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Study on the Mining Plans for $7_1$31 Working Face under Loose Aquifer

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Abstract Qidong Coal Mine is hydrologically one with complex types. Thickness of loose aquifer in the Cenozoic strata is controlled by paleotopography, varying from 189.25 to 453.00 m. Gravel aquifer - the fourth aquifer with a thickness of 50 m is developed in the bottom, whose hydro-static hydraulic pressure reaches 3.7 MPa, directly overlaying above the coal measure strata. 17 crushing and water inrush accidents occurred during the mining on the working face near crops, of which the water inrush volume while recovering on the $3_2$22 working face reached 1520 m^3/h, making the mine be flooded. With many years' mining experience, a successful system of experience is summarized and applied to $7_1$31 working face. Presplitting blasting technology of roof management is applied in water control, resulting in the boost of innovation of water protection technology.
Keywords fourth aquifer, crushing, reasonable coal rock pillars, presplitting blasting

General Situation

Qidong coal mine is located in the Sunan mining area. The working seams are: Shanxi formation, lower Shihezi formation, upper formation of Permian. The thickness of loose aquifer in Cenozoic in the mining area varies from 189.25 to 453.00 m, controlled by paleotopography. There is a gravel aquifer - the 4th aquifer with a thickness about 50m in the bottom and overlaying on the coal measure strata, its hydrostatic pressure reaches up to 3.7 Mpa. Great variations are shown in the lithological association, thickness, and rich water. The complexity in the distribution of the fourth aquifer causes serious threats to the safe-mining in the mining area.

Water situation and crushing of the coal seam's working face over the years

Affected by terrain and landform, hydrogeological condition in the Qidong mining area is moderately complex. As for the working faces, coal petrography columns met the requirement of " Three Down" Mining regulations, but water inrush still occurred to the face. Since the operation, 17 crushing accidents happened to the 8 integrated mining working faces-$3_2$22, $7_1$14, $7_1$12, $7_1$30, $7_1$21, in which there are 15 water inrush accidents accompanied with the crushing accidents.

Analysis of causes and influence factors for crushing and water inrush of the working faces

Although coal petrography columns met the requirement of Regulation for mining under water bodies for the working faces, crushing and water inrush still happened. There are two reasons(Table 1 shows the statistics for every crushing and water inrush in Qidong coal mine):

① The pressure bearing capacity of the loose aquifer is not considered while setting coal petrography column to follow the Regulation for mining under water bodies . Because the fourth aquifer overlaps on the base rock directly, for one thing that the watertight performance of the aquifuge between coal seam and the fourth aquifer is weakened. While the combined action with the mining pressure further aggravates the fracturing in the hard upper roof of the coal seams.

② In the Regulation for mining under water bodies , theory of the caving zone and water conducted zone is based on slicing mining for coal seams, but there had been no scientific conclusion for the rules of caving zone and water conducted zone in the fully-mechanized coal mining. So it's essential to make a synthetic study on the failure law of overlaying strata in the fully-mechanized coal mining process, under specified condition of the overlaying strata's structure, to obtain the real rules so as to guide the setting up of safety coal petrography columns on the working faces. Based on many recovery experiences in the mining area, successful experiences have been summarized. Example of the applied mining plan for the $7_1$31 working face is as shown below.

Table 1 *Statistic table for every water inrush and crushing in Qidong coal mine*

Name of working face	Thickness of rock pillar while crushing(m)	Hydraulic pressure （MPa）	Water volume (m^3/h)	Crushing time
$3_2$22 Fully-mechanized coal mining	66	3.7	1520	Nov.25,2001
$3_2$21	99	3.9	238.5	Aug. 2002
Gaopu	130		178	Dec. 2002
$3_2$48 Fully-mechanized coal mining	260			April 2005
$7_1$14	72	3.7	71	2004.7.29
Fully-mechanized coal mining	80		169	2005.1.16
$7_1$12 Fully-mechanized coal mining	128	3.9	85	2006.10.1
$7_1$30 Level Fully-mechanized coal mining	48	3.2	91	2009.5.3
$7_1$30 Level Fully-mechanized coal mining	43		260	2009.6.7
$7_1$30 Fully-mechanized coal mining	47		850	2009.6.29
$7_1$30 Outer segment Fully-mechanized coal mining	44		92	2009.8.29
$6_1$30	45	3.2	60	2009.9.13
Outer segment	42.5		24	2009.10.24
Fully-mechanized coal mining	43		53	2009.11.14
$7_1$21 Fully-mechanized coal mining	72	3.7		2009.11.24

Selection of recovery plan on $7_1$31 working face

General situation of $7_1$31 working face

$7_1$31 working face is located in east wing of the third horizontal mining area, with a strike length of 1630 m and a trend length of 166 m. The upper part of the working face is the gob of the $7_1$30 working face, in the middle of which there is a protection pillar as 5 m long. The distance between the upper part and the gob of $6_1$30 working face is 32 m. The average thickness of the coal is 3.6 m, with a recoverable reserve of 980000 tons.

Structure within the mining area and rim of the working face is relatively simple, generally monoclinic. Fluctuations are shown in the occurrence of the coal seam partly. Roof of the working face's top tray is compound roof, mainly consisted of sandstone, mudstone and carbonaceous mudstone. Of which the majority is sandstone, with a percentage of 70% and compressive strength of 108.4 MPa. The top and bottom trays are relatively flat, crevices are partly developed, rough and uneven in surface, belonging to the second category.

Recovery plan of the working face

Coal mining methods and techniques

Fully-mechanized coal mining is applied in $7_1$31 working face, wholly caving method is applied in the roof control. Model of hydraulic support is ZY10000/23.5/42 type, with a supporting height of 2350-4200 mm.

Set up anti-water protection safety coal petrography column reasonably

According to the requirements of the Regulation for mining under water bodies and the specific conditions for the $7_1$31 working face in the third mining area, considering the distribution of watery, bottom viscosity and bottom aquifer, and bedrock weathering zone, vertical height of bedrock column of the upper air way of $7_1$31 working face is about 66-71 m, larger than 65.6 m, which is the minimal vertical height of the anti-water safety coal petrography column for mining with the max designed mining depth of 3.40 m.

The reasonable and effective mining methods and supporting measures

According to the analysis on the crushing and water inrush of the working faces, the advance rate and supporting measures are important factors to crushing and water inrush. Reasonable optimization has been done for this on $7_1$31 working face.

By means of advance rate to prevent crushing, specific measures are used according to the different roofs. In the no- weighting stage, keep the working face pushing forward slowly at a constant and balanced speed; in the weighting stage, affected weighting zones should be pushed through quickly to avoid crushing on working faces with poor roof and not enough resistance from the stand .

Stands with working resistance of 10000 kN are selected for $7_1$31 working face to ensure no crushing of the working face in the mining and weighting processes.

The application of presplitting blasting technique

First weighting and periodic weighting distances of working faces are important behavior laws for mining pressure. Presplitting blasting technique is used in No. Ⅰ and Ⅱ block of $7_1$31 working face according to the acquired mining pressure behavior laws to control weighting step so as to avoid crushing caused by the fracturing of hard upper roof.

Proper water prevention and control

According to the predicted max water inflow of the working face, qualified water pumps and the drain lines are equipped with mechanical roadway and air way, flow of both water pumps

and drain lines are larger than 1.5 times of the max water inflow. Besides, two circuit feeding is applied to the working face to ensure that the overflowed working face can drain water normally.

Strengthen the overhaul and maintenance of the draining system, clean the water sump in time so as to ensure the stability and reliability of the draining system.

Reinforce the technical management of the working face, and make observation and analysis on the mining pressure and roof caving for the working faces. Reach the target of having a gradually continuous recovery, and at the same time confine the mining height strictly, mining beyond limit intensively is strictly prohibited.

Reinforce the hydrogeology investigation for working face and dynamic observation of water level for the wells, in the first weighting period, closely notice the structure condition of the working face and the relation between the variation of mining pressure and water yield of the working face. Dynamic observations are made for the water yield and temperature of the working face, and water samples are taken for inspection.

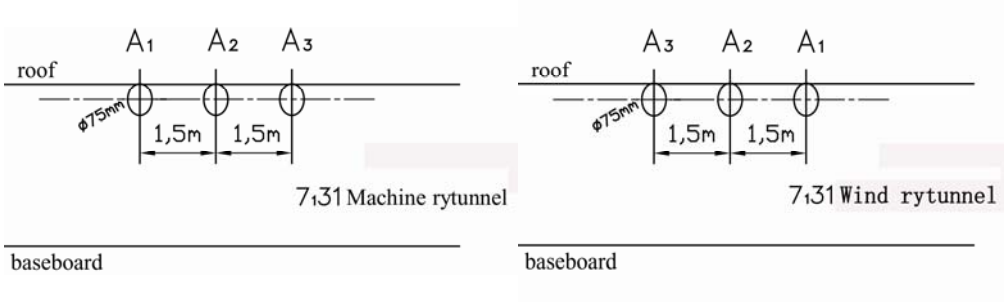

Fig.1 *Layout chart of presplitting holes*

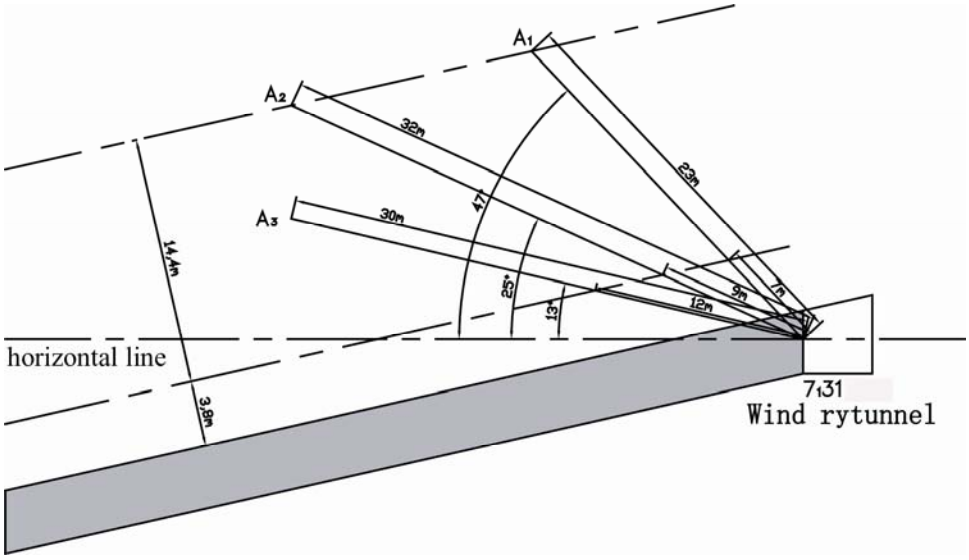

Fig. 2 *Designed layout chart of presplitting holes*

Conclusions

Under the condition of loose aquifer, deep hole presplitting blasting for key seam is an important way to solve the accidents caused by the entire fracture of underlaying strata, load of stands, steps and persistence length of weighting can be remarkably reduced after

presplitting blasting, which controls the crushing and water inrush accidents and leads to the safe recovery of the working face.

Control the roof with high resistance hydraulic support, adjust the mining height of the working face and the advance rate reasonably so as to accomplish the process control of the recovery period of the working face, and ensure the successful advance of the working face in the recovery period, and verify that ZY10000/23.5/42 hydraulic support is suitable for mining condition.

Online observation and analysis of hydrologic outlook long hole of the fourth aquifer around the working face and the setting load and working resistance of the hydraulic support should be done to give an early warning in time.