Thesis Title: Advancing Refuge Alternatives in Mine Emergencies Using Advanced Numerical Simulation and Field Scale Testing

Abstract: Build-in-place (BIP) refuge alternatives (RA(s)) and seals are two main underground constructions to isolate an area from the active working zones with different purposes. While seals are used to prevent methane gas that seeps from coal seams and blast pressures from a possible detonation of the contained gas, RAs are used to provide a safe haven for miners who are unable to escape their working locations after an accident like an explosion or fire. The recommended BIP RA designs can be similar to seals constructed with steel-reinforced concrete. Both seal and BIP RA are constructed in different locations of the mines for a period of time, exposed to a certain convergence due to stress redistribution which can change their responses during an explosion. In this study, a steel-reinforced concrete wall to be used in such applications is simulated to examine the structural performance during an explosion for a coal mine model. Within the scope, the reinforced concrete field experiment was modeled using 3DEC, Itasca, and the effect of strata conditions like the effect of various roof, floor, and seam conditions, and the effect of abutment stress were simulated comparing the explosion resistance of the wall under these strata loadings. Besides, the built-in-place RA with the door and small components will be subjected to explosion loading in an experiment conducted at the Missouri University of Science and Technology. The results will be used in finite element code ANSYS LS-DYNA to extrapolate and interpolate for further analysis to be used. The small components will be investigated physically and numerically to evaluate their ability to be used in case of such an explosion. Different small components like door panels and hinges are designed and will be analyzed using the validated numerical models as well.

Keywords: Built-in Place, Refuge Alternative, Seal, Mine Explosion, Numerical Analysis