Reservoir Geomechanics Lab #1: Unconfined Compression Test and Young's Modulus Determination

SAFETY

This equipment has the capacity to impose loads of 10,000 lbs. You need to protect yourself. Please...

- *Always wear safety goggles*
- Pay attention
- Follow instructions
- Use all required safety equipment/shields as directed

LOAD LIMIT = 8,000 lbs. If you see that you exceed this on your display, press STOP or the EMERGENCY button.

DISPLACEMENT LIMIT= 0.2 inches. The loading machine has greater travel than the displacement transducer does when it is engaged. NEVER exceed 0.2 inches on the displacement transducer (make sure you start your test with displacement close to zero).

SPEED LIMIT=0.22 inches/min. The loading machine has adjustable speed, and you are going to need to make changes during our tests. NEVER exceed 0.22 inches/minute. This should prevent any catastrophic mistakes.

Goal: Measure the Young's modulus (E) and Unconfined Compressive Strength (UCS) of several different rock types tested dry.

TEAM ASSIGNMENTS

1. **Safety**: Watch the load, displacement, and speed on the Humboldt screen to make sure limits are not exceeded. The safety engineer should also set the speed on the Humboldt.
2. **Operator**:
    - Press UP, DOWN or STOP to run the test.
    - Never run the machine if anyone has any part of their body touching or inside the machine, and never run the machine if there is a sample without the safety shield.
    - When a test is running, the Driver should ALWAYS be standing at the controls, paying attention.

3. **DAQ**: Run the laptop program for monitoring the test and collected data.
4. **Sample Prep.**: Measure the sample dimensions and mass, place sample on apparatus and place safety shield around sample.

TEAM TRAINING

All Team Members

Find the EMERGENCY STOP button. Use this if something goes wrong. It will stop everything.

Safety

Set SPEED

1. Press STOP.
2. Press SPEED button.
3. Press F2 to get to the second decimal digit.
    a. Press F3 to increase and F4 to decrease value.
    b. Set the value to 1 (corresponding to 0.020000 inches/min).
    c. You shouldn't have to change this value again.
4. Press F2 to get to the first decimal digit.
    a. Pressure F3 to increase and F4 to decrease value
    b. Set the value to 2 (corresponding to 0.220000 inches/min).
5. SPEED should always be 0.22 inches/min or LESS.
6. Press SPEED button to get back to load/displacement display.

Operator

NEVER rest your hands on the buttons unless it is the STOP button.

NEVER run the machine if anyone is touching anything on it.

ALWAYS make sure the display shows load and displacement before running machine. (if it reads SPEED, press SPEED button to change display)

Slow operation (ALWAYS use this mode when there is a sample in the apparatus)

1. **Press STOP**. (Operator)
2. **Set SPEED**. Set speed to 0.02 inches/min (Safety)
3. **Engage Displacement transducer**. Adjust the lever on the black rod attached to the loading table so that the end of the displacement transducer is just touching it. You DISP 2 reading should be NO MORE THAN 0.05 inches when you start. Max travel is to 0.2 inches. (Sample Prep.)
4. **Check the speed**. Press the SPEED button, read the speed, Press SPEED again so you see the load and displacement display. ALWAYS know what the speed is before activating the table. (Safety)
5. **Press UP to raise table (loading).** Watch the DISP 2 reading to see that table is moving. DO NOT exceed 0.2 inches. (Operator)
6. **Press STOP to stop table**. Check curve on laptop. (Operator)
7. **Check DISP curve on laptop**. Make sure you see the curve for the displacement on the laptop. Load should be at its zero value. (DAQ)
8. **Press DOWN to make table drop (unloading).** (Operator)
9. **Set SPEED to 0.22 inches/minute.** This is the speed you will use to SEAT the sample. You need to watch the displacement limit carefully. (Safety)
10. **Check the speed**. (Safety)
11. **Press UP. DO NOT exceed 0.2 inches on DISP 2**. (Operator)
12. **Press STOP to stop table**. (Operator)
13. **Press DOWN to make table drop (unloading).** (Operator)
14. **Press STOP**. (Operator)

Fast Operation (only with NO SAMPLE and the displacement transducer is DISENGAGED)

1. **Disengage the displacement transducer**. (Operator)
2. **Press and hold the DOWN button**. (Operator)
3. **Press STOP**. (Operator)
4. **Press and hold the UP button**. (Operator)
5. **Press STOP**. (Operator)

SAMPLE PREPARATION

Rock Type	Length	Diameter	Mass	Volume	Density	Area
Berea						
Boise						
Texas Cream						

Sample Rock Type	Ends parallel?	Ends flat?	Bedding visible?	Orientation?
Berea				
Boise*				
Texas Cream				

* For Boise sandstone, please indicate if you used **oil-stained** samples or **clean** ones.

SAFETY EQUIPMENT FOR EACH STATION

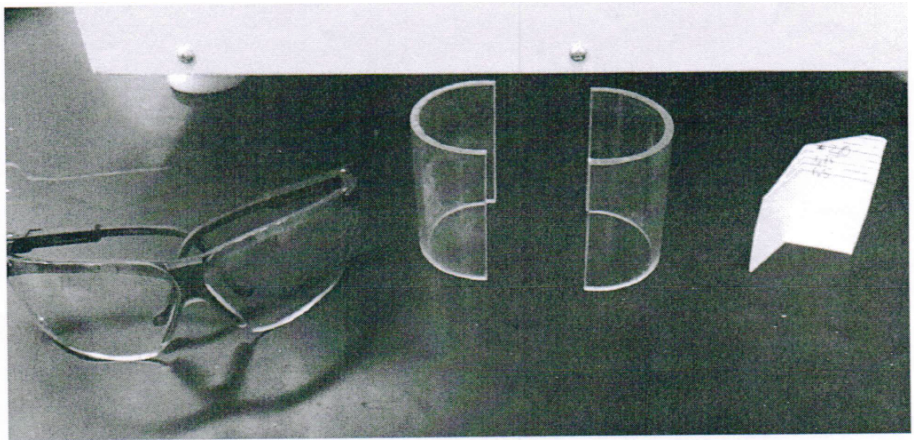

Figure 1: Safety glasses, sample shield and positioning template.

TEST PROCEDURE

1. **Prepare the data acquisition program**. See separate handout. (DAQ)
    a. Check scales on chart.
    b. Choose unique filename for data.

2. **Has the sample been measured?** Don't start without getting mass and dimensions. (Sample Prep.)

3. **Disengage displacement transducer.** Turn knob to loosen arm, let it fall to bottom of rod so it is not touching the transducer. (Operator)

4. **Set SPEED**. Press the SPEED button. Change the speed to 0.220000 inches/min. Have 1 other team member confirm. (Safety)

5. **Pre-position loading table**. Measure the height of your core plug using your positioning template (folded piece of stiff paper). Set the positioning template (NOT your sample) between the loading platens and use the up or down arrow to adjust the gap to be slightly larger than your sample. You can use FAST OPERATION as long as the sample is not in the machine. (Operator)

6. **Center sample between platens and place safety shield so sample is completely wrapped.** Never run UP or DOWN without safety shield around sample. (Sample Prep.)

7. **Seat sample**. Press UP but watch for load to change. When load starts to rise IMMEDIATELY press STOP. (Operator)

8. **Change SPEED. Once sample is seated, change speed to 0.020000 inches/min**. (Safety)

9. **Adjust seat.** Press Down, and unload sample until the load reading is just at its zero value. (Operator)

10. **Engage displacement transducer.** Your DISP 2 reading should be NO MORE THAN 0.05 inches when you start. Otherwise you may not have enough travel. Max travel is to 0.2 inches. (Sample Prep.)

11. **Start writing to file**. (DAQ)

12. **Load sample in cycles**. Press UP. Watch the load! DO NOT exceed 8000 lbs. (Operator)

    a. At 1000 lbs, STOP and unload by 500 lbs. At 1000 lbs, STOP, press DOWN and unload to 500 lbs. STOP at 500 lbs, and press UP to continue loading.

    b. Continue to 2000 lbs, STOP and unload by 500 lbs.

    c. Repeat cycles every 1000 lbs until sample fails or you reach 8000 lbs.

13. **At failure, press STOP**. (Operator)

14. **Take a picture of broken sample**. Note the mode of failure-explosive or gradual, multiple or single fracture or sample fragmented. (Sample Prep.)

15. **After failure, unload**. Press and hold DOWN until the load reads its zero value and the sample no longer touches the top platen. (Operator)

16. **Press STOP**. Before cleaning up, verify that the STOP light is red. (Operator)

17. **Stop writing to file.** On computer, press button to stop writing to the datafile.

18. **Clean up**. Throw away broken sample and sweep grains and fragments up with dust pan and brush or paper towel. (All)

19. **Go to next sample**.

Data Analysis and Lab Report

1. Plot engineering stress as a function of engineering strain for each sample. **Note**: The pore pressure is zero so the effective engineering stress is the same as the engineering stress.

2. Identify the initial linear portion of the stress-strain loading curve and find its slope. This is an estimate of Young's modulus for your sample.

3. Look at the unloading cycles. Is the slope for these cycles different? Find the unloading Young's modulus.

4. For your lab report,

    a. Start with a title for the lab, the names of all your team members, and a brief paragraph on the purpose of the lab.

    b. Tabulate the dimensions, condition, density and mechanical properties for each sample. Your Young's Modulus data should include a loading and unloading modulus.

    c. Include a stress-strain plot for each test showing where you found the slope for Young's modulus and indicating the pick for UCS.

    d. Include a picture of each failure sample.

    e. Briefly describe how each sample failed.

    f. Briefly describe any problems or potential sources of error from your experiments.