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

Fall 1996 Instructor: C.C. Swan

Problem #1: (10 points)

A 3m thick layer of sand with a minimum void ratio of 0.45 and a maximum void ratio of 0.97 has a relative density of 10 percent. The average specific gravity of the minerals in the soil is 2.68, and $\gamma_w = 9.81 kN \cdot m^{-3}$.

a. Compute γ_{dry} and γ_{sat} for the sand in its present state with $D_r = 10\%$.

b. Under vibratory loading, the thickness of the sand reduces to 2.75m. What is the new relative density of the sand?

Problem #2: (10 points)

a. List two or three of the major differences in engineering properties between clay soils and sands/gravels. Briefly, explain why these property differences exist based on physical differences between the soil types.

b. Two methods of "soil improvement" that have been discussed are compaction and consolidation. Explain the differences between the two and give an example of where each might be used in geotechnical engineering.

Problem #3: (20 points)

A dry cylindrical soil-cement specimen has Mohr-Coulomb strength properties c = 670kPa and $\phi = 25°$. Assume that the soil specimen can be successfully tested in a pure, unconfined vertical tension test.

a. What is the tensile strength of the soil?

b. What is the orientation of the failure plane(s) in the soil specimen?

c. What are the stresses (σ, τ) on the failure plane?

Problem #4: (20 points)

Consider the steady horizontal flow occurring in the three-layered artesian aquifer shown in Figure 1.

a. What is the equivalent permeability of the three-layered aquifer for flow in the horizontal direction?

b. How high will water rise in the standpipe at point C?

c. What is the rate of seepage per unit width in layer 1?

d. In layer 3?

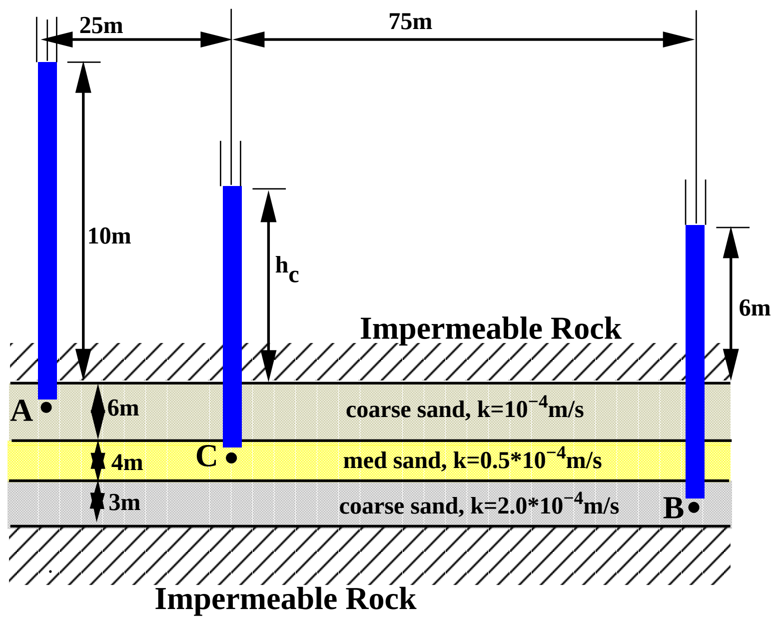

Figure 1. Horizontal seepage occurring in a three-layer artesian aquifer.

Problem #5: (20 points)

Consider the soil profile shown in Figure 2. The phreatic surface (or the water table) now coincides with the ground surface, but a long time ago it used to be at a depth of 5 feet below the ground surface.

a. Use the phreatic surface location "a long time ago" to compute the preconsolidation effective stress in the clay layer.

b. Estimate the ultimate settlement of the ground surface due only to primary consolidation in the clay layer if a uniform pressure of 400 psf were to be applied over a large area.

c. How much of this consolidation settlement would have occurred after 30 days?

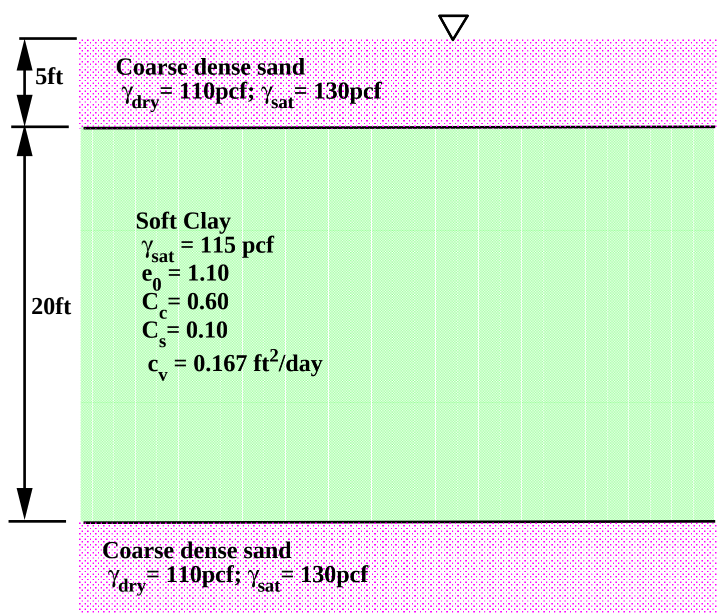

Figure 2. Sand and clay soil deposit.

Problem #6: (20 points)

Figure 3 shows a homogeneous infinite soil slope. The face of the slope makes an angle α with the horizontal. Horizontal, steady state water seepage is taking place in the slope. Once the water reaches the face of the slope, it trickles down the face.

a. What is the porewater pressure at a point A a vertical distance “d” beneath the slope surface?

b. What is the magnitude of the seepage gradient in the soil?

c. What are the magnitude and direction of seepage forces (per unit volume) exerted by the fluid on the soil skeleton?

d. Briefly explain how the seepage tends to stabilize or destabilize the slope.

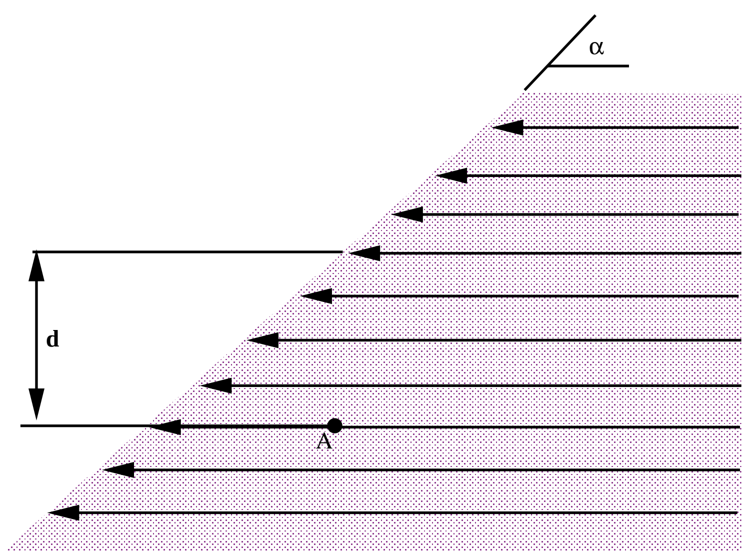

Figure 3. Infinite soil slope with horizontal seepage.