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

Fall 1999 Instructor: C.C. Swan

To get full credit, please show all of your work.

Problem #1: (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 with $H = 5.0m$ and $\alpha = 25°$:

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?

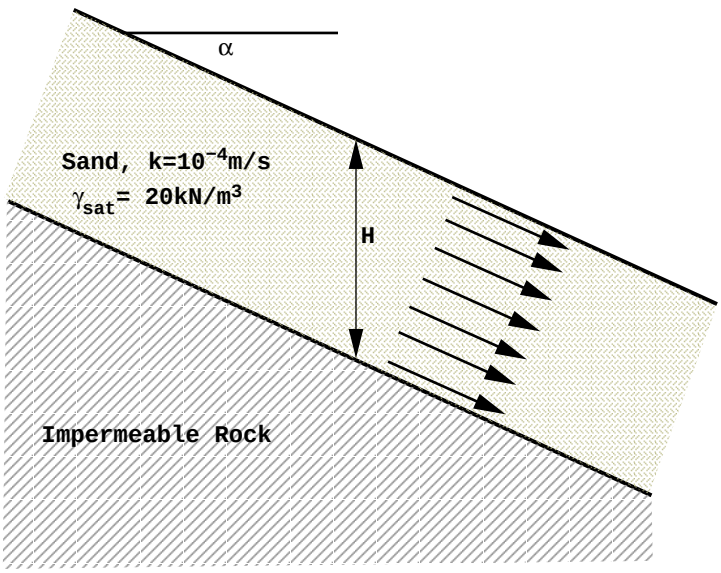

Figure 1. Seepage in a sand layer on an infinite uniform slope.

Problem #2: (20 points)

A moist soil sample has been compacted in a laboratory mold having a volume of $9.44 \cdot 10^{-4} m^3$. The moist soil has a mass of 1.91 kg, and a water content of 14.5%. Given that the specific gravity of the soil solids is 2.66, compute:

a. The dry mass density of the soil;
b. The dry unit weight of the soil;
c. The void ratio of the soil; and
d. The degree of saturation.

Problem #3: (15 points)

a. A soil has a plastic limit (PL) of 30, and a liquid limit (LL) of 60. What moisture content corresponds to a liquidity index of 0.50?
b. How does specific surface area affect soil hydraulic conductivities?
c. Briefly explain the difference between the **hydraulic conductivity** of a soil and its **absolute permeability**?

Problem #4: (35 points)

A U-tube with four layers of soil is shown below in Figure 2, while the vital dimensions and soil properties are also listed.

a. Find the effective horizontal hydraulic conductivity of the four-layered soil system.
b. Compute the volumetric rate of seepage q occuring in the U-tube.
c. What is the fluid pressure at point C, between layers 2 and 3?
d. What is the magnitude/direction of the seepage forces on the soil in layer 3?
e. In which layer would the seepage forces be the largest?

$L_1 = L_2 = L_3 = L_4 = 1m$
$H_i = 5m$; $H_o = 2m$
$T = 1m$; out-of plane thickness = 1m; $z_C^* = 0.5m$
$k_1 = 10^{-2} m/sec$; $k_2 = 10^{-3} m/sec$; $k_3 = 10^{-4} m/sec$; $k_4 = 10^{-5} m/sec$:

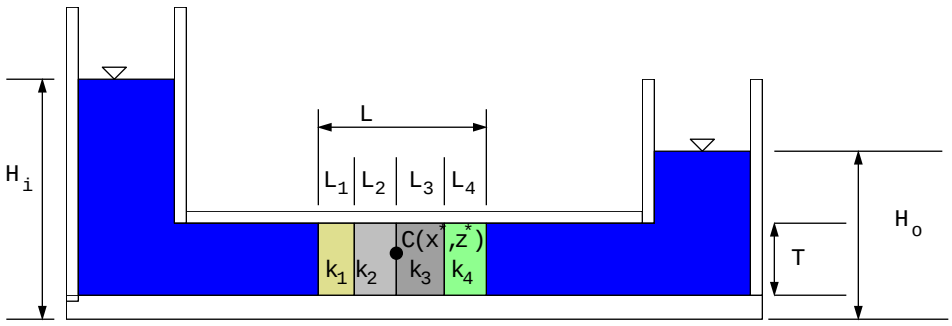

Figure 2. U-tube problem.