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

Fall 1996 Instructor: C.C. Swan

Problem #1: (40 points)

A silty soil has drained Mohr-Coulomb strength parameters c=50kPa and $\phi_D = 30^o$. A sample of this soil has been reconsolidated under the same stresses it experienced in the field: σ_v = 200kPa; σ_h = 160kPa. The pore pressure in the sample after it is fully consolidated under these stresses is 100 kPa. A drained strength test in the triaxial cell is then performed to shear failure: During the test, pore pressure is kept constant while σ_v is increased and σ_h is decreased simultaneously by half the amount (*i.e.* $\Delta\sigma_h = -1$ when $\Delta\sigma_v$ = +2).

i. Using Mohr's circle, find an expression relating the principal effective stresses σ_1' and σ_3' at failure.

ii. What are the total principal stresses σ_1 and σ_3 at failure?

iii. What is the orientation of the plane on which shear failure occurs, and what are the effective stresses on that plane?

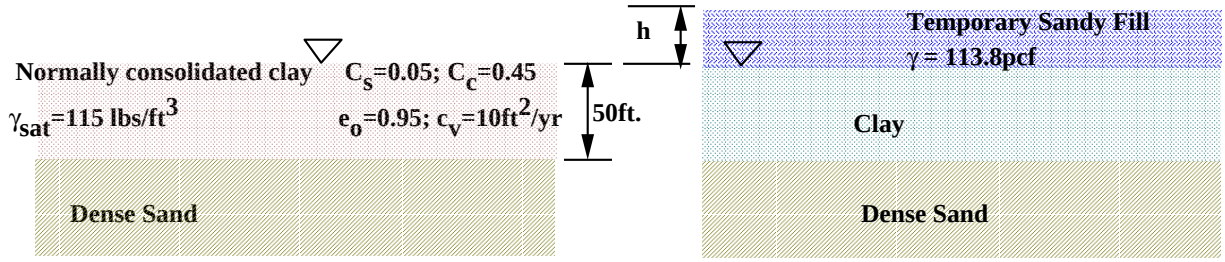
Problem #2: (40 points)

As an engineer working for a major oil company, you are assigned the site planning and preparation associated with an oil storage tank construction project. The oil tank will weigh 20,000 tons when full and will be supported on a circular, flexible foundation of radius 75 feet. The existing site is shown in Figure 1a. To avoid large settlement under the tank, you are considering bringing in fill to pre-load the soft clay soil. The preload layer (Figure 1b) will be completely removed before the storage tank is constructed. Under this plan:

i. How many feet of dry fill (at unit weight γ = 113.8lbs/ft^3) would you need to bring in to the sight so that at the center of the clay layer directly under under the center the tank $(\Delta\sigma_v)_{fill}$ = $(\Delta\sigma_v)_{tank}$? That is, how thick h should the pre-load layer be?

ii. Assuming that you wanted to leave the fill in place until 90% percent consolidation is achieved before building the tanks, how long would you have to wait?

iii. What would be the ultimate (100%) consolidation settlement under the fill loading?



1a) Site as it presently exists **1b) Site with preloading in place**

Figure 1. Existing site configuration and proposed construction configuration

NOTE: The increase in vertical stress below the center of a uniformly loaded circular flexible area is:

$$\Delta\sigma_v = q\left[1 - \frac{1}{\left[(R/z)^2 + 1\right]^{3/2}}\right]$$

where R is the radius of the loaded region and z is the depth below the center.

Problem #3: (20 points)

The plan of a flexible rectangular loaded area is shown in Figure 2. The uniformly distributed load on the flexible area is q=2.0MPa. Using the integrated Boussinesq solution, estimate the increase in vertical stress, $\Delta\sigma_v$, at a depth of 5m below point A.

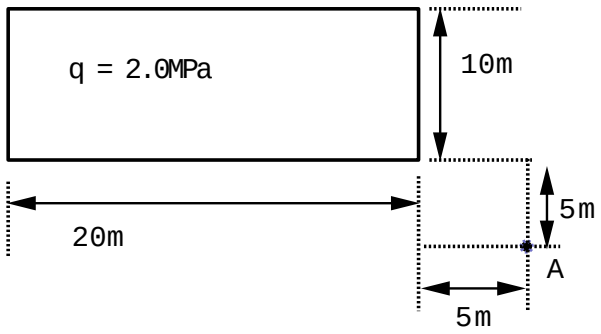


Figure 2.

Recall that the increase in vertical stress below the corner of a uniformly loaded flexible rectangular area is: $\Delta\sigma_v = qI_2$, where: I_2 is a function of the dimensionless parameters $m = B/z$ and $n = L/z$. A plot of $I_2(m, n)$ is shown on the following page.