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Methods of Geological Environment Protection of Luoyang Zhengxingsu Coal Mine

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ABSTRACT: Taking Luoyang Zhengxingsu coal mine as an example, according to the status quo of mine geological environment, the impact assessment of mine geological environment and the protection and management of mine geological environment are carried out.The study area covers the north, south and east of the mining area, with the predicted subsidence influence area extending 50m outwards. Other boundaries are consistent with the mining area, and the assessed area is 1.397km^2.According to the mine geological disaster, aquifer, landform landscape and land resources, the mine geological environment is predicted and evaluated, and the mine geological environment control engineering design is put forward.

KEYWORDS: coal mine; Geological environment; Predictive evaluation

1. INTRODUCTION

With the increase of demand for mineral resources in our country, the construction of the mine production effectively promote the local economic development and social progress, but also with local geological environment and land resources caused a certain degree of influence [1-2], mines is easy to cause soil erosion, ground crack, settlement of goaf, mudslides and landslides and other geological disasters. According to relevant statistics, the economic loss caused by geological disasters caused by mining every year is more than several billion yuan [3].Therefore, the coordinated development of mine ecological environment protection and governance must be realized through the restoration and governance of mine geological environment [4].

The protection and restoration of mine geological environment is to carry out the protection and restoration of mine geological environment on the basis of the investigation of mine geological environment, focusing on the geological disasters caused by and induced by mining, such as collapse, landslide and debris flow. Establish and improve the mine geological environment legal system and management system, the maximum to avoid or reduce the harm caused by mineral exploitation of geological disasters, reduce the impact on the land resources or damage, reduce the influence on landform landscape, effectively curb and governance of mine geological environment, make the evaluation area residents to dramatically improve production and living environment. To realize the coordinated development of mineral resources exploitation and utilization and environmental protection. To establish green mines and promote the harmonious and sustainable development of social economy in the evaluation area.

Taking Luoyang Zhengxingsu coal mine as an example, according to the current status of mine geological environment, the impact assessment of mine geological environment is carried out, and the prevention and control measures of mine geological environment are put forward.

2. BASIC OVERVIEW OF THE MINE

Mining area is located in luoyang, marina district litsun town southwest, administrative districts belong to luoyang, waterfront litsun town night driving kiln village jurisdiction, is a warm temperate continental monsoon climate, low litsun meteorological terrain north town, assumes the ladder-like distribution, the southern foothills, central hills, north river alluvial plain, so mine areas belong to the blunt diluvial loess sloping plains geomorphology.

The mining area is about 610 ~ 1600m long from east to

west and 460 ~ 700m wide from north to south, covering an area of 1.0867km2.Limit the mining of 21 coal seam, elevation -20~-200m.The mine adopts underground mining, and the remaining production service life is 12.22 years. After years of underground mining, the mine has formed a goaf of 0.36hm2, which is mainly located in the eastern mining area of the industrial site. According to the field investigation and mining data, there is no geological disaster of ground collapse, ground fissure, collapse and landslide in the mining area. Mining sequence: 12 mining area-22 mining area-11 mining area-21 mining area; In the mining area, the mining sequence is first down and then up, and the mining direction is backward, that is, from the mining area boundary to the mining area down the mountain; The first mining face is arranged in the 12 mining area.

The coal mining land in Zhengxingsu mainly consists of industrial site, coal storage yard and mining road. According to the on-site measurement, the project land area is 4.79hm^2.The industrial site is divided into two zones according to functions, namely the office and living area and the production area, with a total area of 4.13hm^2.The coal storage yard covers an area of 0.42hm^2 and is located at 200m in the west of the industrial site. The mine has built a total of 300m roads, located on the north side of the industrial site, connecting the industrial site and coal storage yard. The road width is about 8m, covering an area of 0.24hm^2, and the road surface is mud gravel road.

3. MINE GEOLOGICAL ENVIRONMENT IMPACT ASSESSMENT

3.1 Scope and grade of mine geological environment impact assessment

(1) Scope of mine geological environment impact assessment

The determination of the evaluation scope of the scheme should take into account the geological environment conditions of the mining area, the way of mining and development, the geological environment problems caused by mining activities and other factors, and at the same time take into account the restoration and treatment of the early-stage mining damage and the affected areas[5].Under the current condition, the surface engineering of the mine is located within the mining area, and the underground coal seam mining forms goaf, which is in a stable stage and basically has no influence. In the north, south and east of the mining area, the area affected by the predicted collapse extends 50m outwards. Other boundaries are consistent with the area of the mining area, and the assessed area is 1.397km^2.

(2) Mine geological environment impact assessment level

The level of mine geological environment impact assessment is determined according to the importance of the assessment area, the scale of mine production and construction, and the complexity of mine geological environment conditions.

The southern boundary of the mining area is inhabited by villagers with a population of less than 200.The Yul18 highway runs east-west from the north of the mining area, and there are no nature reserves, tourist attractions and important water sources at all levels. The land resources destroyed are mainly cultivated land, garden land and forest land, etc. According to the specification for the mine geological environment protection and restoration plan, the importance of the evaluation area is defined as an important area in Appendix B.

Luoyang Zhengxingsu Coal Industry Co., Ltd. is a coal mine, and the mining method is underground mining. The designed mine production scale is 150,000tons/ year. According to Appendix D "Classification List of Mine Production and Construction Scale" in "Specification for Compilation of Mine Geological Environment Protection and Restoration Management Plan" (DZ/T223-2011), the mine production and construction scale is small.

Luoyang Zhengxingsu Coal Industry Co., Ltd. adopts underground mining, and classifies the mine according to Appendix Table C.1 classification table of complexity degree of geological environment conditions of underground mining mines in accordance with Specification for Compilation of Mining Geological Environment Protection and Restoration Management Scheme (DZ/T0223-2011).According to the division of hydrogeology, engineering geology, geological structure, environmental geology, mining condition and landform in the area, the complexity of geological environment conditions of mines in the area is assessed to be medium.

According to Appendix A of the mine geological environment protection and restoration plan compilation specification, the importance of evaluation area is important area, the scale of mine production and construction is small, the complexity of mine geological environment conditions is medium, and the accuracy of mine geological environment impact assessment is determined to be level 1.

（3）Mine geological risk assessment level

According to the Hazard Code for Geological Disasters DZ/T0286-2015, the assessment level is determined by the importance of the construction project and the complexity of geological environment conditions.

Luoyang Zhengxingsu Coal Industry Co. Ltd. produces coal mine with a production scale of 150,000tons/year. It is a small mine and the project is a general construction project. According to Appendix B.1 (Classification Table of Complexity degree of Geological Environment Conditions) of "Standard for Risk Assessment of Geological Disasters" (DZ/T0286-2015), the complexity degree of geological environment conditions of mines in the evaluation area is determined according to hydrogeology, engineering geology, geological structure, environmental geology, mining condition and landform division. The complexity of geological environment conditions in the evaluation area is complex, the importance of the construction project is relatively important construction project, and the comprehensive determination of mine geological risk assessment level is two.

3.2 Prediction and Evaluation

3.2.1 Geological hazard prediction and assessment

The risk prediction and evaluation of geological disasters are divided into the risk prediction and evaluation of geological disasters caused by mining, the risk prediction and evaluation of geological disasters suffered by the evaluation area and the comprehensive regional risk assessment of geological disasters.

（1）Prediction and assessment of the risk of geological disasters caused by mining

Need to forecast the surface movement deformation caused by the coal mining, ground deformation caused by underground mining is influenced by many factors, such as thick seam mining, mining depth, dip Angle, the overlying strata lithology, geological conditions, working face advancing speed, whether slicing and roof management method directly affect the surface deformation. At present, the applied theories and methods of surface movement calculation mainly include typical curve method, negative exponential function method and probability integral method. For the mining of inclined coal seam, according to the principle of superposition of subsidence, the sum of subsidence influence caused by mining of each mining unit on any point on the surface in the horizontal projection of mining area is the subsidence value of this point. Through the determination and calculation of prediction model and related parameters, the total area of predicted subsidence land in the project area is 83.77hm^2, and the damage objects are cultivated land, forest land, grassland, villages, roads and transmission lines, etc. The boundary of surface movement basin can be divided into three boundaries: the outermost boundary, the dangerous movement boundary and the fracture boundary according to the value of surface movement deformation and its influence on structures and the surface. The prediction and evaluation of the risk of ground collapse disaster caused by coal mining predicts that the ground collapse is likely to be caused by the ground subsidence area, the harm degree is large, and the development degree of ground collapse is strong. According to the classification table of the prediction and evaluation of the risk of ground collapse disaster, the risk of ground collapse disaster caused by the predicted ground subsidence area is large. Prediction of the risk of ground fissures caused by coal mining Ground fissures are likely to be caused by ground subsidence areas, with a large degree of harm and a strong degree of development of ground fissures. According to the classification table of ground fissures risk prediction and assessment, the risk of ground fissures caused by ground subsidence areas is high.

（2）The risk prediction and evaluation of geological disasters in the evaluation area

Industrial sites and mining roads are located outside the influence range of ground collapse and ground fissures, and are less likely to suffer geological disasters of ground collapse and ground fissures. There is no surface deformation and ground cracks, no cracking phenomenon and no cracks in the surface buildings (structures), and the geological disasters of ground collapse and ground cracks are weak and their harm degree is small. Therefore, the industrial site and mining road suffer from ground collapse, ground crack geological disaster risk is small. It is predicted that the village in the ground subsidence area is Sujiayao Village, which is located in the area affected by ground collapse and associated ground cracks. The village is highly likely to suffer from ground collapse and ground cracks, and the surface buildings (structures) may crack or even collapse. The geological disasters of ground collapse and ground cracks are highly developed and the harm degree is large. Therefore, it is predicted that the villages within the range of ground collapse will suffer from ground collapse and ground fissures. Some sites of coal storage yard are located in the influence range of predicted ground collapse and associated ground cracks, so it is highly likely to suffer ground collapse and ground cracks, and the surface buildings (structures) may crack or even collapse. The geological disasters of ground collapse and ground cracks are highly developed and the hazards are moderate. Surface collapse deformation and ground cracks caused by ground collapse in goaf may cause uneven road collapse or wrong fault, which will affect traffic and threaten pedestrian safety. The geological disasters of ground collapse and ground fissures are highly developed. Its harm

degree is great. Surface collapse deformation and ground cracks caused by ground collapse in goaf may cause uneven collapse or wrong break of roads and ditches, and tilt or tilt of electric poles, thus affecting local people's access and electricity safety. However, the road and power transmission line are of low level, the repair measures after damage are simple, the repair difficulty is small, the economic loss is relatively small, so the road, transmission lines and other public facilities suffer from geological disaster risk is small.

(3) Comprehensive zoning assessment of geological hazard risk

According to the present situation assessment and forecast assessment of geological hazard, the assessment region is divided into one large geological hazard area and one small geological hazard area. Among them, the subsidence area is the geological hazard area, and the other areas are the geological hazard area. It is predicted that the risk of geological disaster in ground subsidence area is high and that in coal storage area is medium.

3.2.2 Prediction and assessment of effects and damage of aquifers

(1) Normal mine inflow

According to the data provided by the mine, it is predicted that the normal water inflow of the mine in future production is 6648m^3/d (277m^3/h), the maximum water inflow is 13296m^3/d (554m^3/h), and the normal water inflow of the mine is between 3000-10000m^3/d. Therefore, mining activities have a serious impact on aquifer water volume.

(2) Prediction and evaluation of damage to aquifer structure by mining activities

After coal mining, overburden deformation in goaf can be divided into three zones, namely falling zone, fracture zone and bending deformation zone. If caving and fracture zone are highly connected with overlying aquifer, the overlying aquifer will not only be drained when mining coal seam, resulting in mine water inrush and other disasters.

The overlying rock of coal seam roof in this area is mostly sandstone, belonging to medium hard rock. According to the Regulations of Coal pillar placement and Coal pressing mining for buildings, water bodies, railways and main shafts and lanes, the height of falling zone and water-conducting crack zone formed by coal seam mining can be calculated according to the following formula:

$$H_m=\frac{100\sum M}{4.7\sum M+19}\pm 2.2 \quad \text{……(2-1)}$$

$$H_{li}=\frac{100\sum M}{1.6\sum M+3.6}\pm 5.6 \quad \text{……(2-2)}$$

Where: Hm -- height of falling zone, M;

Hli -- Height of water-conducting fracture zone, m;

Sigma M -- seam thickness, M.

During the service life, the thickness of No.2 coal seam is 3-10.00m. According to calculation, the height of caving zone formed after mining is 8.22 ~ 12.62m, the height of water-conducting fracture zone is about 45.42 ~ 56.62m, and the maximum height of water-conducting fracture zone in caving zone is 12.62+56.62=69.24m.

The aquifer is 24-124m away from er1 coal seam, and most sections are within the influence height of the water-conducting fracture zone of the caving zone. After the mining of Er1 coal seam, the roof of the coal seam falls across and the resulting fracture zone damages the aquifer structure. Therefore, it is predicted that the influence degree of mining activities on the aquifer structure is serious.

The fractured confined aquifer of sandstone at the top of Er1 coal seam is the aquifer directly filled with water in the roof of Er1 coal seam. The thickness of the aquifer is 10-30m, the lithology is dense and hard, and the cracks are not well developed. Q =0.0021L/s.m, K= 0.0088-0.848m /d.The roof of the coal seam falls across because of the use of long-wall backward mining, and the resulting fracture zone damages the aquifer overlying the coal seam, and the mining of no.2 coal seam may cause a certain degree of drainage effect on the aquifer structure, so it is predicted that the mining activity will have a serious impact on the aquifer structure.

(3) Prediction and evaluation of the impact of mining activities on aquifer water level

Mining pumping is a necessary workflow that causes a drop in the surrounding groundwater level while draining the ore bed water. Long-term continuous pumping forms a groundwater drop funnel centered on the mining site, which belongs to the area of influence of aquifer drainage. This range is affected by the water abundance, permeability coefficient and pumping amount of rock. The following formula is used to calculate the influence range of mining on aquifer drainage

$$R=2S\sqrt{HK} \quad \text{……(2-3)}$$

Where R -- influence radius of pumping and draining, m;

S -- water level drop, m;

H -- aquifer thickness, m;

K -- Permeability coefficient, m/d.

After coal mining in the evaluation area, the water level of the roof aquifer of no.2 coal seam will decrease. According to the hydrogeological data of the mining area, the thickness of fractured confined aquifer in sandstone roof of No.1 coal seam is 10-30m, with an average thickness of 20m and permeability coefficient K=0.091m/d. According to the hydrologic hole pumping test data in the area, the current static water level elevation of the aquifer is -71m, and the average mining level elevation of no.2 coal seam is -120m, so the water level drop depth S of the aquifer is about 49m.These values are substituted into the above equation for calculation, and the influence radius of pumping and dredging after coal mining in the evaluation area is 132m.The mining area is about 610 ~ 1600m in length from east to west and 460 ~ 700m in width from north to south. It can be seen that the influence of mining on underground aquifer is smaller than the mining area and has no regional characteristics. The prediction and evaluation show that mining has a serious impact on the water level of the aquifer.

3.2.3 Prediction and assessment of impact and damage degree of topography, geomorphology and landscape

There are no geological relics and cultural landscapes in the area, such as scenic spots, natural reserves and scenic tourist areas. Under the present condition, the main factors affecting and destroying the topographic and geomorphic landscape are predicted subsidence area, soil extraction site, industrial site, coal storage site and mining road.

(1) Prediction of subsidence area

According to the geological disaster prediction and evaluation, the predicted subsidence area is 83.70hm^2 (0.07hm^2 repeated area has been deducted), and the maximum depth of subsidence is 3.34m.Collapse is distributed in most areas of the surface of the proposed mining area, and the change of geomorphic form is obvious to a certain extent. Therefore, it is predicted that the impact and damage degree of ground subsidence area on the native topographic and geomorphic landscape are serious.

(2) Soil collection site

After the end of mining, the villages in the predicted subsidence area need to be reclaimed and covered with soil. Therefore, it is proposed to build a temporary earth collection site in the mining area, located in the southern boundary of the mining area, with a total area of 0.43hm^2.The thickness of soil is 4 ~ 10m.The soil harvesting site destroys the original landform, changes the consistency and coordination of the surrounding landform, and affects and damages the original landform and landscape seriously.

(3) Industrial sites

The industrial site covers an area of 4.13hm^2, and the height of the buildings in the site is generally 3-15m. In the future mining process, the industrial site will continue to occupy the land, destroy the original terrain, change the consistency and coordination of the surrounding landform, and have a serious impact and damage on the original terrain and landform landscape.

(4) Coal storage yard

The coal storage yard covers an area of 0.42hm^2 and is predicted to be 5-8m high. The continuous compression of coal storage destroyed the original landform, changed the consistency and coordination of the surrounding landform, and affected and damaged the original landform and landscape seriously.

(5) Mine roads

One mining road was formed in the mine, covering an area of 0.24hm^2.Continuous compression has changed the consistency and coordination of the surrounding landforms and seriously affected and damaged the native landforms and landscapes.

3.2.4 Prediction and evaluation of land resource destruction

Under the current conditions, the main impacts and damages of the evaluation area on land resources are predicted subsidence area, soil extraction site, industrial coal storage site and mining road.

(1) Prediction of subsidence area

During the service life, the area of new subsidence area in the evaluation area is 83.70hm^2 (0.07hm^2 repeated area has been deducted), and the maximum depth of subsidence is 3.34m.The subsidence area destroyed 74.06hm^2 of farmland, all basic farmland.1.86hm^2 of garden, 0.90hm^2 of grassland, 2.11hm^2 of rural road and 0.26hm^2 of village were destroyed. Because the subsidence area is predicted to destroy the basic farmland, the subsidence area is predicted to have a serious impact on land resources and damage degree.

(2) Soil collection site

The soil collection site covers an area of 0.43hm^2, and the thickness of soil collection is 2-5m.All the damaged land was other forest land, and the damaged grassland was less than 2hm^2. Therefore, the impact and damage degree of soil collection site on land resources was relatively light.

(3) Industrial sites

The industrial site in the appraisal area covers an area of 4.13hm^2, and the occupied land type is mining land. Industrial

sites have less impact and damage on land resources.

(4) Coal storage yard

The coal storage yard covers an area of 0.42hm^2, and the land occupied is town, village, industrial and mining land, which has a light impact and damage on land resources.

(5) Mine roads

Mine road covers a total area of 0.24hm^2, and the land occupied is mining land, which has a relatively light damage to land resources.

3.2.5 Comprehensive zoning of mine geological environment influence degree prediction

According to the mine geological disasters, aquifer, landform landscape, four aspects of land resources, the result of the mine geological environment impact prediction could be divided into mine geological environment in predicting subsidence are determined comprehensively affected area, industrial sites, coal yard, earth-fetching area, mine road is divided into mining area with severe geological environment impact, the other section is divided into mine geological environment impact is lighter.

4. MINE GEOLOGICAL ENVIRONMENT PREVENTION AND CONTROL PROJECT

4.1 Prevention and control project of geological disaster prevention area

(1) Predict the prevention and control project of the subsidence area

Subsidence cracks are the main form of surface deformation in coal mines. Subsidence cracks occur in various land use types in different subsidence stages, mainly concentrated in the edge zone of coal pillar and mining area boundary, as well as the edge zone of different subsidence depth. Before land reclamation, the cracks should be filled up and remedied in order to restore land function and prevent soil erosion.

In view of the convenient transportation in the area and the fact that there are perfect trunk roads and branch roads outside the reclamation area, the design can only repair the rural roads in the reclamation area. The damaged roads are mainly caused by ground collapse in and around the subsidence area. The comprehensive prevention and control measures, such as filling with filling, tamping after filling, repairing and maintaining after mining, should be taken to control the damage of public facilities, such as uneven settlement or wrong break of road, tilt or tilt of electric pole caused by mining process.

(2) Industrial site prevention and control area control engineering

The industrial area of the mining area is 4.13hm^2, which is divided into two areas: office living area and production area. The area of office living area is 0.58hm^2, and this part of land is permanent construction land. The production area covers an area of 3.55hm^2, mainly including gangue discharge field, machine repair room, shaft, etc. After the mine is closed, the construction structures in the production area will be dismantled, including the building foundation, equipment foundation, wall, etc., and the waste slag removed will be directly used for backfilling the shaft.

4.2 Deployment of prevention and control engineering in aquifer damage prevention and control area

The mining party shall strictly implement the water pollution prevention measures proposed in relevant documents. The mine drainage and other production and domestic wastewater generated by coal mine production shall be treated by sewage treatment plants and recycled after reaching the standard, so as to improve the utilization efficiency of water resources. In the process of treating and controlling mine water pollution, biochemical method, reverse osmosis method, thermal method, wetland ecological engineering method and other treatment methods can be adopted [6].In production should actively use the water such as "limit" high mining coal mining technology, mining the reasonable design parameters, reduce lead water fracture height, reduce the damage to the surrounding rock in the coal mine, to reduce the emissions of mine water, so as to reduce the impact on the surface water and groundwater, to ensure that the mining right big impact on residents' production and living water.

Draining groundwater is an important safety measure in mining activities. At the same time, it destroys the structure of aquifer and affects the supply of water for production and life, thus constituting a contradiction. Grouting reinforcement measures for underground areas with water inrush risk and concrete arch walling support for poor surrounding rock in roadway to improve sealing and compressive strength of roadway to surrounding rock can reduce mine water inflow and protect aquifer and mining personnel. This measure is closely related to mining, and the project put into the mine should be included in the safety production cost.

The mine aquifer damage is mainly arranged to monitor the damage of aquifer, and the specific engineering quantity is included in the monitoring project summary; Artificial control measures such as filling fissures and flattening steep slopes should be taken in the local water leakage area, and the specific engineering quantity should be included in the ground crack

prevention and control project. The mine side should increase the drainage facilities and capacity of the mine and production area to prevent the increase of accidental water quantity from affecting the safety of the mine. Optimize production layout and coal mining methods to avoid the harm of quaternary loose layer pore water drainage to mine water filling; In order to prevent the occurrence of confined water inrush from floor limestone, the technical measures of combining drainage and plugging are adopted, that is, the water of carboniferous upper Taiyuan Formation aquifer directly filled with water in coal seam floor is mainly drained, and the water of Ordovician and Cambrian aquifer indirectly filled with water is mainly blocked.

4.3 Deployment of mine geological environment monitoring project

Monitoring mainly includes mine geological environment problems and main environmental factors, such as ground collapse and ground crack caused or possibly caused by mine construction and mining activities.

Leveling survey is used to measure surface movement, and l980 Yellow Sea elevation system is used. Instruments and scales should be checked and measured before operation. The measuring method was used to read, and the visual distance was read directly. The observation was conducted in the order of one after the other before the other. The accuracy reached grade four, and the error in observation was less than 25mm/km. In the active period of surface movement, intensive leveling is carried out to determine the dynamic process of subsidence, and patrol observation is often carried out to provide data for determining the dynamic movement and deformation of the surface. In addition, it can be determined that the surface movement process is basically stable when the accumulated subsidence value of all points on the surface is less than 30mm observed for six consecutive months.

5. CONCLUSION

Taking zhengxingsu coal mine in Luoyang as an example, this paper provides a basis for the implementation and management of mine geological environment management, minimizes the impact of mining activities on the geological environment, realizes the effective protection and restoration of mine geological environment, and implements the obligations of mining enterprises to protect and manage mine land and geological environment, It provides technical support for mining enterprises to implement mine geological environment protection and management, and provides a basis for the effective supervision and management of mine geological environment by government administrative departments.

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