Abstract

The inadequacy of barrier pillar width poses the most significant risk of accidental mine inundation from abandoned water-logged workings. This dissertation deals with developing design criteria based on a steady-state hydro-mechanical coupled numerical modelling approach for evaluating the rational size of PWBP and the adequacy of existing barrier pillars. It calibrated the strain-softening behaviour of coal pillars based on the laboratory test results. It also considered the effect of water on residual cohesion and friction, mobilization of dilation with plastic shear strain, and induced permeability and flow vector based on the induced volumetric strain and pore pressure as a function of the redistributed stress and failure condition of the rock mass forming the pillar for obtaining a realistic quantification of its mechanical and hydraulic performance.

The study evaluated profiles of induced volumetric strain, effective stress, permeability, and seepage through the pillar for varying strength cover depth, pillar width, in-situ permeability and flow regimes. The governing relations for assessing mechanical performance in terms of the zone of positive volumetric strain (ZOPVS) and the rate of water seepage through the pillar were established. A seepage severity classification was developed to decide the maximum permissible seepage for acceptable performance of the pillar. The critical pillar width for avoiding piping failure, controlled seepage width, rational pillar width, and acceptable water head were also delineated for safe working. The outcome of the study has also been validated for two case studies.