THE UNIVERSITY OF IOWA
Department of Civil & Environmental Engineering
FOUNDATION ENGINEERING 53:139
Final Exam: 2.0 Hours – 100 points

Spring 1997 Instructor: C.C. Swan

Question #1: (25 points)

Assume that you are designing a cantilever retaining wall to support a granular, cohesionless backfill soil that slopes at an angle α with the horizontal:

a. Draw a sketch of such a wall system, and draw a **neat and clearly labeled** free-body diagram you would use to assess the overturning stability of the system.

b. Which method would you use to compute the overturning force exerted by the soil on the wall system?

c. Aside from overturning, what other standard checks would you perform to assure that your design is adequate?

d. Assume that in performing these design checks, you find that the wall you've designed has **inadequate** factors of safety. Please identify specific measures could you take with respect to each item checked to improve the factor of safety of your cantilever retaining wall system?

e. To mitigate possible water and/or freeze-thaw damage to the wall system, what measures would you take in designing the wall?

Question #2: (10 points)

a. What materials are most often used in pile foundations? For each material system, identify at least two associated strengths and deficiencies.

b. What material system is used primarily in drilled pier or shaft foundations?

Question #3: (15 points)

Numerous methods exist for quantifying 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 (but fully) discuss the potential advantages and disadvantages of all three of these methods.

Question #4: (25 points)

Consider the free cantilever sheet pile wall of Figure 1 shown penetrating an undrained saturated clay soil. Using limit state equilibrium considerations along with the **total stress** $\phi = 0$ **concept**, and the assumed shape of the net pressure distribution on the wall as shown in Figure 1:

a. Compute expressions for the net stress magnitudes p_6 and p_7.

b. Using equilibrium arguments, find a quadratic expression for the minimum necessary depth D of embedment of the wall based on: the soil cohesion c, as well as P and L.

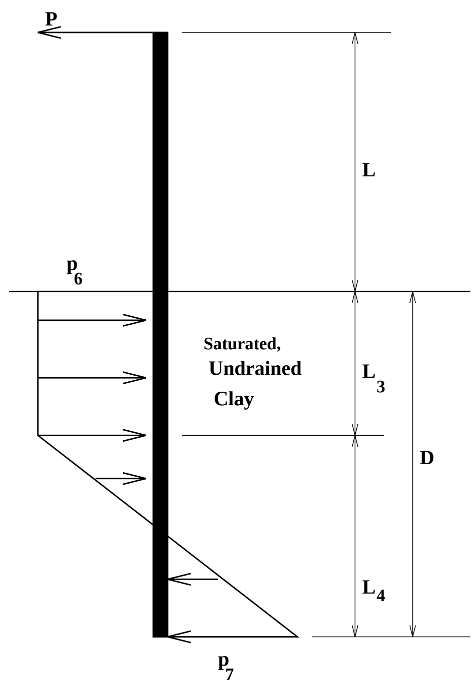

Figure 1.

Question #5: (10 points)

a. What is a hydro-collapsible soil?

b. What tests might you perform on a soil sample to test for hydro-collapse potential?

c. When designing/building shallow foundations on such collapsible soils, what preventative measures can be taken to minimize damage?

Question #6: (15 points)

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

a. Dense, compacted, saturated sands are highly vulnerable to liquefaction during earthquakes since they tend to dilate (expand) when sheared.

b. Shallow footings for retaining walls and shallow strip footings in general should always be placed as close to the existing ground surface level as possible.

c. When designing deep foundations to resist uplift loads, it is standard practice to use a factor of safety against uplift failure that is larger than the standard factor of safety against downward loading failure.

d. General shear failures tend to occur in dense, well-compacted soils whereas local punching failures are likely to occur in loose soils of low relative density.

e. Three semi-empirical methods of computing the end-bearing capacity of deep foundations bearing on soils are Meyerhoff’s, Vesic’s, and Janbu’s methods. Of these, only Meyerhoff’s method accounts for the possibility of local punching failure at the pile or pier tip.

f. H piles are “high-displacement” piles.

g. Invariably, the larger the shear capacity between the soil and the pile, the better.

h. Piles are generally driven in groups and structurally integrated through either grade beams or pile caps.

i. Iowa loess is highly expansive.

j. 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.

k. A commonly observed rate effect in granular, cohesionless soils is that they show lower strength when loaded rapidly as opposed to quasi-statically. This means that pile driving formula methods to estimate the ultimate capacity of piles in granular, cohesionless soils systematically **underpredict** the quasi-static capacity of the piles.

l. The “freeze” behavior of piles driven in clay is unrelated to thixotropic behavior.

m. The friction angle between soil and steel piles is generally less than that of a soil’s internal angle of friction ϕ.

n. 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.

o. A high liquid limit(LL) and plasticity index (PI) are strong indicators of a highly collapsible soil.