The University of Iowa
Department of Civil & Environmental Engineering
FOUNDATIONS OF STRUCTURES 53:139
Spring Semester 2002 Midterm Examination
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Question #1: (30 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? (5 points)

b. Using γ_{sat} = 120 pcf, what is the FS against slope failure in the short term? (5 points)

c. If you were to analyze the **long term** stability of this cut slope, which method would you use and why? (5 points)

d. Neglecting seepage and pore pressure effects, and using γ = 100 pcf, what is FS against slope failure in the long term? (15 points)

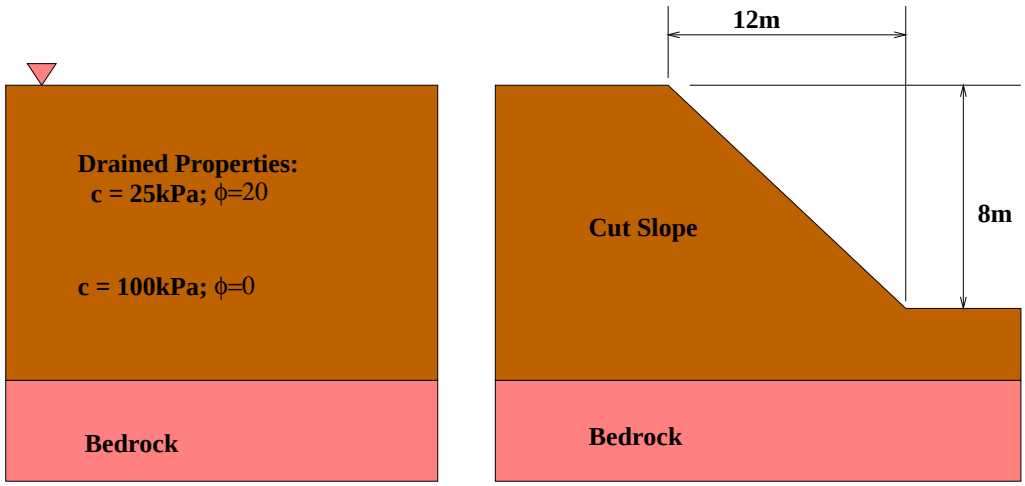

Figure 1: Clay soil deposit before and after slope is cut.

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: (5 points)

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

a. Under a given foundation loading and size, if the soil strength were reduced by a factor of FS, the system would be in a state of incipient failure;

b. Under a given foundation loading and size, if the soil weight were increased by a factor of FS, the system would be in a state of incipient failure;

c. For a given foundation size and soil properties, if the loading were increased by a factor of FS, the system would be in a state of incipient failure;

d. For a given foundation loading and soil properties, if the size of the foundation were descreased by a factor of FS, the system would be in a state of incipient failure.

Question #4: (20 points)

The standard penetration test is sometimes used as a quick, inexpensive way to estimate soil mechanical properties at a given site.

a. In just a few sentences, explain what the test is.

b. Using the material in chapter 2 of the text, provide an extensive list of soil properties that can be estimated with the SPT.

c. What is the difference between N_{F} and N_{corr}?

d. Why is N_{corr} rather than N_{F} frequently used in empirical equations to estimate soil properties?

e. What, if any, potential disadvantages do you see in using the SPT to estimate soil properties at a site?

Question #5: (15 points)

a. Please briefly state the effect of each of the following on a foundation's ultimate bearing capacity q_u: (5 @ 2 points)
   - size of the foundation;
   - eccentricities of applied loads;
   - loads being applied at an inclination;
   - depth of the foundation;
   - the soil's unit weight;

b. In Terzaghi's model (and in reality), what are the three mechanisms that contribute to the bearing capacity of a given shallow foundation? (5 points)

Question #6: (15 points)

a. For a given bearing stress beneath a shallow spread footing that rests on a homogeneous soil, how does the elastic settlement of that footing scale with the size of the footing?

b. For a fixed column load Q that will be applied to an individual square spread footing with edge-length B, how does the elastic settlement beneath that footing scale with B?

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

Question #7: (15 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.

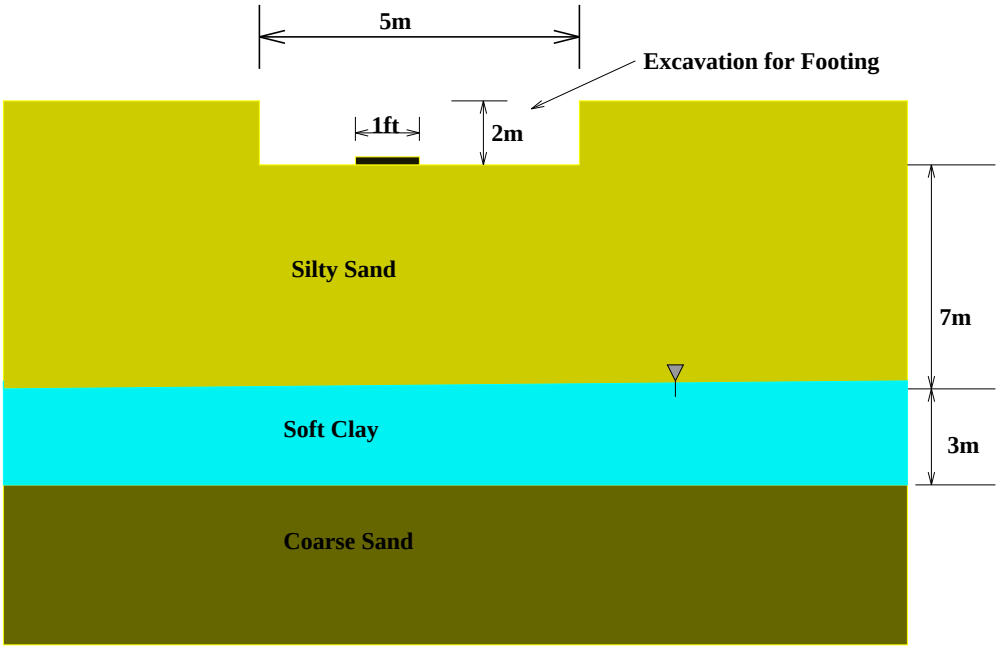

Figure 2.

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?

e. Why does the subgrade modulus change as the size of the foundation changes?