The University of Iowa
Department of Civil & Environmental Engineering
SOIL MECHANICS 53:030
Midterm Exam
(1 Hour)

Fall 1996 Instructor: C.C. Swan

Bonus Question: (10 extra points!!) **Answer this question after questions 1–4.**

The potential head distribution in an infinite soil domain is given by $h(x, y) = 5x^2 - 5y^2$. Assume that the permeability for the soil is isotropic, and $k = 1.0$.

a. At the point $(x, y) = (1, 1)$ what is the discharge velocity **v** in the soil? (Provide the x and y components of the velocity vector.)

b. Does the flow associated with the head distribution h(x,y) satisfy the continuity equation $\nabla \cdot \boldsymbol{v} = 0$?

Problem #1: (20 points)

A moist soil has these values: $V = 0.25 ft^3$, $W = 30.75 lb$, $w = 9.8\%$, and $G_s = 2.66$. Determine the following:

a. $\gamma(lb/ft^3)$;

b. $\gamma_d(lb/ft^3)$;

c. e;

d. n;

e. S(%);

f. Volume occupied by water V_w (ft^3).

Problem #2: (15 points)

a. In a sentence or two, explain the significance of "effective" stresses in soils.

b. What is the relative density D_r of a granular soil? Also, briefly explain the physical meaning of the different terms in the definition of D_r.

c. If as a geotechnical engineer you were asked to consider a major construction project in a seismically active region on a large silty sand deposit with a relative density D_r of 2%, how might you respond and why ?

Problem #3: (35 points)

Consider the steady flow down the slope shown in Figure 1. The flow direction is parallel to the slope. For the geometry shown:

a. Draw a flow-net over the flow domain in your exam booklet.

b. What is the magnitude i of the hydraulic gradient in the flow direction?

c. What is the flow rate q in the permeable layer per unit width out of plane?

d. What is the pore pressure along the sand/rock interface? (**Hint:** Use an equipotential line on your flow net to answer this question.)

e. Assume that at the sand/rock interface the total vertical stress is given by the expression $\sigma_v = H \cdot \gamma_{sat}$. What is the vertical effective stress at the sand/rock layer?

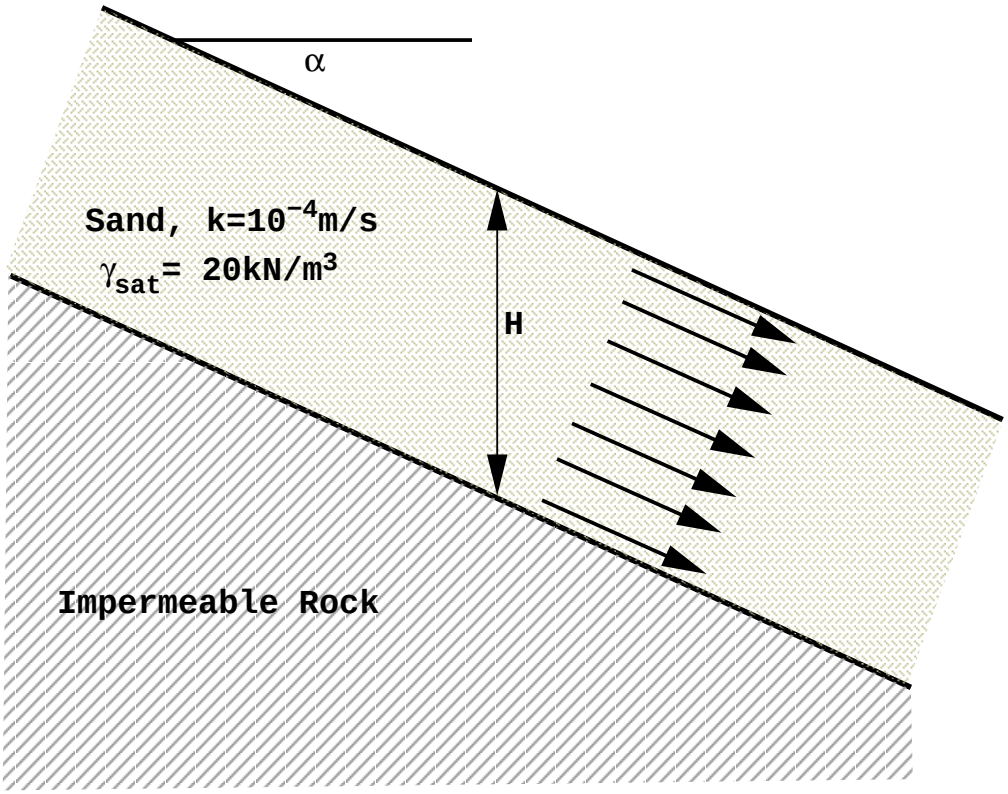

Figure 1. Seepage in a sand layer on an infinite uniform slope.

Problem #4: (30 points)

Steady state seepage is occuring in the soil profile shown in Figure 2. Note the standpipes inserted at points B and C.

a. How high (h) is the water standing in the standpipe located at C?
b. Compute the magnitude of the hydraulic gradient in the silty sand layer.
c. Compute the vertical effective stress at point A in the silty sand layer.
d. How high would the water have to stand in the standpipe at B to cause a quick (boiling) condition at point A in the silty sand layer?

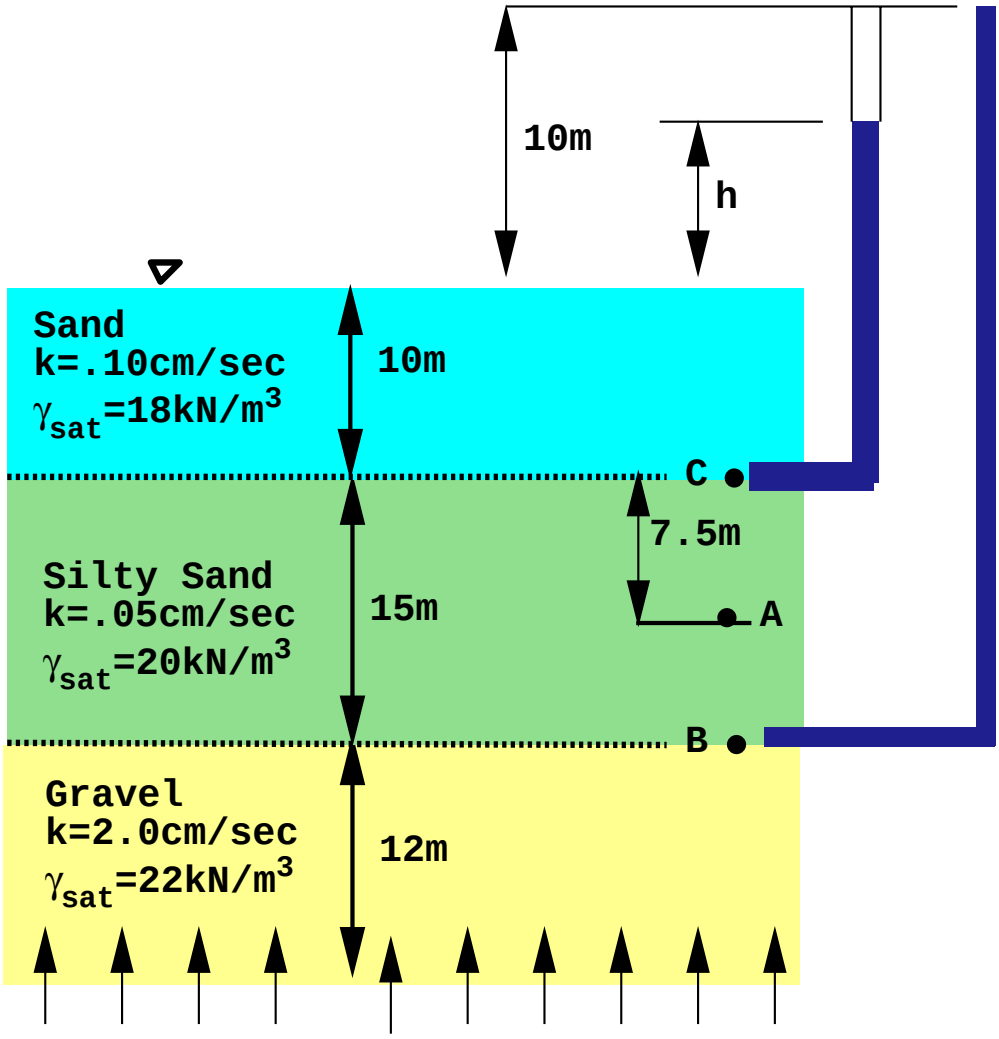

Figure 2. Uniform upward seepage in a multi-layered soil deposit.