The University of Iowa
Department of Civil & Environmental Engineering
FOUNDATION ENGINEERING 53:139
Spring Semester 1998 Midterm Examination
Prof. C.C. Swan

Question #1: (20 points)

A major computer manufacturer is considering building a $ 300 million 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 region, you have proposed to the owner of the facility to develop a subsurface exploration (SSE) plan. Briefly, explain:

a. How much might you expect to budget for the SSE?

b. What preliminary information would you request from the owner's structural engineers or architects before designing your SSE plan?

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

d. For each soil property listed above, specify at least one method that could be used to quantify it, either directly or indirectly.

Question #2: (20 points)

In Terzaghi's bearing capacity equation for general shear failure under shallow strip foundations the ultimate bearing stress was found to be:

$$q_u = cN_c + qN_q + \frac{1}{2}\gamma B N_\gamma$$

This suggests that three separate mechanisms exist in the soil to resist general shear failures. Briefly explain how each of the three mechanisms work, according to Terzaghi's theory, using sketches and physical arguments for each.

Question #3: (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? Please provide a thorough justification for the method you would use.

b. If you were to analyze the **long term** stability of this cut slope, which method would you use? Again, please justify the method you would use.

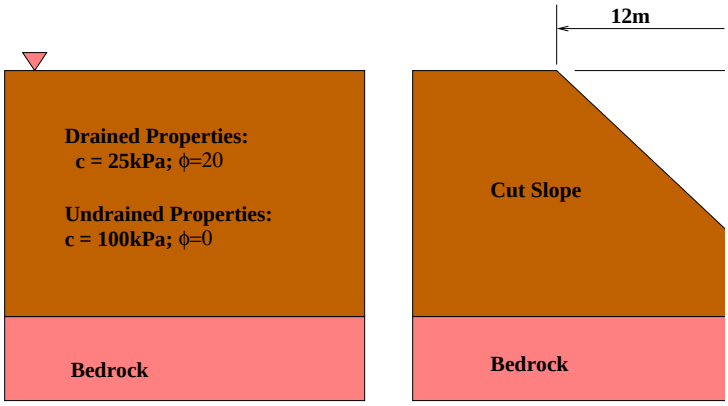

Figure 1: Clay soil deposit before and after slope is cut.

Question #4: (20 points)

The field plate load test is sometimes used to estimate both the expected settlements and bearing stress capacity q_u of full scale structural foundations. While the field plate load test uses a plate having a dimension of approximately one foot square or round, the actual foundation dimensions can be on the order of many meters. The bearing stress capacity of the full scale foundation $(q_u)_F$ can be considerably different than that of small plate foundation $(q_u)_P$. Also, for the same bearing stress, full-scale foundations will experience much larger settlements. Please explain briefly why these scale effects exist for both

a. settlements; and

b. ultimate bearing stress capacities.

Do not just write the scaling equations. Instead, discuss in words and/or sketches the physical reasons why the scaling equations are needed.

Question#5: (20 points)

a. List four reasons why mat foundations are sometimes used as opposed to individual spread footings.

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

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

d. When and how is the subgrade modulus used in the analysis/design of mat foundations?

Bonus Question#6: (10 Extra Points!)

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