Numerical Simulation of Crack Evolution Mechanism and Subsidence Characteristics Effected by Rock Mass Structure in Block Caving Mining

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Abstract

In the block caving mining, the significant rock mass deformation and surface subsidence will be formed with the continuous extraction of ore. However, the internal crack evolution mechanisms in rock mass and associated subsidence characteristics present one of the key issues in rock mining engineering. Although block caving method has been used for many years, current knowledge of the crack evolution mechanisms, the subsidence characteristics under the influence of rock mass structure and subsidence prediction capabilities are limited. Based on the rock mechanics model provided by CEMI, crack evolution mechanisms and subsidence characteristics effected by the rock mass structure in block caving are numerically investigated using RFPA 2D, a numerical code based on FEM. Crack formation, propagation and coalescence in the overlying strata and the stress-balancing arch evolution in the stress field are represented visually during the whole process of extraction. The numerically obtained crack evolution shows that the stress-balancing arch has a significant influence on the fracture development of rock mass, and directly determines the slump form and rate of the rock mass. After understanding of the crack evolution mechanism in rock mass, the characteristics of surface subsidence are analyzed. Numerical experiments emphasize the geometrical configuration of joints and faults about mechanisms of subsidence development, including joints orientation, faults location and inclination, which can provide significantly meaningful guides for investigation of subsidence mechanisms and implementation of remedial measures.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

Elastic-brittle damage constitutive law of elements subjected to uniaxial stress. (a) The case under uniaxial tensile stress; (b) The case under uniaxial compressive stress

Figure 2

Conceptual representation of surface subsidence associate with block caving mining, subsidence characterization terminology

Figure 3

Rock mass mechanics model provided by CEMI [20]

Figure 4

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The rock mass deformation range for B1, B2, B3, B4, B5 and B6 models

Figure 15

Extent of 5cm surface vertical displacements at 160m ore extraction, m

Figure 16

Extent of 5cm surface horizontal displacements at 160m ore extraction, m