Undergraduate Research Topics - Fall 2015

Please send your resume and topic(s) of interest to uct@mines.edu

Topic: Jet Grouting
Advisors: Mike Mooney
The Center for Underground Construction and Tunneling (UC&T) is seeking to hire a mechanical engineering student to help our research team design and build a field-ruggedized push probe and delivery system for testing of construction materials. The individual will be involved in designing and building the probe sections and section couplings. In addition, the individual will be involved in designing and building a field delivery system to vertically push the probe into the ground. Development of instrumentation is not part of the job description, but robustly integrating instrumentation into the probe is. The individual will work with CSM faculty, staff, and research students, and will be provided with advice/input on design requirements and specifications. The ideal candidate would be proficient at design and be experienced with common machine shop tools and techniques.

Topic: Slurry Infiltration
Advisors: Mike Mooney
The Center for Underground Construction and Tunneling (UC&T) is seeking to hire a geophysics student to assist in laboratory experiments on bentonite infiltration into sand. The individual will be involved in acquiring data using an array of electrical geophysical techniques (e.g., DC resistivity, self potential, and induced polarization). Depending on experience, the individual is encouraged to take an active role in processing/interpreting data as well. The individual will work with CSM faculty, staff, and research students, and will be provided with advice/input on testing specifications, data processing, etc. The ideal candidate would have experience in laboratory testing and geophysical data acquisition. Experience using the electrical geophysical techniques mentioned above is preferred but not required.

Topic: Big Data
Advisors: Mike Mooney, Wendy Zhou
The Center for UC&T has acquired geotechnical baseline and data reports from a number of tunneling projects throughout the US. Efforts are underway to compile information from these reports into a database where researchers can easily access the information for data analysis, geological modeling and other applications. This position will help with continuing to build our database. The ideal candidate would have experience reviewing and interpreting borehole logs and geotechnical reports and be proficient in Excel. Experience in ArcGIS is desired but not a requirement.

Topic: The Characteristics and Physics of Foam
Advisor: Mike Mooney
Foam is commonly used to condition soil during tunneling. Injecting and mixing foam with soil alters the soil’s properties in many advantageous ways. The characteristics of the foam play an important role in conditioned soil behavior. This project will involve experimenting with the Center’s foam generation system to examine how various system features influence the properties of foam. These features include applied pressures, tubing and other plumbing features, and mechanical dispersers used to create turbulence. The project will be experiment-based and is suitable for a student from any discipline, e.g., mechanical, civil, geological, mining, physics.
**Topic: TBM Performance in weak/sensitive rock**
*Advisor: Rennie Kaunda*
This work will build on ongoing work at the EMI to evaluate mechanical excavation in shale. Efforts are underway to understand machine performance in problematic rock such as shale using index testing such as abrasivity, punch penetration, linear cutting and other physical tests. Data are compiled for statistical analysis in Excel and Microsoft Access. The ideal candidate will have be motivated, have an eye for detail and safety minded. A background in rock mechanics is desired but not a requirement.

**Topic: Geological Controls on Rock Strength**
*Advisor: Gabriel Walton*
At a fundamental level, the petrologic characteristics (i.e. structure, composition, alteration, etc.) of a given rock will determine its strength. One key characteristic is mineralogy – for example, a quartzite will almost always be stronger than a rock composed of clay minerals. However, other more subtle relationships exist (relative abundance and distribution of different mineral components, grain size, and grain shape all have some influence). This position will involve examining these relationships using quantitative methods by first identifying geological controls on rock strength and developing a database of geological and geomechanical data. The ideal candidate would have some geological background and a basic knowledge of statistics.

**Topic: Modelling Mine Pillar Behaviour for Brittle Rock**
*Advisor: Gabriel Walton*
Pillars constitute one of the most geotechnically important elements of underground mines. When pillars take on large loads, they may go through a progressive yield process which has the potential to increase their capacity or to induce pillar failure, depending on the material and system characteristics. This research will focus on testing the relationships between the constitutive properties of the rock material, the geometry of the pillar, and overall pillar response to loading through numerical modelling. Experience with Rocscience and/or Itasca modelling software is desired, but not a requirement. Applicants are welcome from all disciplines.

**Topic: Development of a Geophysical Measurement System**
*Advisor: Reza Hedayat*
There is an ongoing effort in developing a data acquisition system for laboratory measurement of waves through geomaterials like rocks and construction materials like concrete. At the early stage of the project, the student will be involved with the development of the equipment and will then carry out geophysical measurements on rock specimens. Although not required, the ideal candidate will have experience with LabView programming. This project is experiment-based and provides a great opportunity for a student to develop research skills and gain experience from multiple disciplines. This project is suitable for a student from any discipline, e.g., electrical, computer science, civil, mechanical, geological, mining, and physics.
**Topic: EMI Database Analysis**  
**Advisor: Eunhye Kim**

The Earth Mechanics Institute (EMI) was established in 1974 to improve academic research and education at the Colorado School of Mines (CSM). During last four decades, a number of innovative rock mechanics researches have been conducted through various rock mechanics tests, which are recorded in a database for research purposes. This database includes over 20,000 tests from over 1,000 different research projects. We anticipate that the database analysis obtained from EMI will reveal comprehensive information for understanding the mechanical properties and responses of numerous rocks.

**Topic: Tunnel Lining System (Colorado Department of Transportation)**  
**Advisor: Eunhye Kim**

This project involves developing a new standard test for slip-lining system for culvert regarding structural stability of the lining system. Efforts will be taken to improve the effectiveness of structural stability evaluation for lining materials, pipes, and new shapes of the culvert system.

**Topic: Thermal Imaging of Shotcrete**  
**Advisor: Mike Mooney**

The excavation of large caverns and tunnels is increasing significantly in urban environments. The process of excavation is typically performed using construction equipment (road headers) or drill and blast methods. Once an area is excavated, the face of the rock/hard soil is coated with steel reinforcing and shotcrete (sprayed concrete). There is a need for a cost-effective and rapid method for quality control testing of the shotcrete. This project involves hands on laboratory experiments where the curing of shotcrete is monitored using thermal imaging techniques. The student will mix various batches of shotcrete and monitor temperature activity as the shotcrete cures.

**Topic: Tunnel Support Analysis: Development of an Excel spreadsheet/Matlab code**  
**Advisor: Reza Hedayat**

This project involves developing an excel spreadsheet or Matlab code to calculate the stresses, strains, and displacements around a circular underwater tunnel. A mathematical solution is currently developed for the calculation of the stresses and displacements around the tunnel. The student will be involved with the implementation of the solution into either an excel spreadsheet or Matlab code. Experience with Matlab and other programming languages is desired but not required. This project is suitable for a student from any discipline, e.g., mathematics, statistics, computer science, electrical, civil, mechanical, geological, mining, and physics.