Grant: AFC820-82

Title: Development of a wireless borehole instrument device to measure 3D rock mass stress and strain change from modifications to a friction rock bolt

Organization: University of Utah

Principal Investigators: Jeffrey C. Johnson

Topic: Health and Safety Interventions

Priority Area: Ground Control

SYNOPSIS

Problem Statement: The problem is to build an inexpensive and simple to use device that measures the change of stress and strain in any rock mass (i.e. the change rock mass mechanical state) caused by excavation in real-time. The device is based on the design of the friction rock bolt but with the ring-head removed and machined for the installation of strain gages to measure strain along and stress perpendicular to its axis. This modification allows the device to be inserted to any depth in a borehole. The device measures the stress and strain change with a wireless data logger. Change of stress and strain in a rock mass is important engineering information because it can be used to monitor the rock mass for safety and to validate computer models.

Research Approach: The research approach is to develop a simple instrument, based on a previous patent design of an instrumented friction rock bolt, that can be used throughout a rock mass. The research is conducted in three phases; laboratory testing, shallow field installation tests, and finally a full array installed deep into a rock mass. At the conclusion of each research phase the results are reported to the Foundation to decide if the project should continue. If the project continues then new funds are appropriated for the next phase, if not then the project is terminated thus saving funds for the Foundation. The approach is based on the accomplishment of three major steps (initial laboratory testing, shallow field tests, and deep array rock mass tests) that concern the modification of a friction bolt into a general three-dimensional (3D) mechanical measuring device that can monitor the change of the mechanical state in a rock mass. The device is designed to measure both a change in stress and strain induced with mining or excavation.

The instrument begins with a standard friction rock bolt that is modified by minimal machining to create a device that measures a strain gradient along its axis and a change in biaxial stress in the plane perpendicular to its axis. By measuring both a stress and strain change the instrument design can measure a 3D change in the mechanical state of a rock mass.

Impact of the Research: The impact of the research will have a direct effect toward improving the safety of a mine because the interior of the rock mass can be monitored for changes of stress and strain that can lead to potential rock mass failure and thus warn personnel of unsafe conditions. In addition, the measurement of stress and strain change can be used to validate computer models for future mine design. Thus, safety of mine workers is increased with monitoring and safer excavation designs can be engineered from numerical analysis validated with field data.