The University of Iowa
Department of Civil & Environmental Engineering
FOUNDATION ENGINEERING 53:139
Spring Semester 2000 Midterm Examination
Prof. C.C. Swan

Question #1: (20 points)

As part of a construction project, 8m of an over-consolidated clay soil is to be excavated relatively quickly as shown below on a time scale of approximately one month. The clay soil has a very low permeability, and its drained and undrained shear strength properties are as shown in Figure 1.

a. If you were to analyze the **short term** stability of this cut slope which method would you use and why?

b. Using γ_{sat} = 120 pcf, what is the FS against slope failure in the short term?

c. If you were to analyze the **long term** stability of this cut slope, which method would you use and why?

d. Neglecting seepage and pore pressure effects, and using γ = 100 pcf, what is FS against slope failure in the long term?

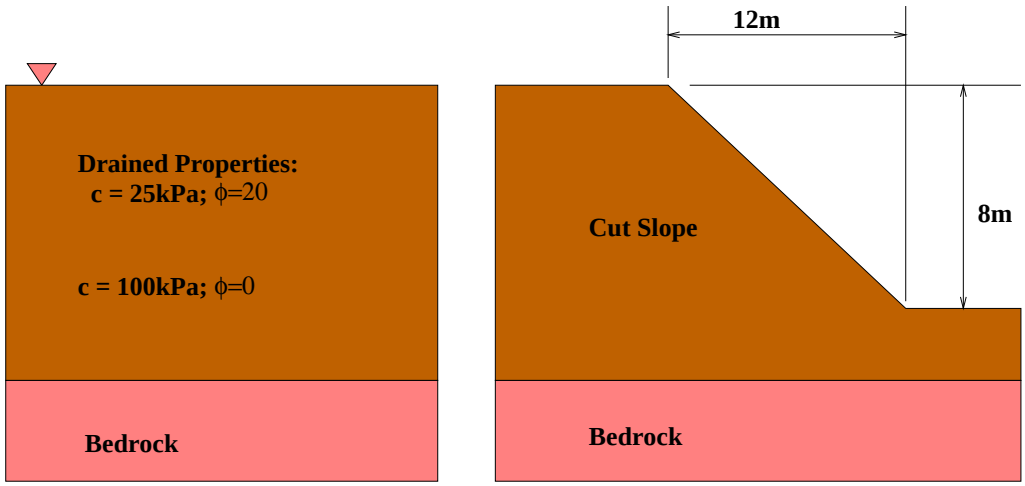

Figure 1: Clay soil deposit before and after slope is cut.

Question #2: (10 points)

Please state **briefly** the general effect of each of the following on a given slope's stability:

a. height;

b. the soil's unit weight;

c. unconfined seepage;

d. the slope's steepness;

e. earthquakes.

Question #3: (10 points)

As used in the textbook, which of the following definitions corresponds to the factor of safety against slope failure?

a. Under the given slope height and soil unit weight, if the soil strength were reduced by a factor of FS, the slope would be in a state of incipient failure;

b. Under the given slope height and soil unit weight, if the soil strength were increased by a factor of FS, the slope would be in a state of incipient failure;

c. For a given soil composition and strength, if the loading on the slope were decreased by a factor of FS, the slope would be in a state of incipient failure;

d. For a given soil composition and strength, if the loading on the slope were increased by a factor of FS, the slope would be in a state of incipient failure.

Question #4: (20 points)

The Dell Corporation is considering building a large production facility on what is currently rural farmland between Iowa City and Lone Tree. The proposed location is relatively virgin in that no major construction has yet been performed in the area. Working for a local geotechnical firm that is just getting started in this local area, you are preparing a bid for the subsurface exploration (SSE) plan. Briefly, explain:

a. What preliminary information would you request from the owners or their structural engineers/architects so that you could prepare a plan for the SSE?

b. So that foundations for the structure can be designed and analyzed, what specific soil properties would you seek to quantify in the SSE?

c. For each soil property listed above, specify what you see as the most reliable method that could be used to quantify it, either directly or indirectly.

Question #5: (10 points)

A vertical column carries an axial load N of 100 kips, a transverse shear V of 15 kips, and a bending moment of 200 kip-ft to the center of a spread footing. Using this information, determine:

a. the eccentricity e of the applied load; and

b. the inclination angle β of the applied load.

Question #6: (10 points)

Please briefly state the effect of each of the following on a soil's ultimate bearing capacity q_u:

a. size of the foundation;

b. eccentricities of applied loads;

c. loads being applied at an inclination;

d. depth of the foundation;

e. the soil's unit weight;

Question #7: (20 points)

A purely empirical method of estimating ultimate bearing stresses under foundations is the field plate load test. A building contractor who wants to estimate the ultimate bearing stress under 5m square footings uses a field load test on a 1ft square plate to directly measure q_{ult} under the 1ft square plate. The contractor believes that $q_{ult,B=5m} = q_{ult,B=1ft}$. The subsurface soil conditions are as shown below: Briefly, assess the validity of the contractor's thinking. If the contractor is mistaken, state what factors he/she has neglected.

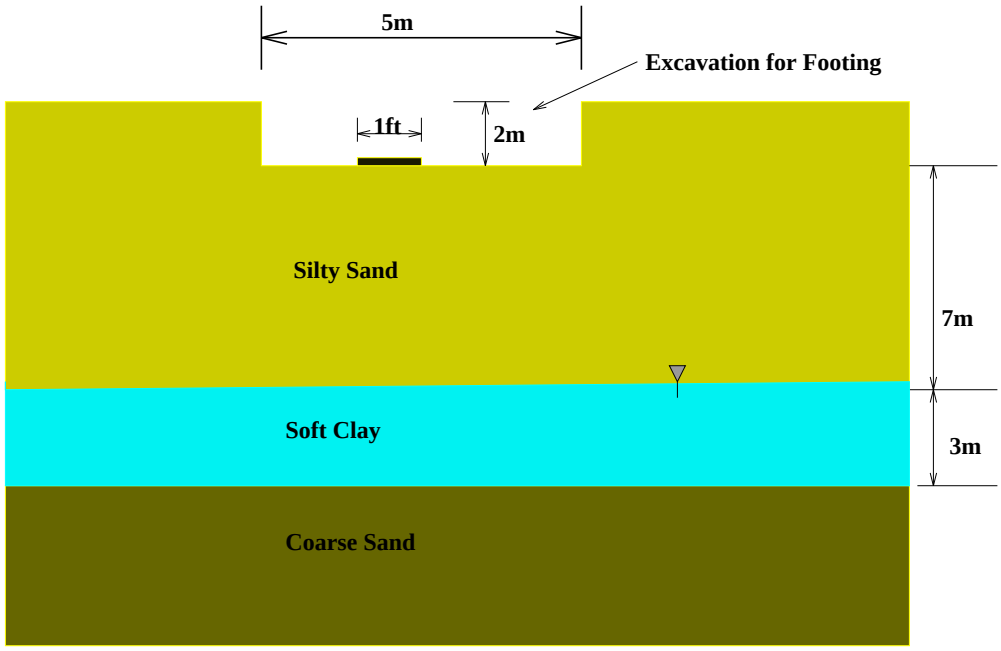

Figure 2.

Question#8: (20 points)

a. List three of the primary advantages in using compensated mat foundations as opposed to individual spread footings when building on soft, compressible soils.

b. What is the depth of a fully compensated mat foundation?

c. What is a subgrade modulus, and what are its units?

d. For a given homogeneous soil deposit, would increasing the foundation dimensions cause you to use a larger or smaller value of k_s?

Question #9: (10 points)

a. Why are most buildings' shallow foundations in Iowa placed at a minimum depth of 3-4 feet beneath the ground surface?

b. Is it true that the ultimate bearing capacity always controls the sizing of individual spread footings? Briefly explain.

Question#10: (10 points)

Consider an "infinite" homogeneous slope submerged under water. There is no flow occurring. The soil has Mohr-Coulomb strength parameters c and ϕ. Develop an expression for the factor of safety of this slope against shear failure.