Study on Stability of Inter-panel Barrier Pillar in Underground Longwall Coal Mine under Weak Geological Condition in Indonesia

Hiroto Hashikawa

Laboratory of Rock Engineering and Mining Machinery

Department of Cooperative Program for Resources Engineering

1. Introduction

Indonesia is one of the world's leading coal-producing countries, and more than 99% of coal is produced from open-pit mines in Indonesia. However, the underground coal mining method began to be adopted to extract coal due to the increasing demand for coal and limited coal reserves that are suitable for surface mining. However, as the geological condition in Indonesia is very weak compared to that of the U.S., Europe, and Australia, where the longwall mining method is often applied, occurrence of various ground control issues is expected during underground coal mining operation. This study mainly focuses on the inter-panel barrier pillar. Designing an appropriate inter-panel barrier pillar under weak geological conditions is important to maintain the stability of the longwall face and the stability of the surrounding ground. This study discusses the stability of inter-panel barrier pillar in underground longwall coal mine under weak geological conditions in Indonesia by means of FLAC3D.

2. Numerical analysis

Figure 1 shows the numerical model used in this study. The model consists of panels 1 and 2, and an inter-panel barrier pillar between those panels. A half-section model is created for the enclosed area by the red dotted line. The thickness of the coal seam is 3 m. The width and length of longwall panel are 150 m and 200 m, respectively. The pillar width is changed to 10 m, 15 m, and 20 m in order to discuss the effect of pillar width on the stabilities of pillar and longwall face. The overburden depth is changed to 100 m and 200 m. An elastoplastic model with Mohr-Coulomb failure criterion is adopted. The stress ratio is 1.0.

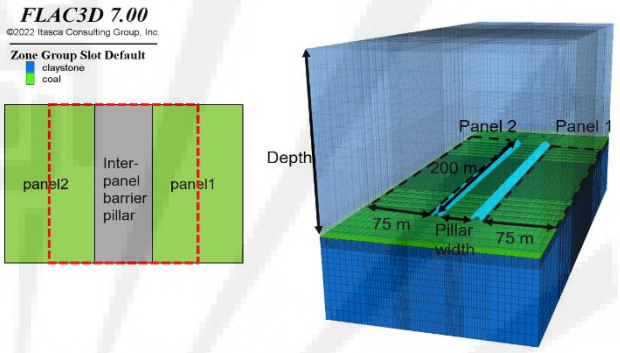

Fig.1 Numerical model.

3. Results and discussions

The analytical model is used to examine the stress acting on the inter-panel barrier pillar and to determine the safety factor of the pillars. The safety factor can be calculated from the ratio of the strength of the pillar to the stress acting on the pillar. Figure 2 shows the relationship between safety factor of the pillar and pillar width under different overburden depths. The pillar stability decreases significantly as the overburden depth increases. Table 1 shows the appropriate inter-panel barrier pillar width determined based on the design guidelines developed in the U.S. and that obtained from the results of a series of numerical analysis. For the 100 m overburden depth, the appropriate pillar width calculated by the two methods are 13.5 m and 13.6 m, respectively, which are very close to each other. However, for the 200 m overburden depth, the appropriate pillar width calculated by the two methods are 19.8 m and 25.8 m, respectively, and there is a large difference. Under weak geological conditions such as in Indonesia, the stability of inter-panel barrier pillar decreases significantly by increasing in-situ stress, and then the wider pillar has to be left compared to coal mines in the U.S. and Australia, where rock mass is high strength. Therefore, it is necessary to develop and apply new guideline for inter-panel barrier pillar for underground coal mines in Indonesia, because the existing design guidelines are insufficient especially when the mining depth increases.

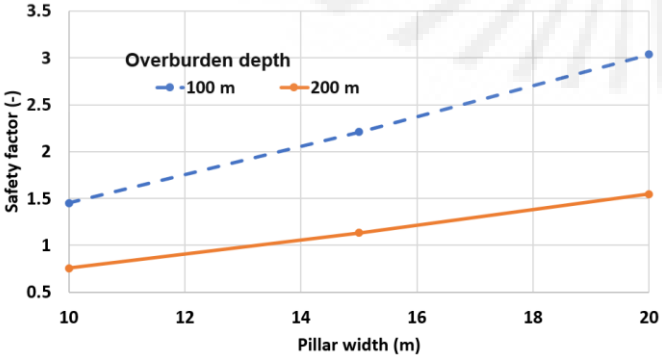

Fig.2 Relationship between the safety factor of the inter-panel barrier pillar and the pillar width under different overburden depths.

Table.1 Appropriate inter-panel barrier pillar width at each overburden depth.

	Guidelines developed in the U.S.	Analytical results
Depth: 100 m	13.5 m	13.6 m
Depth: 200 m	19.8 m	25.8 m