Grant Number: AFCRFP20-112

Title: Towards Reducing Rib Hazards in Underground Coal Mines by Improvement of the Coal Pillar Rib Rating (CPRR) System

Organization: Missouri University of Science & Technology

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Partnerships: NIOSH, Pittsburgh Mining Research Division

Focus Area: Health & Safety Interventions: Ground Control

Synopsis

Project Goal: Our proposed research aims to minimize rib failure hazards by further developing the CPRR system to aid in the selection of rib supports and identification of potentially hazardous rib conditions.

Research Approach:
1) Expand the CPRR empirical data set from its current 22 surveyed coal seams by conducting coal rib and rib support observations at 10 more underground coal mines throughout the United States with the support of our industry partners at Peabody Energy and Arch Coal Resources.
2) We propose to convert the coal-mass constitutive model from its current form, to be used only in FLAC3D, to a constitutive model that can be used in distinct element based solvers such as 3DEC, in order to include discrete discontinuities such as face/butt cleats, faults, and mining induced fractures. This will allow us to model both the stress driven and kinematic failure mechanisms commonly observed in underground coal mines.
3) Expand the CPRR calculation through DEM-based numerical simulations to include:
   - Plastic roof and floor conditions
   - Thick in-seam rock/coal partings
   - Strong rock/coal brows

Our compiled Coal-Mass constitutive model will be validated by comparing our results to those published by NIOSH researchers for the CPRR for solid coal ribs. Using 3DEC, a distinct element based solver, we will conduct a series of parametric studies to determine the impact of each new parameter (discontinuity spacing/ orientation, roof/floor conditions, thick in-seam partings, and strong rock/coal brows) on all over performance of the rib. We will then update the CPRR calculation sheet to include these features and make recommendations on the minimum ground support required for coal ribs as a function of CPRR and overburden depth.

Expected Project Outcomes: We expect the outcome of our research will be the eventual wide-spread use of the CPRR by coal mining engineers throughout the United States. The improved CPRR will provide mine operators with advanced notice to potentially hazardous conditions in coal pillar ribs, which can be proactively mitigated with the proper rib supports for the conditions at hand.