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A novel approach for modelling coal permeability during transition from elastic to post-failure state using a modified logistic growth function

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Abstract

Although many coal permeability models have been developed in the past decades to describe the coal permeability behaviour under elastic state, few of them address the coal permeability change under plastic and post-failure state which is often the case within the plastic region adjacent to the excavation face in underground coal mining. In this study, a methodology to model permeability change from elastic to post-failure state is developed by using a modified logistic growth function in conjunction with the classic exponential coal permeability correlation. The proposed coal permeability model is a function of mean effective stress which controls the coal compaction and deviatoric effective stress which controls coal fracturing. The coal permeability may increase by up to several orders of magnitude after failure and then reaches a plateau during triaxial tests. The new model is able to capture this behaviour by matching a set of permeability data in transition from elastic to post-failure state under triaxial stress conditions. This modelling approach may be used to better understand coal permeability changes associated with mining activities, which have applications in the prediction of gas emission, risk assessment of coal and gas outburst, and analysis of gas drainage near mining openings. It is anticipated that the current work may attract more attentions on coal permeability modelling under plastic condition, a critical issue for mining safety.

Keywords: permeability; coal; mining; elastic; failure; logistic growth function

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