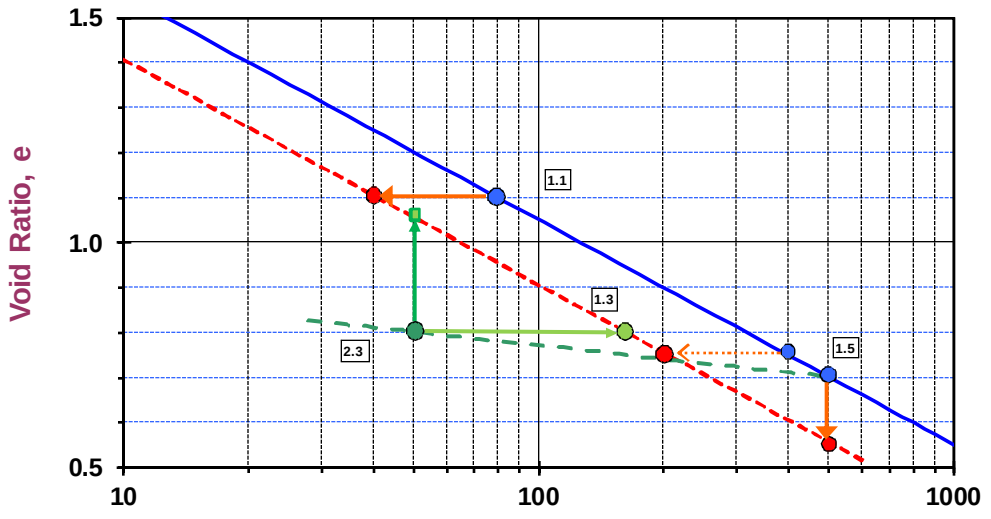
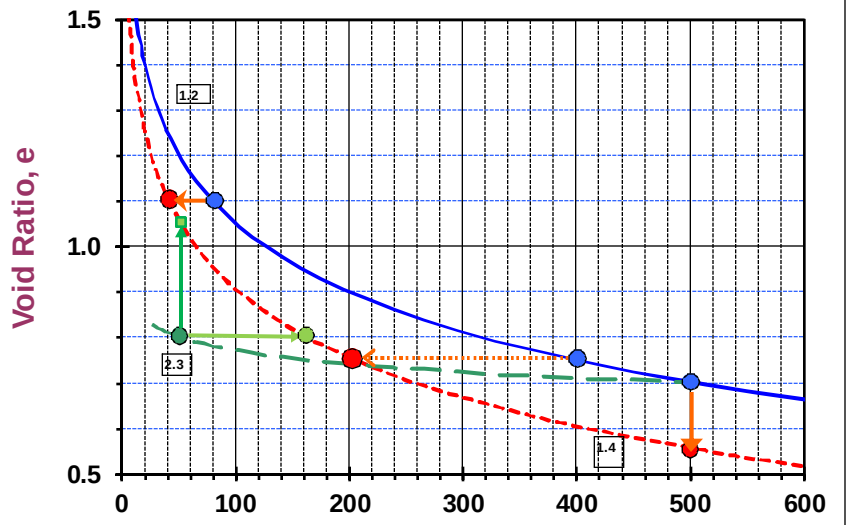
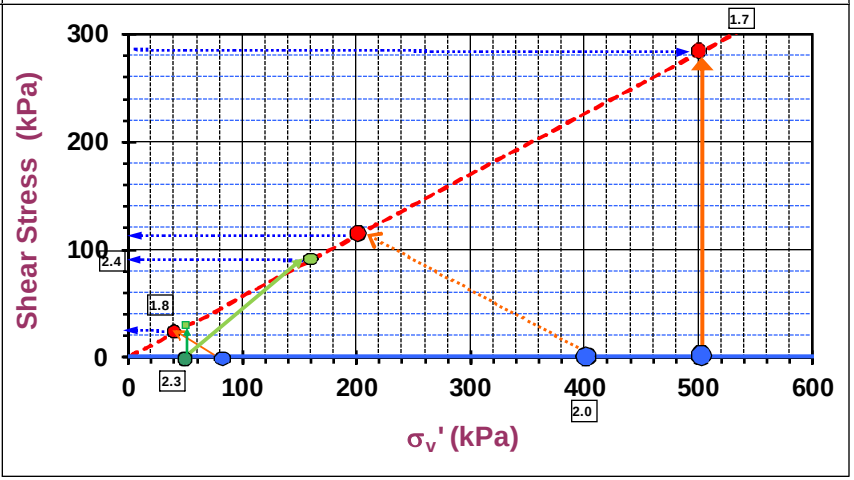
CRITICAL STATE SOIL MECHANICS

29 January 2013







PROBLEM. A uniform deposit of blue silty Clay (CL) lies offshore Georgia and may serve as the foundation bearing stratum for a new tidal energy research facility for renewable electricity supplies. A special jackup soil drilling platform is used to procure undisturbed tube samples for consolidation & shear testing in the GT Sowers Laboratory. Use these graphs to help answer the following questions: NOTE: Solve all these graphically.

1.1 Sample SC01 is taken from a depth of 10.0 m below the mudline. Upon consolidation to restore the stress state to its in-situ value, test specimen SC01-01 is normally-consolidated with an initial void ratio (e0 = 1.10) at its respective effective vertical overburden stress of 80 kPa. The marine clay has a virgin compression index = 0.50. Draw the initial stress state point and then draw the virgin compression line through it in the e-logsv' space. Color this a blue line.

1.2 Pick several points on the VCL and scale these over to draw on the e-sv' space. Also make this a blue line.

1.3 Estimate the critical state line as a line with same slope in e-logsv' but at stresses one-half the VCL for any given void ratio. Use red.

1.4 Construct CSL similar to problem 1.2 as a red (dashed line) in the e-sv' space.

1.5 Specimen SC01-02 is NC also along the VCL to a consolidated void ratio e0 = 0.70 Draw this initial stress state on all 3 spaces. What is the corresponding inital svo' ? σ_{vo} ' = 500 kPa

1.6. Specimen No. SC01-02 is then sheared drained to failure with a measured maximum shear stress = 282 kPa
Plot this stress path in the Tau-SigmaV' Space. What is the corresponding effective stress friction angle? ϕ' = 29.5 degrees

1.7. Show the CSL in the tau-sigmaV' space. (use a red dashed line).

1.8. Lets return to Specimen No. SC01-01 in part 1.1. This is now tested undrained shear to failure. What is the undrained shear strength of this test ? s_u = 22.8 kPa

1.9 For the specimen in part 1.8. What is the excess porewater pressure recorded at failure? Δ u = 40 kPa

2.0 A third specimen (No. SC01-03) is consolidated to 400 kPa and sheared undrained to failure. What are su and maΔu ?
s_u = 114 kPa Δ u = 200 kPa

2.1 For specimen No. 2 (part 1.6), what is the final void ratio ? Evaluate the volumetric strain aΔe divided by (1+e0).
ef = 0.55 for this specimen, initial e0 = 0.70, so ε_{vol} = (0.70- 0.55)/(1+0.70) = 0.088 = +8.8% (contractive)

2.2 A fourth specimen SC01-04 is first consolidated along the VCL to a maximum applied vertical stress = 500 kPa and then unloaded along a swelling line (Cs = 0.10) to a final vertical consolidation stress = 50 kPa. What is the final void ratio? e = 0.80

2.3 For specimen SC01-04, what is its OCR ? OCR = 500/50 = 10

2.4. Specimen SC01-04 is sheared undrained to failure. What are the values of su and maxΔu obtained in this test ?
s_u = 91.2 kPa Δ u = 50 - 160 = - 110 kPa (negative PWPs)

2.5 A fifth specimen SC01-05 is consolidated with same stress and OCR as SC01-04, but then sheared drained to failure
What are the values for final void ratio after shearing and the corresponding volumetric strain?
ef = 1.06 for this specimen, initial e0 = 0.80, so ε_{vol} = (0.80 - 1.06)/(1+0.80) = -0.144 = -14.4% (dilative or dilatant)