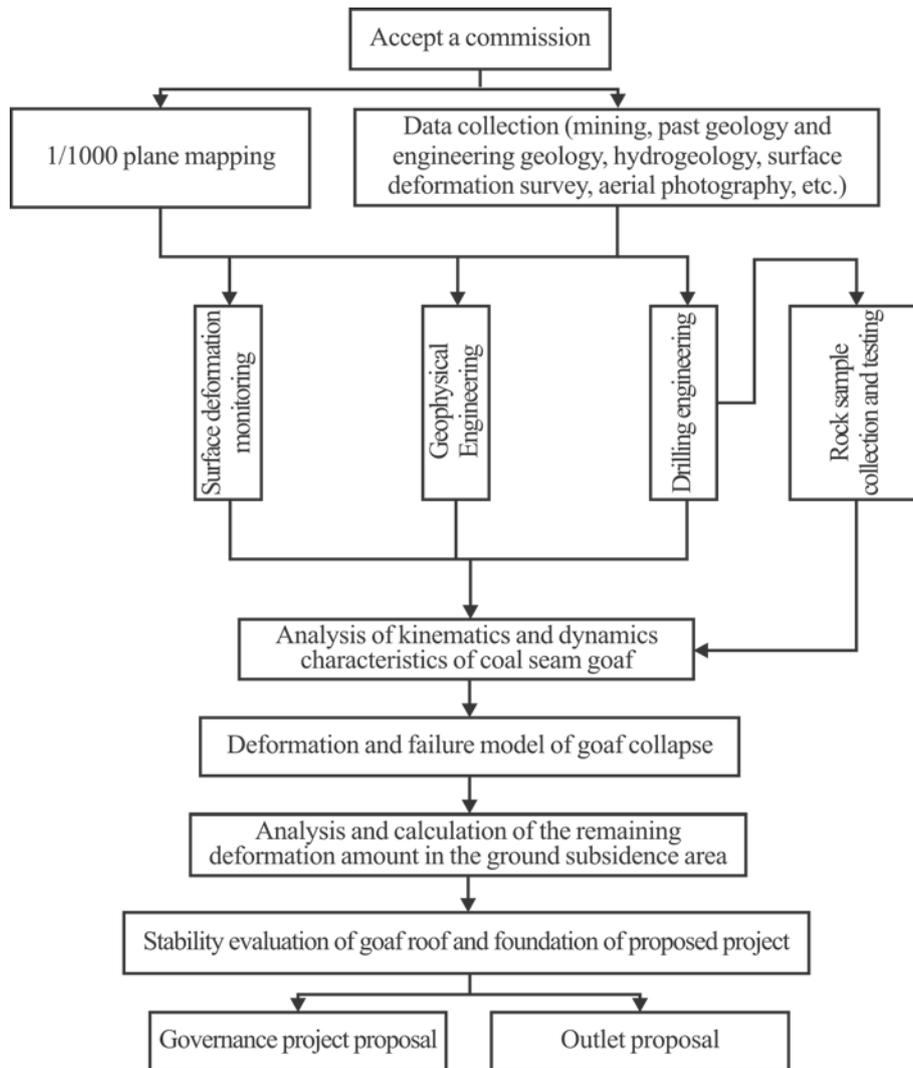


Fig.1 Goaf Survey Process

(1) Strengthen the management staff's attention to the safety of the mine goaf

Currently, most of the goaf safety problems are due to the lack of attention paid by the relevant management personnel to the safety of the mine goaf. Therefore, to maximize the safety of the mine goaf, the relevant personnel must face the safety issues of the goaf, take active measures to improve the existing goaf building safety system, eliminate the safety problems of each goaf building in the bud state, and create conditions for the regular advancement of mine production. The eternal theme of safety and production in the development of an enterprise can only ensure the advancement of production by maximizing the safety level in construction. This means that any production where safety is not taken as the prerequisite will not be sustainable. Compared with other industries, mine production faces more risk factors. Under this background, relevant management personnel must strengthen the establishment of safety awareness and take safety as the first element of development. Only in this way can the smooth building construction in the goaf be guaranteed.

(2) Strengthen the rationality of the mining sequence

About the cause of the current goaf collapse, a large part of the goaf has the issue that the mining order selected during mining is not sufficiently scientific.

For example, in the process of mining, some mining companies choose the mining order from bottom-up, and the ground conditions are not adequately considered in the control of the distance between the two layers so that the distance between the upper and lower layers is small. The mining of the upper ore body based on the lower ore body can easily cause deformation of the upper ore body and increase the risk of the collapse of the goaf. Hence, in the mining process, the mining sequence shall be followed from top-down, and the distance between adjacent mining layers shall

be determined according to the stratum conditions to minimize the possibility of safety problems in the goaf.

In addition, the application of the interval mining method can be strengthened during the mining process. This mining method can significantly reduce the ground pressure. To ensure the safety of the goaf, many mines use this mining method during the mining. Where it is not easy to take mining measures due to the terrain, the method of letting the mining houses on both sides fall can be used. This is because after the mining houses on both sides fall behind, the associated stress increase zone will be expanded. Subsequently, a large pressure-free arch may be formed, which is of great significance for the middle stope in the stress reduction zone. The reduction of stress will make the goaf remain protected during processing, which has a significant effect on the safety of the goaf.

(3) Strengthen ground pressure detection

During the construction of the mine goaf, the relevant construction departments must strengthen the detection of ground pressure, which has a vital role in the maintenance of the mine goaf. Therefore, the corresponding construction department shall strengthen the establishment of a special measurement team, improve the overall quality level of each person involved in the measurement as much as possible, strengthen the use of multiple measurement methods, and ensure the accuracy of the measured results to the greatest extent. For example, when testing the pillars, relevant inspectors can understand and master the basic range of ground pressure by judging the sound of the pillars and observing the surface cracks and shedding phenomena of the pillars. Take precautionary measures to provide a basis.

3. Impact of Mine Goaf on Surface Buildings

Currently, the underground mine goaf has become a critical problem that restricts the development of the mine. As the mining gets increasingly deeper, the ground pressure increases, and the empty underground area is under intense ground pressure, which is prone to collapse accidents. In particular, it has a huge impact on mining from underground to open-pit. Mine impact is huge. Since the end of the 20th century, China's mining has been relatively messy. Illegal and disorderly mining has left a lot of goaves in some mines and their surroundings, which is one of the main hazards affecting the current safe production of mines. There are goaves in many mines, such as the Changba Lead-Zinc Mine in Gansu, the Dabaoshan Mine in Guangdong, the Shizhuyuan Mine in Hunan, the Luanchuan Molybdenum Mine in Henan, the Lanping Lead-Zinc Mine in Yunnan, the Dachang Mine in Guangxi, and the Tongling Lion Mountain Copper Mine. The goaf, resulting in deteriorated mining conditions, causing deformation of mine pillars, difficulty in maintaining stopes and roadways in adjacent operation areas, large-scale fall in underground mines, rock movements, and surface subsidence, etc. In more severe cases, the high-speed airflow can suddenly collapse in the goaf. Casualties and equipment damage caused by shock waves, which can pose a severe threat to the safety of mine production and created environmental degradation and a serious waste of mineral resources. At the same time, the ventilation of the goaf can make the residual coal in the goaf accelerate the oxidation and spontaneous combustion, and can also take out or dilute the gas and other toxic and harmful gases to the explosive concentration, a gas explosion accident occurs, the harm is extremely great, and it is strictly prohibited to use the goaf for ventilation in coal mines.

The observation period t can be shown in formula (1) according to the formula of surface deformation speed and mining depth:

$$t = \frac{\sqrt{2}}{s} kn \quad (1)$$

T represents the observation period (month), k represents the coefficient, n represents the average error of leveling (mm), and s represents the monthly subsidence of the ground surface deformation (mm / month).

The maximum slope of the earth's surface is shown in formula (2):

$$T_{\max} = \frac{W_{\max}}{R} \quad (2)$$

The maximum curvature is shown in equation (3):

$$K_{\max} = \pm 1.52 \frac{W_{\max}}{R^2} \quad (3)$$

The maximum horizontal movement value is shown in equation (4):

$$U_{\max} = bW_{\max} \quad (4)$$

The maximum horizontal deformation value is shown in equation (5):

$$E_{\max} = \pm 1.52 \frac{W_{\max}}{R} \quad (5)$$

Where R represents the ground influence radius, H represents the mining depth, b represents the horizontal movement coefficient.

4. Analysis of Mine Goaf Construction Technology

(1) Bored pile technology

One of the most commonly used technologies in the construction and construction of goaves is the technique of artificial hole-forming cast-in-place piles. The application of this technical measure can improve the holding capacity of goaves so that they are accessible. Requirements for the support layer. When implementing the hole-forming cast-in-place technique, the relevant personnel must make the drilled hole depth and the formed hole size consistent with the applicable design requirements. The construction method of the concrete bored pile can be adjusted according to the specific construction conditions. For example, affected by the construction conditions, part of the project can be used to level the flat rock surface during the construction in the goaf so that the robustness of the column support is improved.

In addition, where the construction conditions allow, the integrated construction method of the pneumatic down-the-hole hammer can be used to complete the construction in the goaf in the goaf during the process of the goaf. The current construction method of the artificial bored pile has been applied in a specific project. Hence, more attention by the relevant construction enterprises is required.

(2) High-pressure rotary jet grouting technology

In order to prevent the pressure-bearing capacity of the mine goaf from decreasing further, another major technique used in the construction of mine goaf is the high-pressure rotary jet grouting technology. The application of this technology can minimize the probability of new soil holes in the goaf, which is of great significance for ensuring the pressure-bearing capacity of the goaf.

In addition, the high-pressure rotary spray technology does not require massive pumping and drainage during the use process, which also improves construction efficiency to some extent. The primary raw material of the slurry used in the high-pressure rotary grouting technology is concrete, so ensuring the quality of the concrete is the essential prerequisite to ensure the exerting of high-pressure rotary grouting technology.

(3) Filling processing technology

In the process of processing the goaf, it is one of the simplest and most effective ways to use the filling material to backfill the goaf. Currently, there are many types of filling materials commonly used in goaf construction such as gravel, water sand, and concrete are the most widely used fillings at present.

The application of the filling material allows the goaf to have support again so that the pressure on the goaf area can be reduced. This technology can be used to prevent the sinking in the upper

part of the ore body, which also has a specific positive effect to prevent ore-rock internal caused fire. Hence, relevant personnel shall pay more attention and strengthen the application.

5. Conclusions

The advancement of the construction work in mine goaf is of great significance to the entire mine production. Relevant business practitioners shall attach more importance and take active measures to improve the safety performance of mine goaf, thereby laying a foundation for the long-term stable development of the mine.

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