University of Iowa
Dept. of Civil & Environmental Engineering
FOUNDATION ENGINEERING 53:139
Take-home Final Exam
Due Wednesday, December 15th, noon.

Fall 2004 Instructor: C.C. Swan

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 two weeks. 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 $\gamma_{sat} = 20kN/m^3$, 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
d) Neglecting seepage and pore pressure effects, and using $\gamma_{sat} = 17.5kN/m^3$, what is FS against
e) slope failure in the long term? (15 points)

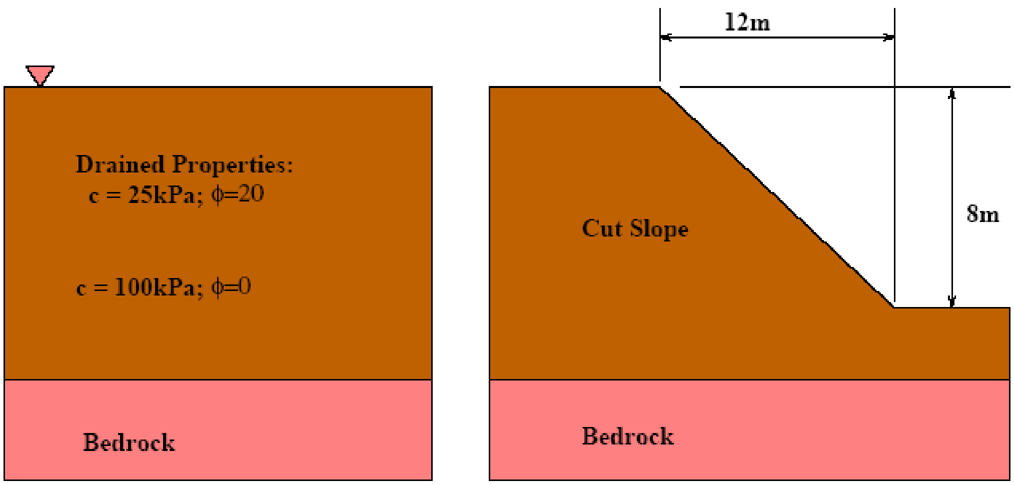

Fig. 1. Clay soil deposit before and after a slope is cut.

Question #2: (15 points)

Numerous methods exist for estimating the ultimate capacity of driven piles. The methods generally fall into the classes listed below:

1. analytical and/or semi-empirical formulas based on site material properties,
2. full-scale field tests, and
3. pile driving formulas.

Briefly discuss the limitations or precautions that should be taken when employing each of these general classes of methods.

Question #3: (10 points)

Two distinct types of bearing failures under both shallow foundations and deep foundations are general shear failure and local compression failure. Discuss the different mechanisms that cause these two types of failure. What soil characteristics lead to likelihood of punching failures? (Use figures as necessary to demonstrate your points.)

Question #4: (30 points)

Consider the free cantilever sheet pile wall of Fig. 2 shown penetrating dry, cohesionless sandy soil. Using equilibrium considerations, and given the assumed shape of the net pressure distribution on the wall, derive a quartic equation for the theoretical depth of penetration D of the wall in terms of the soil cohesion c, as well as P and L. Do not simply find the equation and write it down, but derive it, showing all of your work.

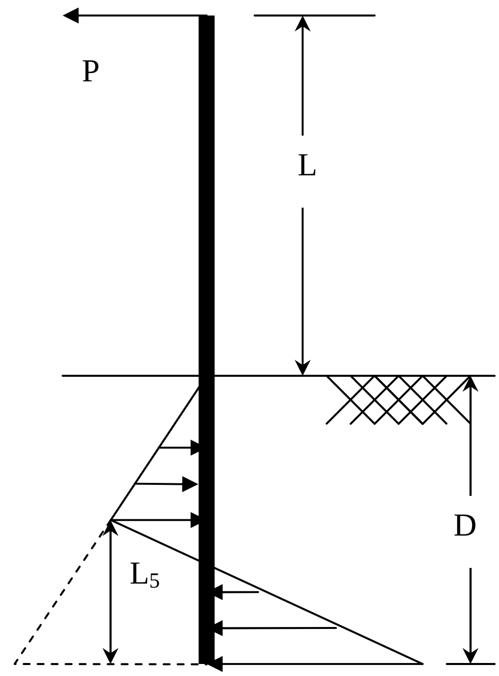

Fig. 2.

Question #5: (10 points)

What is a collapsible soil? Given a number of undisturbed soil samples, how might you go about testing a soil for hydro-collapsibility?

Question #6: (24 points)

The following are true/false questions. To answer each, just enter “T” or “F” for each in your test work. If you find a question ambiguously worded, you may provide a more extended answer or explanation.

a) The worst case scenario for stability of sheet pile walls is when the water elevation is the same on both sides of the wall.
b) Coyle and Castello are best known for their work in providing design correlations based on full scale load tests on piles driven in sand.
c) H piles are ``high-displacement'' piles.
d) Skin friction between piles and soil **never** leads to problems. The larger the shear capability between the soil and the pile, the better.
e) Piles are generally driven in groups and structurally integrated through either grade beams or pile caps.
f) Iowa loess is highly expansive.
g) Expansive soils are those which exist in loose ``cemented'', semi-dry states and which expand when the cemented bonds disintegrate in the presence of water.
h) A commonly observed rate effect in dry soils is that they show higher strength when loaded rapidly as opposed to quasi-statically.
i) The ``freeze'' behavior of piles driven in clay is unrelated to thixotropic behavior.
j) The friction angle between soil and steel piles is generally less than that of a soil's internal angle of friction ϕ.

k) In general, sheetpile wall anchors can be safely placed a distance of 3.5h away from the wall, where h is the height of the anchor.

l) A high liquid limit(LL) and plasticity index (PI) are strong indicators of an expansive soil.

Question #7 (31 points)

Design a foundation system for an elevated 30'x30'x30' water storage tank shown in the Figure below. For the weight of the structure (dead load) use a load factor of 1.4, and for the live loads on the structure from winds, use a load factor of 1.7. The soil is granular with a friction angle of 29°, and a unit weight of 120 pcf and a Young's modulus of 20 MPa; the depth of the foundation can be taken as 6 ft.; assume that when the 30'x30'x30' tank is full, water constitutes 50% of the total weight of the structure. Compute the minimum permissible size of a shallow square footing which will serve as the foundation for the tank such that:

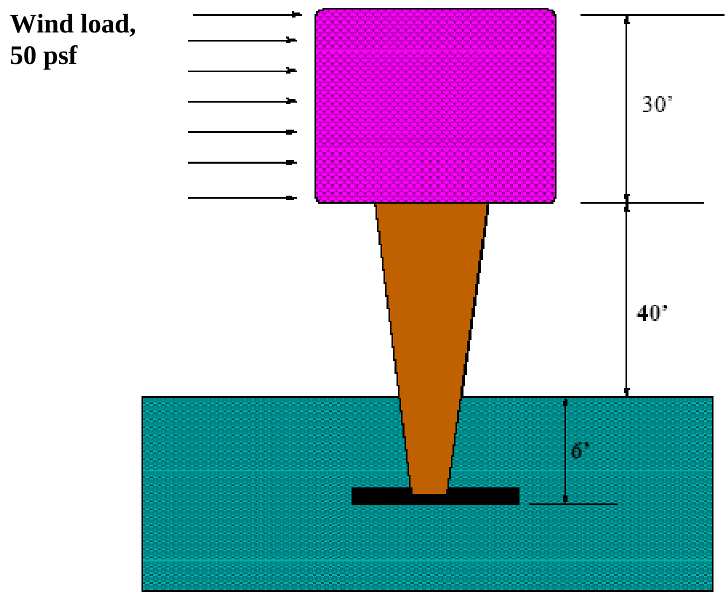

Fig. 3. Schematic of an elevated water tank and its foundation.

1. A factor of safety against bearing failure of at least 3 is achieved;
2. Under the factored design loads, the settlement of the tank's foundation is no more than one inch;