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FRACTURE MECHANISM OF HARD MAIN ROOF AND DETERMINING THE WIDTH OF COAL PILLARS WHEN EXTRACTING FLAT-LYING COAL SEAMS

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In underground coal mining, the stability of roadways and gob-side entry depends on the coal pillar width. An unreasonable width of the coal pillar will cause the roadway to be in a dangerous zone of influence of the abutment pressure, leading to severe roadway deformation. This paper studies the fracture mechanism of the hard main roof and reasonable coal pillar width to protect the stability of gob-side entry driving. The research results show that when mining a coal seam under a hard main roof, the console of the main roof on the edge of the coal seam has the form of hinge structure. The great load of the roof layers and the rotation of the console are the main causes leading to the variation of the stress field in the coal seam. According to the development law of the stress field, after the main roof completes the collapse process, the peak of the maximum stress will move deep into the solid coal seam, and on the edge of the coal seam it will form a low-stress zone. Research results from the case of Seam #11 of Khe Cham coal mine, Vietnam show that the gob-side entry will be well stabilized when the narrow coal pillar between it and the boundary of the gob is 4-5 m.

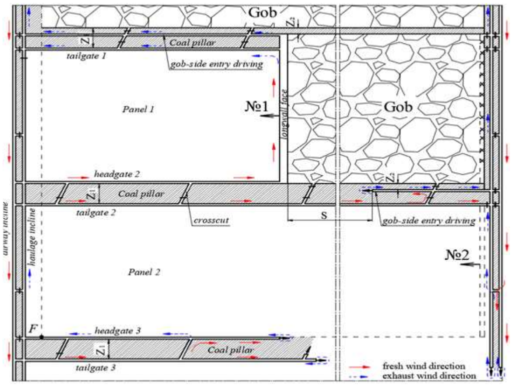

Fig. 1. Longwall mining system, in which coal pillar will be extracted together with the adjacent longwall face

Rys. 1. System ścianowy, w którym słup węglowy będzie wydobywany wraz z przyległym przodkiem

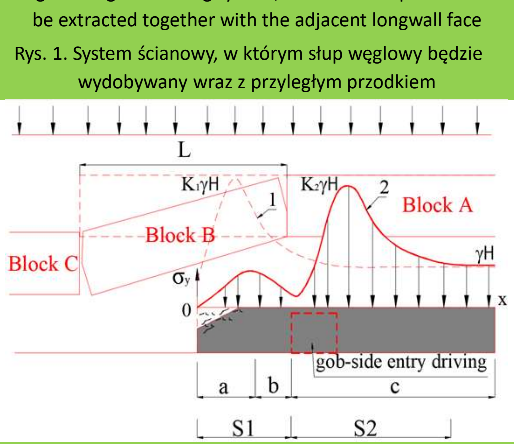

Fig. 2. Mechanical model of the "hanging-collapse" structure of the main roof and the stress distribution on the edge of coal seam

Rys. 2. Model mechaniczny konstrukcji „wisząco-zawaleniowej" stropu głównego oraz rozkład naprężeń na krawędzi pokładu węgla

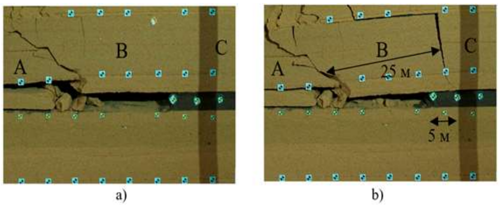

Fig. 3. Fracture mechanism of hard main roof: a - the formation and sagging displacement of the main roof; b - collapse of the main roof

Rys. 3. Mechanizm pęknięcia twardego stropu głównego: a - formacja i przemieszczenie ugięcia głównego dachu; b - zawalenie się dachu głównego

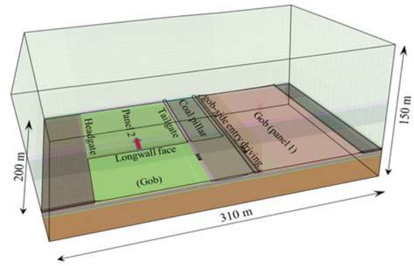

Fig. 4. Configuration of longwall model using FLAC3D

Rys. 4. Konfiguracja modelu ściany za pomocą FLAC3D

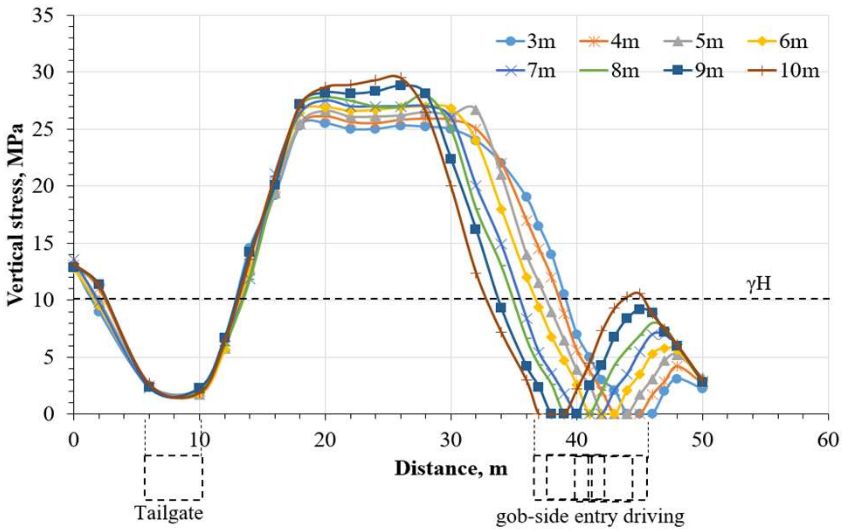

Fig. 5. Distribution of vertical stress with different narrow pillar widths

Rys. 5. Rozkład naprężeń pionowych przy różnych szerokościach słupków wąskich

The fracture mechanism of the main roof on the edge of the coal seam has been theoretically analyzed. The results show that, after the main roof collapses, two stress fields will be formed on the edge of the coal seam, including an external stress field (S1) and an internal stress field (S2). The boundary of these two stress fields is determined at the crack location of the main roof. A favorable location to excavate a gob-side entry should be located in the S1 zone (Fig.2).

A study by an equivalent material model shows that the fracture location of the main roof is 4-5 m from the boundary of the gob. After the collapse of the main roof, the peak of the maximum stress moved deep into the coal seam. Then, on the edge of the coal seam, there is a reduced stress zone due to the console of the main roof breaking and unloading into the gob. With this method, a favorable location to excavate a gob-side entry should be located between 4 m and 8 m from the boundary of the gob (Fig. 3).

Numerical simulation has demonstrated that a coal pillar which is too narrow (3 m) will be easily destroyed, and it does not guarantee stability and separation between the gob-side entry and the gob. As the pillar width increases, the stress concentration in the pillar also increases. However, the great stress concentration will not be favorable for maintaining the stability of the gob-side entry and coal pillar because the coal pillar has to play the main role in supporting the load of the roof rock layers. The deformation monitoring results show that the gob-side entry is stable when the width of the coal pillar is 4-5 m. As the pillar width increases, the stress concentration increases that leads to greater deformation of the gob-side entry (Fig. 4).