Grant Number: AFC719FO-101

Title: Mine-Specific**,** Geology-Dependent Pillar and Standing-Support Design Tools

Organization: West Virginia University

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Focus Area: Health and Safety Interventions Topical Area: Ground Control

SYNOPSIS

Problem Statement: In underground coal mines, pillar load, deformation and local ground response of the entries are affected by the local geology, in situ stress state and operational parameters of the mine and can change drastically from one coal basin to another, or even within the same mine. Design software developed by the National Institute for Occupational Safety and Health (NIOSH) for global pillar stability, Analysis of Longwall Pillar Stability (ALPS) and Analysis of Retreat Mine Pillar Stability (ARMPS), and for local entry stability, the Support Technology Optimization Program (STOP), have improved the design of stable pillar layouts and successful standing support systems. These design tools have successfully incorporated the influence of the mine operational parameters into the design. However, the mine-specific mechanical response of the rockmass due to the mine-specific geology is not included in the NIOSH design software.

Despite major progress in reducing ground control related fatalities and injuries between 2011 and 2019, fall of ground incidents still accounted for almost 30% of the occupational fatalities in underground coal mines (MSHA, 2020). Out of these ground control related fatal accidents, 25% of them were in longwall mines. Also, for fatalities related to ground control, 80% of them have occurred in areas with roof support (Sears et al., 2019). These statistics highlight the potential safety impact of fall of ground on underground coal miners. Safety in underground coal mines would be improved by enhancing ground control design software by incorporating mine-specific, geology-dependent, mechanical rockmass response into pillar and support design tools.

Expected outcome: The recent research presented in the final report for the AFC719-15 project was an initial step towards incorporating a mine-specific, geology-dependent overburden model into pillar design, and the results of this report have shown that: (i) an accurate mine-specific overburden model can raise the quality of the mine design and improve the safety of the underground coal miners, (ii) strong beds in the overburden can significantly influence the response of strata and the resultant load distribution, and (iii) the mine-specific, geology-dependent Ground Reaction Curve (GRC) can be developed on both a global and a local scale.

This project proposes (i) to develop mine-specific, geology-dependent mechanical loading models that will be immediately available to the mining industry, (ii) to improve the loading models developed in AFC719-15 further by including the 3D load concentration near the longwall tailgate T-junction split, and active panel loading condition in the retreat room-and-pillar mines, (iii) to improve the longwall

gateroad pillar design by incorporating the improved mechanical overburden model into the ALPS program, and (iv) to develop a local geology-dependent GRC analysis for the STOP program that will incorporate the immediate roof/floor geology, mining induced stress changes, and primary and secondary bolt designs into the GRC approach.

Specific aims of proposed research: Ultimately, this project proposes to develop geology-dependent mechanical loading models to improve pillar design, and a geology-dependent GRC to improve longwall gateroad support design. The research to be accomplished in this project will include:

1) *Develop a mine-specific, geology-dependent global loading model*: Using a database of 27 field monitoring case histories of calibrated Boundary Element and Finite Volume models to determine the optimal "Laminated Overburden Model" structural input given the specific geology of the case histories.
2) *Adapting practical, mechanics-based design tool for longwall pillar design*: Program the ARMPS-LAM software to make it compatible with the inputs from the longwall mining geometries.
3) *Develop a local geology-dependent GRC design option for STOP*: Use a database of 12 field monitoring case histories of calibrated finite-difference models and more than 30 immediate roof/floor lithologies from across the U.S. to develop a suite of local geology-dependent Ground Reaction Curves.