Computational study of pillars stability in longwall mining of adjacent panels of inclined seams

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Stability of coal pillars remains one of the most important practical problems for ensuring geodynamic safety of underground mining. Underground workings disturb strongly virgin state of stress and strain and cause their redistribution. Stress enhancement in the vicinity of openings is responsible for manifestation of rock, coal and gas bursting, immediate roof crushing into the working zone, the unsustainability of protective pillars. Stress-induced damage of pillars occasionally causes interruptions of mining due to outbursts. Filling working sections of air or conveyor roadways, caused by pillars failure, leads to stoppages in the operation of the mine equipment, as well as possible casualties among the personnel. The latter results in worsening of economic efficiency of mine and necessity to eliminate the circumstances of emergency situation. For this reason, development of scientific background for maintaining the operational properties of protective pillars is one of the most important task of geomechanics.

With development of high-performance computations technology, different numerical methods occupied a sufficient part of pillar stability calculations. The numerical modeling allows for explicit account of many factors affecting rock massif behavior. These are gravity forces, lithology, tectonic stresses, natural discontinuities, geotechnical and mining parameters. When model parameters are carefully calibrated against experimental and/or in-situ observations, the results of numerical modeling might provide a reliable basis for pillars stability assessment.

In this work, we apply finite-difference continuum damage mechanics approach to modeling stress-strain evolution of the rock mass during extraction of adjacent longwall panels of an inclined seam. The initial state of the rock mass is the result of gravity forces. We build a structural model of a rock mass containing an underground working on the basis of a simplified stratigraphy of the Kondomsky deposit, Kuznetsky coal basin, Russia. Based on the results of numerical modeling, the stability of coal pillars is analyzed.