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Investigation into Key Strata Movement Impact to Overburden Movement in Cemented Backfill Mining Method

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Abstract

The overburden movement in cemented backfill mining is different from what it is in traditional longwall mining. This paper analyses the overburden movement in cemented backfill mining by using computer simulated model, observes the overburden movement in different mining advances distance, compares to traditional longwall mining and finds the characteristic of overburden movement in backfill mining. Studies show that the range of periodic weighting is relatively wide in back fill mining, and the weighting strength is also low; The key rock strata will be bending subsidence without failure situation. The displacement of overburden movement can be dramatically decreased. As a result, ground surface deformation can be well controlled.

1. Introduction

The backfill mining gradually become one of main technique in current Chinese coal mine, It can solve many problems such as excavating the coal seam under the building, reducing the waste rock disposal and controlling surface subsidence. It also has been used successfully in Xiao Tun and

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Xin Wen coal mine in China.

Most of the researches referred to traditional longwall mining roof pressure theories into backfill mining, it makes sense sometimes, but if we are concerned about the backfill supporting the roof and limiting the overburden movement, the immediate roof and main roof movement is different from traditional longwall mining, so we need to restudy this issue and find how the overburden move in backfill mining.

2. Cemented Backfill Mining Method

The materials of Cemented Backfill Mining Method(Fig 1)are waste rock, fly ash, cementing material and water. The cementing material is Ordinary Portland Cement 425#. The backfill process is presented in Figure 1. The waste rock needs to be crushed first. The crushed waste rock, fly ash, cement and water are mixed up well according to a certain proportion, and then pumped to gob. The whole backfilling process can be separated waste rock crush subsystem, mixing subsystem, pumping subsystem, face backfilling subsystem.

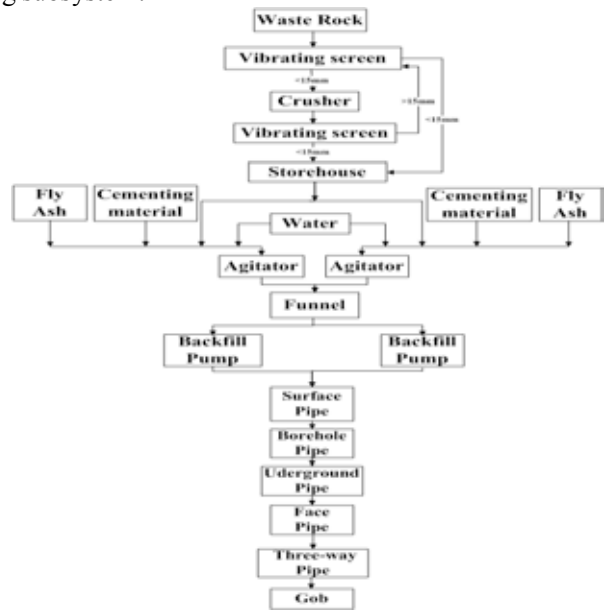

Figure 1 The process of solid waste rock cemented backfill mining

3. The overburden movement simulation model

The dynamic surface movement is controlled by the key strata, so it is better to control the surface deformation by researching the key strata movement.

3.1. numerical model

The model has 7 layers. Table 1 shows rock properties parameter of the model. The length is

400m, the height is 110m and the width is 80m. The mining depth is 103m.The key stratum is the 10 m thickness sandstone located at 30m above the coal seam in figure 3. The computer code used is FLAC 3D.

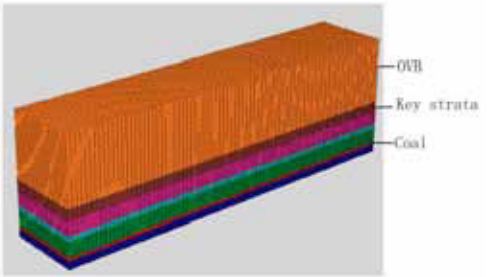

Figure 3 The numerical simulation model

3.2. Key strata movement in traditional longwall mining

The key strata and overburden movement in different mining advance.

(1) The figure 8 shows key strata movement in mining advances 60m, 100m, 125m and 150m.

When the mining advance is within 100-125m, the main key strata fall slowly, the movement displacement is 230mm. But when the mining advance is in 125m, the key strata movement increases sharply, the displacement reaches to 2.59m. And when the mining advance is in 150m, the main key strata movement keeps increasing, but falls slowly. It is indicated that the key strata have been breaking when the mining advance is within 100-125m.

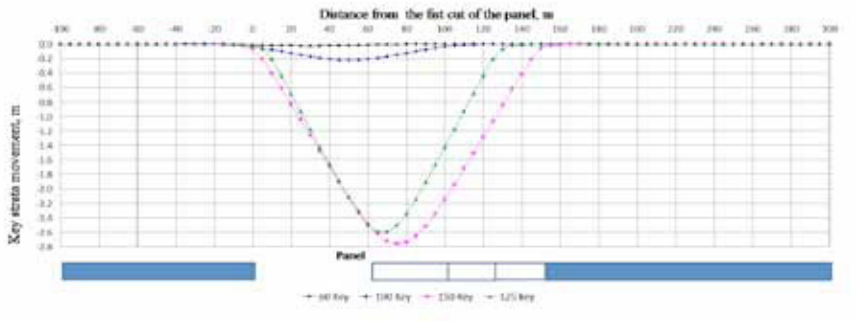

Figure 8 Key strata movement in different mining advances

（2）The figure 9 shows the surface subsidence in mining advances 60m, 100m, 125m and 150m.

According to figure 9, the surface subsidence is so small in mining advances 60-100m, it is just 159mm. When the mining advance is 125m, the subsidence increases sharply, the displacement reaches to 1.88m. And the face keeps moving forward, when the mining advance is 150m, the

subsidence keeps increasing, but falls slowly, the displacement is just 2.04m.

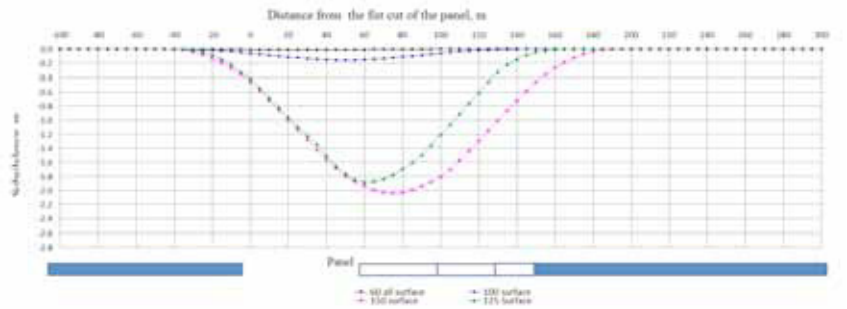

Figure 9 Surface subsidence in different mining advance

According to figures, the surface and key strata have similar movement trend, the surface falls slowly before the key strata broke. So the broken of key strata significantly effect on surface deformation.

(4)The surface subsidence velocity with mining advance

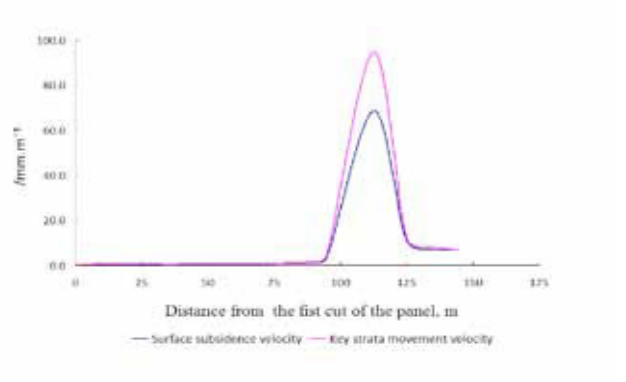

Figure 11 Surface subsidence velocity compares to key strata movement velocity

From figure 11, when the face advances in 100-125m, the subsidence velocity reaches to 68.68mm/m^{-1}， and the key strata subsidence velocity also reaches 94.51 mm/m^{-1}. When the mining advances after 125m, the subsidence velocity obviously slows down, it drops to 6.67 mm/m^{-1}, the key strata subsidence velocity drops to 6.81 mm/m^{-1}.

4. Key strata movement in backfill mining

Considering about the backfilling ratio and compressive ratio of backfilling material, the backfilling coefficient (k_f) is between 0.80~0.98. We choose backfilling coefficient is 0.9 in this paper. The mining high is 3m in model, so the backfilling high is $h_b=h*k_f=2.7$m.

(1) The figure 16 shows key strata movement in mining advances 60m, 100m, 125m and 150m.

General speaking, after backfill mining, the main key strata fall slowly, and it doesn't happen

that the movement increment increases sharply. It just bends and subsides gently, and doesn't break.

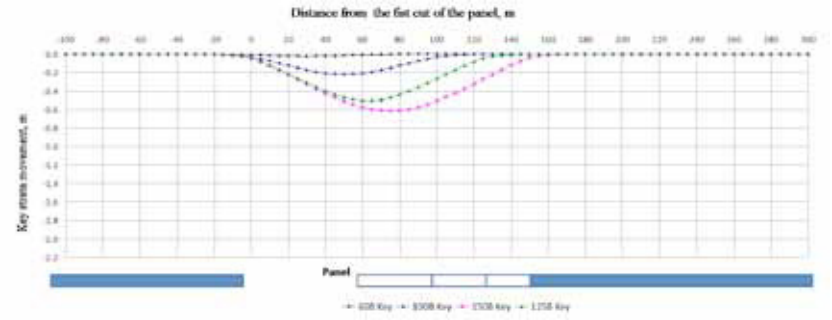

Figure 16 Key strata movement of backfill mining advances in different distance

(3) The figure 17 shows the surface subsidence in mining advances 60m, 100m, 125m and 150m. From figure 17 and 18, the surface subsidence is much less than traditional longwall mining.

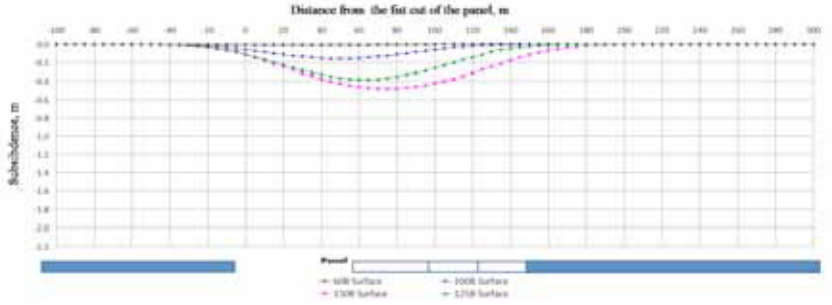

Figure 17 Surface subsidence of backfill mining in different mining advance

The figure 18 is the movement comparison between surface and key strata in backfill mining advance 150m. According to the figures, the surface subsidence is mainly impacted by the key strata movement.

(4) The surface subsidence velocity with mining advance

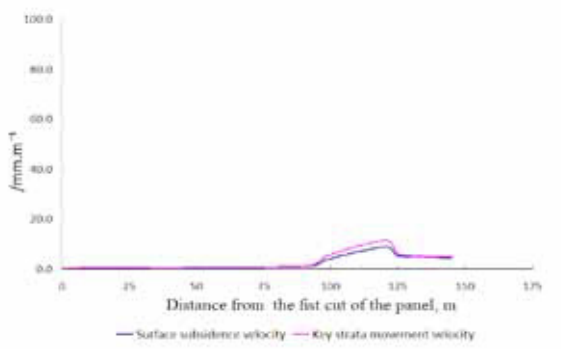

Figure 19 Backfill mining surface subsidence velocity compares to key strata movement

From figure 19, in backfill mining process, we could see that the velocity of surface subsidence and key strata movement is still consistent with mining advance. But the difference from traditional longwall mining is that the movement velocity doesn't rapidly increase.

(5) The contrast analysis of overburden movement between traditional longwall mining and backfill mining.

Table2 Cemented backfill mining compares to traditional longwall mining in 150m mining advances

	Traditional longwall mining	Cemented backfill mining	Difference
Key strata movement/m	2.76	0.618	2.142
Surface subsidence/m	2.04	0.483	1.557
Maximum subsidence velocity/ mm/ m^{-1}	68.68	8.82	59.86

From figure 20, 21 and table 2, in backfill mining method, the surface subsidence and key strata movement is much less than the traditional longwall mining, especially the key strata movement displacement decreases 2.142m, surface subsidence reduces 1.557m, and the max subsidence velocity decreases almost 60 mm/ m^{-1}. Also the max subsidence velocity shows up lately, it is indicated that the weighting interval has increased, and the weighting doesn't come obviously.

5. Conclusions

(1)The model simulated the overburden movement in traditional longwall mining. The key strata supporting the overburden generate deformation. When the strength reaches to ultimate bearing capacity, the key strata are breaking and the surface subsidence and subsidence velocity sharply increases, but before and after it broke, the velocity of surface subsidence tends to slow.

(2) The model also simulated the overburden movement in backfill mining. When the backfilling materials are up to certain strength, they will hold the immediate roof. In backfill mining, surface subsidence is very slow, the key strata are not sharp deformation and just bend- subside slowly with better integrity.

(3) The key strata play an important role in ground control. So if we can control the key strata movement, we could limit the surface deformation. Using cemented backfill mining method can effectively control the key strata movement range and surface subsidence.

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