The University of Iowa
Department of Civil & Environmental Engineering
SOIL MECHANICS 53:030
Final Examination
2 Hours, 100 points

Fall 1997 **Instructor: C.C. Swan**

Problem #1: (10 points)

a. List two or three of the major differences in engineering properties (permeabilities, strength behaviors, compressibilities, etc.) between clay soils and sands/gravels. Briefly, explain why these differences exist based on fundamental physical differences between the soil types.

b. What is the difference between a soil that is normally consolidated and one that is over-consolidated?

Problem #2: (10 points)

In order to guide the soil compaction in earth construction, moisture-density studies on a given soil are typically performed in the laboratory. In performing such tests, a laboratory technician found two dry densities of $2.00 \text{ g} \cdot \text{cm}^{-3}$ and $2.21\text{g} \cdot \text{cm}^{-3}$. The water content at which both soil samples were compacted was reported to be 12%. Questions have been raised regarding these tests. You, as the engineer, have been asked to determine whether or not these unit weights are possible. Show your computation to support your conclusion. Assume that $G_s = 2.70$ and that $\rho_w = 1.0\text{g} \cdot \text{cm}^{-3}$.

Problem #3: (25 points)

To build an underwater foundation, a temporary sheetpile wall system has been constructed as shown in Figure 1, and the soil has been excavated to a depth of D=4m. The water level H on the back side of sheetpile is 3m. The corresponding flownet for this problem is also shown in Figure 1.

a. At what rate is water being pumped out of the excavation to maintain the water level shown?

b. What is the vertical effective stress at point A?

c. What is the factor of safety against heaving in the critical regions around the sheetpiles?

d. How high H would water have to be on the back side of the sheetpile wall to create an unstable situtation in the critical regions? (Assume that the water level in the excavation remains as shown in Figure 1.)

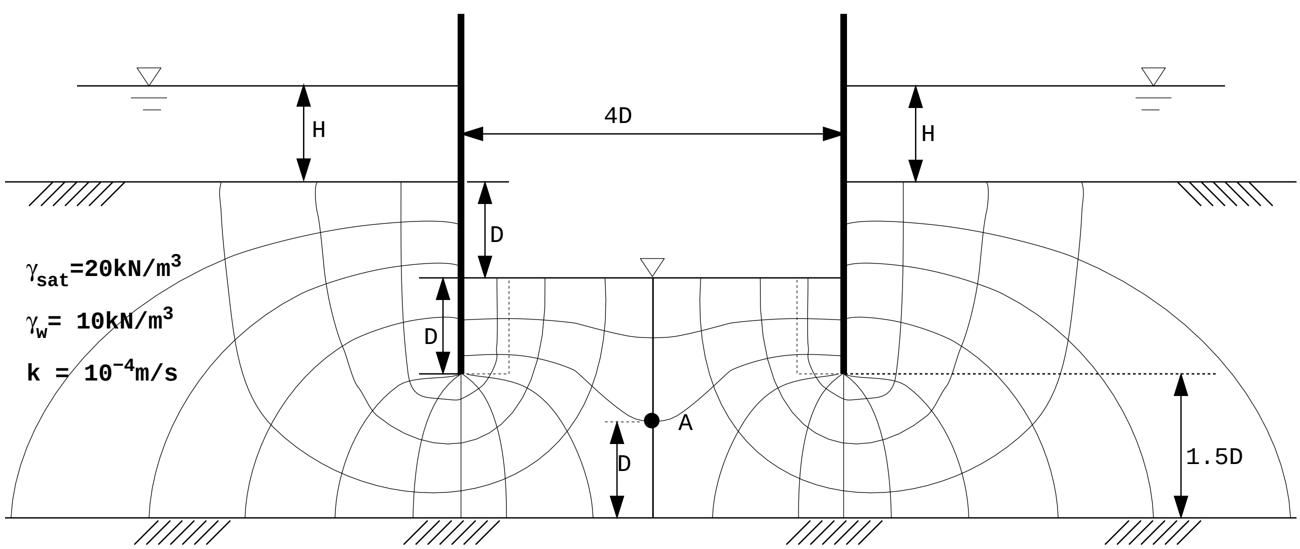

Figure 1. Seepage around sheetpile walls.

Problem #4: (25 points)

Figure 2 shows a three-layered soil system. Note that the preconsolidation vertical effective stress σ'_{vc} at the center of the clay layer is 300 kPa.

a. Just after the uniform load q = 250kPa is applied to the soil (assuming that it could be applied instantaneously), how high h would water rise above the existing water table level in the standpipe?

b. Considering only primary consolidation, how much will the clay layer have compressed three years after the load is applied?

Assume $\gamma_{water} = 10kN \cdot m^{-3}$.

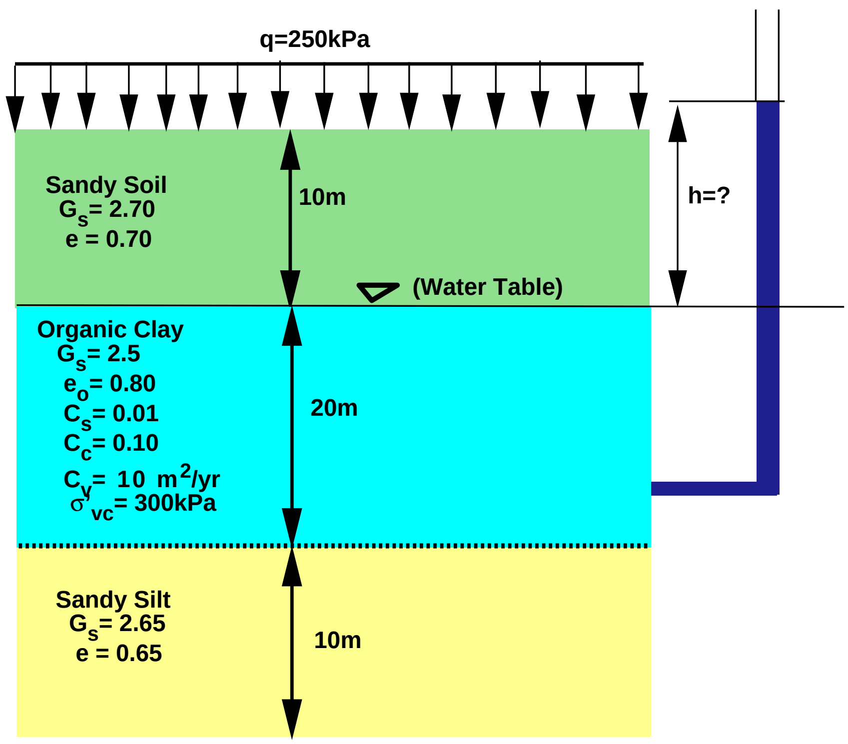

Figure 2. Three-layered soil system with standpipe.

Problem #5: (30 points)

In preparing a sandy soil for a drained triaxial compression test, a specimen (c = 0, ϕ = 40°) has uniform atmospheric pressure acting on it $\sigma_1 = \sigma_3$ = 100kPa. The pore pressure (air pressure) in the voids is also atmospheric as well, u = 100kPa.

a. Draw the Mohr's Circle for the soil's stress state in terms of

1. total stresses; and

2. effective stresses.

b. Why can't the soil in this state support any shear stress?

The soil sample is then sealed in a rubber membrane and the pore space is evacuated with a vacuum pump reducing the absolute pore pressure to u = 0kPa. Atmospheric pressure $\sigma_1 = \sigma_3$ = 100kPa continues to act externally on the soil.

c. Draw the Mohr's Circle for the soil's effective stress state.

The soil is then subjected to an axial compression test in which the horizontal stress remains atmospheric σ_3 = 100kPa; the vertical stress σ_1 is increased until shear failure occurs; and the pore pressure is maintained at a vacuum u = 0kPa.

d. Draw the Mohr's Circle for the effective stresses at shear failure.

e. What is the orientation of the shear failure plane in the soil? (Show your work to receive full credit.)

f. What are the effective shear and normal stresses on the failure plane?