

# Study on the Method of Prevention and Control of Dynamic Disasters in Isolated Island Face

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**Abstract**—In order to study the safe mining method of isolated island coal face, the stratum movement and stress condition of the island's working area are analyzed theoretically, and the criterion of safe mining in isolated island coal face was put forward. The paper holds that rational mining parameters can avoid the occurrence of dynamic disasters in island coal face. And results indicates that, When the island coal face length is greater than the sum of abutment pressure range of nearby coal faces, abutment pressures can not superpose, so that the coal face is relatively safe. When the length of the nearby coal face is greater than the fracture length of the key stratum, the key stratum can collapse. In this collapse, there is no danger of dynamic pressure in the island coal face, so that there is no risk of rockburst; and there is no risk when tunneling the mining gateway in a stable internal stress field.

**Keywords**—*island face, dynamic disaster, abutment pressure, key stratum, internal stress field*

## I. INTRODUCTION

The isolated island coal face caused by skip-mining is prohibited by the "Coal Mine Safety Regulations" [1]. However, due to the coal face succession and the need of production, in site operation, engineers often blindly ventures without any criteria and basis. Due to the high stress concentration in the crossheading and working face, dynamic disasters such as rockburst, mine earthquake, coal-gas outburst are very likely to occur [2-9]. For example, on July 29, 2015, the coal face of Zhaolou Coal Mine's #1305 suddenly produced huge sounds and vibrations happened in working face. In this accident, 19 workers in the coal face suffered from different degrees of harm. On December 25, 2015, a gypsum mine in Pingyi County, Shandong Province, suffered an collapse accident of the gypsum-column clusters. In this accident, many people were buried downhole. At the same time, an earthquake with  $MS=4.0$  was caused. In recent years, scholars have done some research on the mechanism of disasters in isolated island coal face [2-11], but the

academic and engineering circles have not yet fully understood stratum movement and stress conditions of disasters in the isolated island coal face, and have not yet fully understood safety mining of isolated island coal face. So until now no unified mining standard have been formed. In present study, we deem that as long as a certain mining conditions are controlled and the relevant mining parameters are properly setted, it is possible to control the occurrence of accidents related to isolated island coal mining.

## II. Multiple Accidents at Island Coal Face

Rockburst, coal-gas outburst all belong to the coal or rock dynamic disasters in mine. They are strong reaction forms of mine pressure under it's action, and all have strong dynamic instability characteristics. Mining in high stress areas, maintenance of roadways and stoping are the main causes for the occurrence of various dynamic disasters.

An isolated island coal face refers to a coal face in which goafs are located on upper and lower sides or located on all sides( Fig. 1 )Due to the islands have mine around, the weight of the overlying strata is transferred to the island coal mass, forming a large area of high stress in the coal body(Fig. 2).In this situation, the three main roofs of goaf have been joined together which form an approximate "C" spatial structure. And because the large-area movement of this structure ,the range of the lead abutment pressure in island coal face is 2 to 3 times bigger than that in common face [12].In high stress areas, there is a high possibility of accidents for mining and maintenance of roadways and mining face.Because there are large areas of high stress in the island coal face, so the double crossheading support and maintenance is difficult in the it.And in these positions,dynamic disasters such as rock burst, coal-gas outburst are more likely to occur.

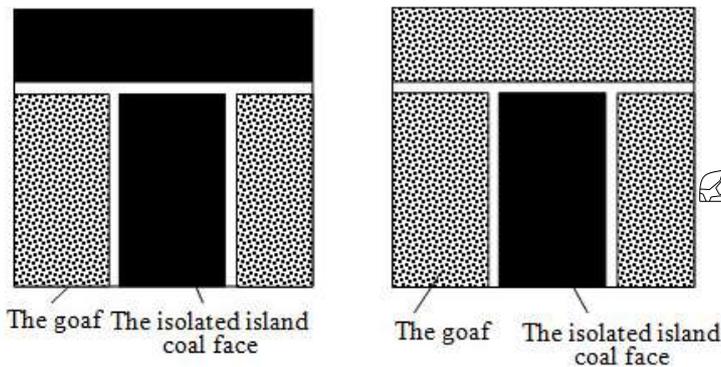


Fig. 1 The isolated island coal face

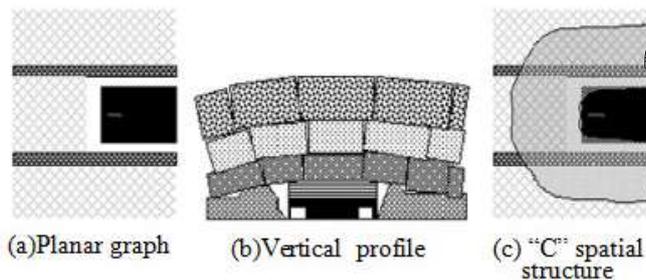


Fig. 2 The spatial structure of the island coal face and the high stress area [12]

### III. PRINCIPLE FOR SAFE MINING OF ISLAND COAL FACE

Although there are many dynamic disasters occurred on the island coal face, there are also conditions for its occurrence. But not all island coal faces inevitably appear by dynamic disasters. The paper believes that there are three relationships that must be considered in the safe mining of island coal face. Detailed discussion is below.

#### A. The relationship between the island coal face length and the influence scope of abutment pressure on nearby coal face

During When the island coal face length is less than the sum of abutment pressure range of nearby coal faces, as shown in Figure 3(a),

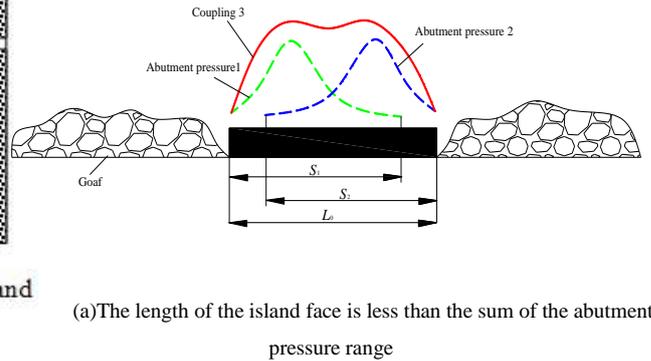
$$L_0 < S_1 + S_2$$

Due to abutment pressures on both sides superimposed on each other, it will increase exceedingly in island coal face, so that the value of stress peak and the high stress area increases relatively. This causes both mining gateway and the island coal face in danger.

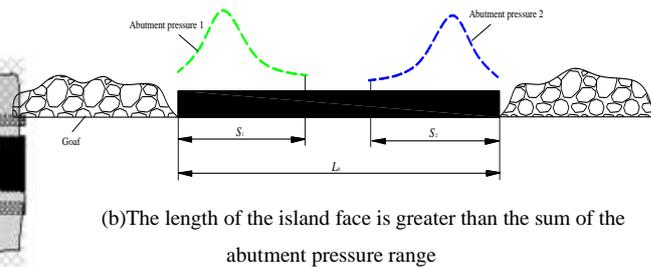
When the island coal face length is greater than the sum of abutment pressure range of nearby coal faces, as shown in Figure 3(b),

$$L_0 > S_1 + S_2$$

Because of the length of the island coal face is greater than the sum of the abutment pressure ranges of nearby coal faces, the abutment pressure on both sides will not be superimposed, and the stress peak and its range will not change much. In this situation, the mining gateway and island coal face are relatively safe.



(a) The length of the island face is less than the sum of the abutment pressure range



(b) The length of the island face is greater than the sum of the abutment pressure range

Fig. 3 The relationship between the length of the island coal face and the sum of the abutment pressure range

Therefore, in order to ensure the safe mining on the isolated island coal face, its face length must be long enough. So that the island coal face length is greater than the sum of abutment pressure range of nearby coal faces to prevent the occurrence of dynamic disaster caused by superposition of the abutment pressure on both sides.

#### B. Relationship between length of nearby coal face and fracture length of key stratum

The isolated island coal face formed by skip-mining often induces severe rockburst, because its nearby coal face's length is setted unsuitable. Traditional view holds that the smaller the nearby coal face, the safer the isolated island coal face. This is not actually true. Whether or not the coal face is affected by strong dynamic pressure depends on the position of nearby coal face's key stratum of covering rock. When its nearby coal face's length does not reach key stratum of covering rock, the key strata will not be broken (Fig. 4(a)). In the process of mining the nearby coal face, the roadway and the coal face will not be affected by strong dynamic pressure and are in a safety state. However, when mining the island coal face, the suspended area is equivalent to the length of the three coal faces (Fig. 4(b)), it will inevitably lead to the accumulation of compressive elastic energy in the coal pillar and cause the breaking of the key stratum and the releasing of the bending elastic energy. This will cause serious dynamic pressure shocks whether in the mining roadway or in the coal face.

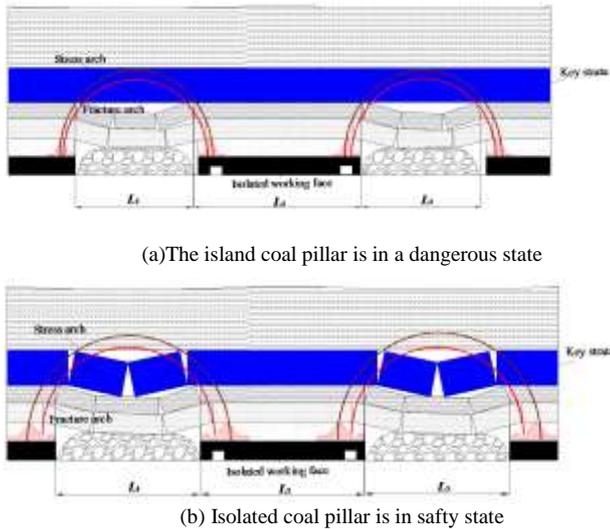


Fig. 4 Relationship between length of nearby coal face and fracture length of key stratum

Therefore, the viewpoint that ‘the smaller the length of the nearby coal face of the island coal face is, the more secure’ is not true. So in order to ensure that the island coal face is not effected by the dynamic pressure of the fracture of the key stratum, the length of its nearby coal face must be greater than that of the first fracture length.

C. Temporal-spatial relationship of gateway tunneling in island coal face

The space and time of gateway extraction in island coal face have important influence on roadway safety. Excavating and maintaining roadway in correct space and time conditions is the key to ensure roadway safety.

(1)Influence of roadway excavation’s position on the occurrence of rockburst (spatial effect of rock burst)

With the stope advancing, the stress in the original gravity stress field will be redistributed. According to the differences in stress magnitudes,the redistributed stress field is divided into low stress area ( $\sigma < \gamma H$ ), high stress area and original stress area that is not affected by the mining (Fig.5).Low stress area includes the internal stress field caused by gravity of faulted blocks and the stress in the plastic failure zone where the stress is smaller than the original stress;high stress area includes stress which exceeds the original stress in the elastoplastic zone.Obviously, in one mining pressure field,under the same depth of mining conditions, there will be significant differences in magnitude of the surrounding rock stress and the occurrence possibility of rockburst in the roadway where different parts are excavated. If the roadway (roadway 1) is to be excavated in a stable internal stress field, there is no possibility of rockburst no matter how deep the field is;if the roadway (roadway 2) is to be excavated in a high stress area, the chain pillar will happen rockburst inevitably;if the roadway (roadway 3) is excavated in the original rock stress area, not only a large amount of pillars are wasted, but also there is a danger of rockburst when the depth reaches a certain limit.

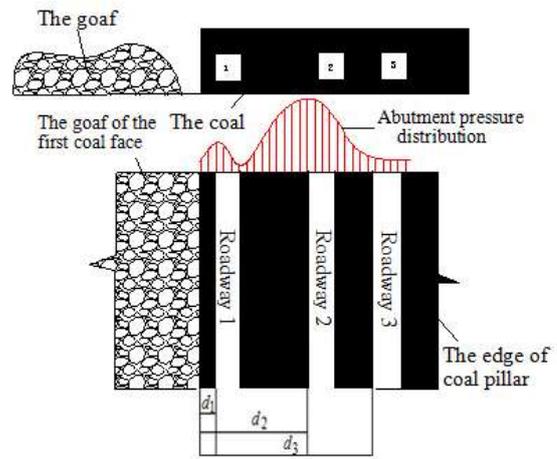


Fig.5 Mechanical model of tunneling in different position (2) Influence of roadway excavation time on rockburst (time effect of rockburst’s generation)

Roadway excavation time also has an important influence on the occurrence of rockburst. After the first coal face finished mining, it’s rear roof faulted from top to bottom.How far the heading face laggess the first coal face determines whether it happens rockburst. If the excavation roadway lags behind the first coal face (Fig. 6, roadway 2), its roof is in a fixed state and its back part stores a large amount of moment and bending elasticity when excavate under it the stored energy will release. ; if the roadway lags behind the first coal face far enough (more than  $L_0$ ) (roadway 1), it’s roof has been fractured and settled to its stability, and its stored moment has been released, the chain pillars will be in a safe state;if the two excavation roadways (roadways 3 and 4) are facing each other,the extension and intensity of the rockburst failure will increase exponentially under the action of superposition of abutment pressure.

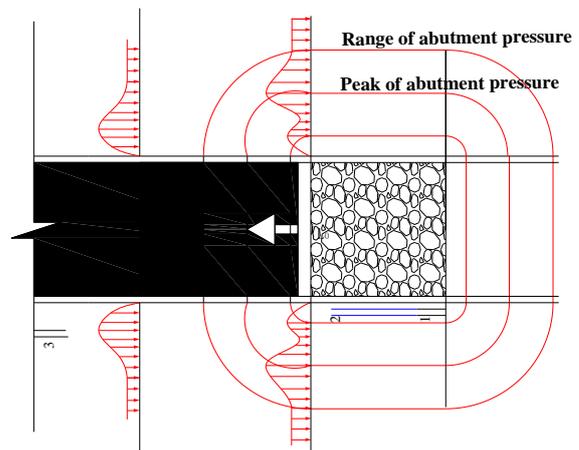


Fig.6 Time effect diagram of tunneling

IV. CONCLUSIONS

The isolated island coal face formed by skip-mining is frequently ventured in coal mines. The safety issue caused by it should be taken into consideration. This paper comprehensively analyzes the reasons of disasters in the isolated island coal face and summarizes the principles for safe mining. The main conclusions are as follows:

Affected by mining around the stope, the isolated island

coal face is easy to form a large range of high stress area and severe dynamic pressure shock in roofs, easy to induce rockburst, coal-gas outburst and other dynamic disasters.

By analyzing the stratum movement and stress condition of the dynamic disasters of isolated island coal face, it is considered that reasonable mining parameters can avoid the occurrence of this kind of disasters. When the island coal face length is greater than the sum of abutment pressure range of nearby coal faces, abutment pressures can not superpose, so that the coal face is relatively safe. When the length of the nearby coal face is greater than the fracture length of the key stratum, the key stratum of can collapse. In this collapse, there is no danger of dynamic pressure in the island coal face. So that there is a stable internal stress field, there is no risk of impact. In this case, there is no risks in mining gateway.

#### ACKNOWLEDGMENT

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