

Experimental Study and Numerical Modelling of Failure of Rocks Typical for Kuzbass Coal Basin

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Abstract : Present work is devoted to experimental study and numerical modelling of failure of rocks typical for Kuzbass coal basin (Russia). The main goal was to define strength and deformation characteristics of rocks on the base of uniaxial compression and three-point bending loadings and then to build a mathematical model of failure process for both types of loading. Depending on particular physical-mechanical characteristics typical rocks of Kuzbass coal basin (sandstones, siltstones, mudstones, etc. of different series - Kolchuginsk, Tarbagansk, Balohonsk) manifest brittle and quasi-brittle character of failure. The strength characteristics for both tension and compression are found. Other characteristics are also found from the experiment or taken from literature reviews. On the base of obtained characteristics and structure (obtained from microscopy) the mathematical and structural models are built and numerical modelling of failure under different types of loading is carried out. Effective characteristics obtained from modelling and character of failure correspond to experiment and thus, the mathematical model was verified. An Instron 1185 machine was used to carry out the experiments. Mathematical model includes fundamental conservation laws of solid mechanics - mass, impulse, energy. Each rock has a sufficiently anisotropic structure, however, each crystallite might be considered as isotropic and then a whole rock model has a quasi-isotropic structure. This idea gives an opportunity to use the Hooke's law inside of each crystallite and thus explicitly accounting for the anisotropy of rocks and the stress-strain state at loading. Inelastic behavior is described in frameworks of two different models: von Mises yield criterion and modified Drucker-Prager yield criterion. The damage accumulation theory is also implemented in order to describe a failure process. Obtained effective characteristics of rocks are used then for modelling of rock mass evolution when mining is carried out both by an open-pit or underground opening.

Keywords : damage accumulation, Drucker-Prager yield criterion, failure, mathematical modelling, three-point bending, uniaxial compression

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