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

Answer any three of the four questions.

Fall 1995 Instructor: C.C. Swan

Problem #1: (33.33 points)

An oil tank weighing 18,000 tons is to be supported on a square foundation mat 120 ft. x 120 ft. at a depth of 17 ft. beneath the ground surface (see Figure 1).

(a) Plot qualitatively but neatly, the motion of point B (which is directly beneath the center of the square foundation) from the time the excavation is started until the tank has been constructed and sitting in place for several years. Briefly explain your reasoning.

(b) Calculate the vertical settlement of point B two years after the tank was completed. Clearly identify any major assumptions you make.

(c) At what point in time after the tank has been constructed would the soil beneath the foundation be most susceptible to shear failure from the bearing stresses? Explain.

Recall that the increase in vertical stress at a depth z below the corner of a uniformly loaded flexible rectangular area is: $\Delta\sigma_v = qI_3$, where: I_3 is a function of the dimensionless parameters $m = B/z$ and $n = L/z$ and is provided on page 5 of this exam handout.

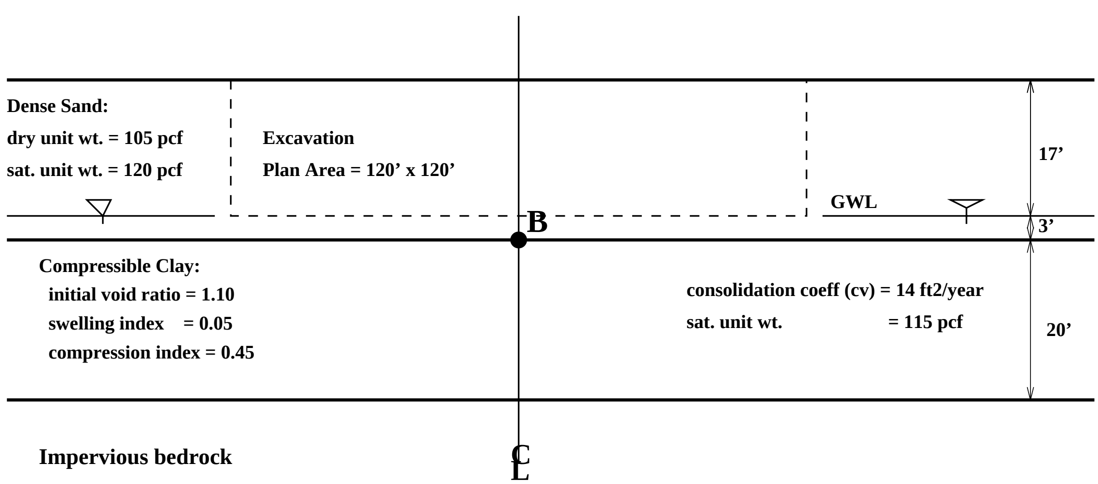

Figure 1.

Problem #2: (33.33 points)

Consider the soil profile shown in Figure 2. The phreatic surface 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. Assume that a uniform pressure of 400 psf is to be applied over a large area:

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

b. How long will it take to achieve 50% and 90% consolidation of the clay layer under the imposed loading? (Refer to the U vs. T_v curve shown on page 5 of this exam handout.)

c. Estimate the ultimate settlement of the ground surface due only to consolidation in the clay layer.

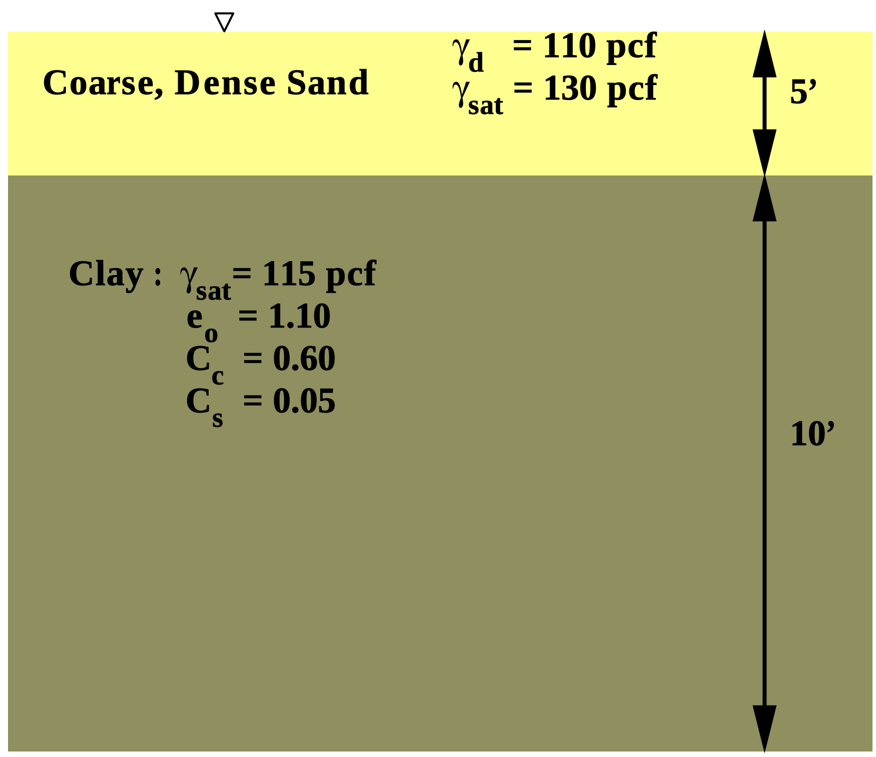

Figure 2.

<u>Problem #3</u>: (33.33 points)

Figure 3 shows a homogeneous, dry sandy soil deposit with a horizontal ground surface. Before the strip load is applied, the stresses at point A are as follows: vertical stress σ_v=95kPa; horizontal stress σ_h=47.5kPa.

a. Compute the maximum shear stress at point A <u>before</u> the surface pressure is applied.

b. Using the information provided in Figure 4, calculate the maximum shear stress at point A <u>after</u> the uniform strip load is applied.

c. Calculate the intensity of the strip surface pressure q that would be required to cause shear failure in the soil at point A.

d. What would be the orientation of the failure planes at point A if shear failure were reached by increasing the surface pressure?

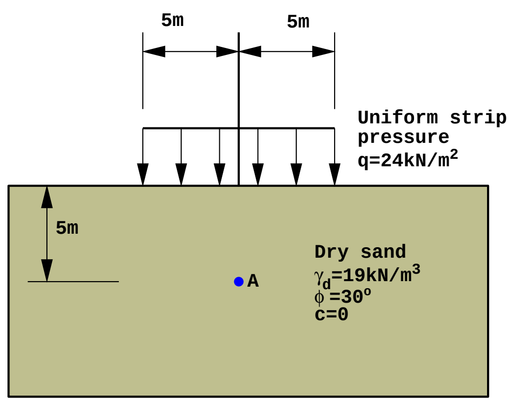

Figure 3. Uniform strip load applied to a dry soil deposit.

Figure 4. Principal stress increases under strip loading

<u>Problem #4</u>: (33.33 points)

Consider the jointed stone mass resting on a level bed of sand as shown in Figure 5. To maintain stability of the sand layer against erosion, a concrete retaining wall was constructed as shown. The retaining wall shown completely blocks drainage of the sand layer and over the years, rainfall has been accumulating in the fissure.

a. How high h would water have to rise in the fissure shown to initiate a **sliding** (shear) instability of the jointed stone mass on the sand layer? Neglect the resistance to sliding provided by the retaining wall and assume that sliding is caused by shear failure in the sand layer. (25 pts.)

b. If as an engineer you became responsible for this situation, how would you increase the stability of the stone mass against sliding? (8.33 pts.)

Sand properties are: G_s=2.68; e=0.72; c=0; ϕ=25°
Stone properties: γ_{stone} = 25$kN \cdot m^3$.

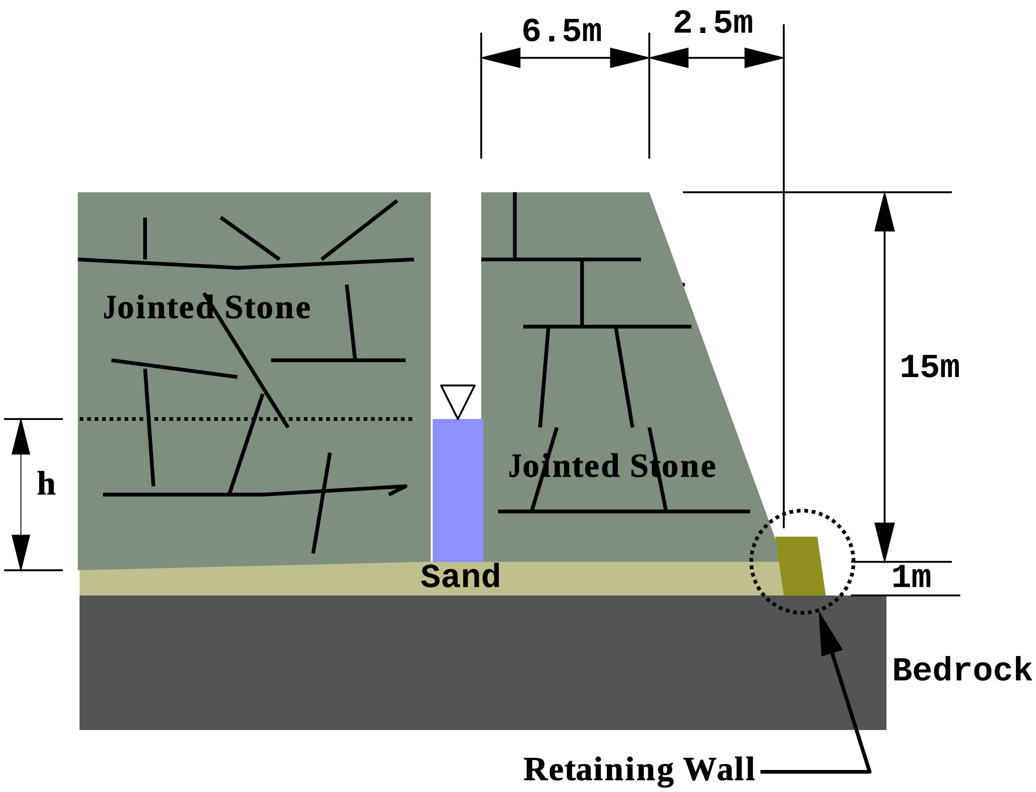

Figure 5. Jointed stone mass on an undrained sand layer.