GEOMECHANICS - GEOL 542

Instructor: Simon Kattenhorn
Fall Semester 2009: TR 12.30 - 1.45 p.m., McClure 315

Course Summary

This course provides an introduction to the assessment of rock strength and the mechanical criteria used to predict and analyze rock failure. Rock is an inherently flawed material, from the scale of individual mineral grains to the large-scale boundaries between tectonic plates. These flaws impact greatly on failure characteristics and associated deformation. In order to understand how brittle failure occurs, it is necessary to describe the mechanical laws that enable us to quantify deformation occurring in rock under the influence of applied stresses.

We therefore introduce the concept of the tensor quantity, stress, and its consequences for rock deformation. This requires an examination of elasticity theory, which commonly provides a good approximation to the mechanical behavior of rock in the crust. A thorough overview of continuum mechanics applied to rock deformation will segue into the concepts and mathematical theory of linear elastic fracture mechanics (LEFM), which is used to address how cracks in rocks enable brittle failure. LEFM theory can be used to quantify the stress, strain, and displacement fields around cracks subject to external loads, and subsequent failure characteristics.

Such studies have important applications to the analysis of geological structures (e.g., faults, joints, dikes, sills, and veins), geological engineering concerns (e.g., excavations, well drilling, hazardous waste repository site evaluation), seismic hazard analyses, resource exploration and management, and the hydrogeology of fractured rock masses.

Course Goals

This course will develop your understanding and intuition of the mechanics of deformation in the Earth, highlighting the importance and usefulness of quantitative analyses of rock failure using the concepts of fracture mechanics. Although geomechanical studies can be fairly math-intensive, it is vital to develop a qualitative comprehension of the meaning behind the equations that describe the mechanics of deformation. Therefore, this course will emphasize the quantitative aspects of geomechanical analyses as well as attempting to enhance your intuition about the mechanics of brittle failure and why rock deforms the way it does in response to the stresses that exist in the Earth’s crust.

Prerequisites

Although many of the mathematical and engineering concepts will be described from first principles, it is important that students enrolled in this course have an understanding of basic mechanics and calculus. The following courses (or their equivalents) are thus prerequisites:

- Phys 111 or 211 (General Physics I or Engineering Physics I)
- Math 170 (Analytic Geometry and Calculus I)

If you have concerns about the adequacy of your math background for completing this course, please see the instructor.

Course Logistics

Instructor: Simon Kattenhorn

I am an Associate Professor in the Dept. of Geological Sciences. My office is in McClure Building (directly opposite the Mines Building), Room 303B. McClure is wheelchair accessible from the entrance opposite Mines building and has two elevators (NW and SW corners).
Office hours: Tuesdays from 10 - 11 am. Please feel free to make an appointment to see me another time if this is not convenient for you.

Office phone: 5-5063 from on campus (else 885-5063). The best time to reach me is during the office hours. My office has an answering machine- if you would like me to call you back, leave your name, telephone number and a convenient time to call you and I will attempt to return your call as soon as possible.

Email: simkat@uidaho.edu (this is the most efficient way to get a hold of me).

Mailbox: if you wish to leave items in my mailbox, it is in the room directly opposite the Geological Sciences departmental office (Mines 322).

FAX: you can FAX materials to me at (208) 885-5724. Be sure to include my name on the FAX.

Course Website: http://www.uidaho.edu/~simkat/geol542.html

Required textbook: Available in the UI bookstore.

*Fundamentals of Structural Geology*
David D. Pollard and Raymond C. Fletcher
Cambridge University Press, 2005

Additional reading: you are welcome to borrow my personal copies (sign-out sheet)

J. C. Jaeger, N. G. W. Cook, R.W. Zimmerman
Blackwell Publishing, 2007

*Fracture Mechanics of Rock*
Barry Kean Atkinson, ed.
Academic Press, 1987

*Theory of Elasticity* (3rd edition)
S. P. Timoshenko & J. N. Goodier
McGraw-Hill, 1987

Assignments and Examinations

1) Weekly homework assignments, due in class each Thursday.
2) Midterm exam handed out on Thurs, Oct 15th, due on Thurs Oct 22nd (hand in to Debbie Jensen by 4 p.m.)
3) Final exam handed out on Thurs, Dec 3rd, due on Thurs Dec 10th (in class)

Grading

Homework assignments: 60% (lowest homework grade will be dropped if all homeworks are completed with a score >50%)

Exams: 40% (each exam will count for 20% of your grade)