53:139 FOUNDATIONS OF STRUCTURES

College of Engineering
The University of Iowa
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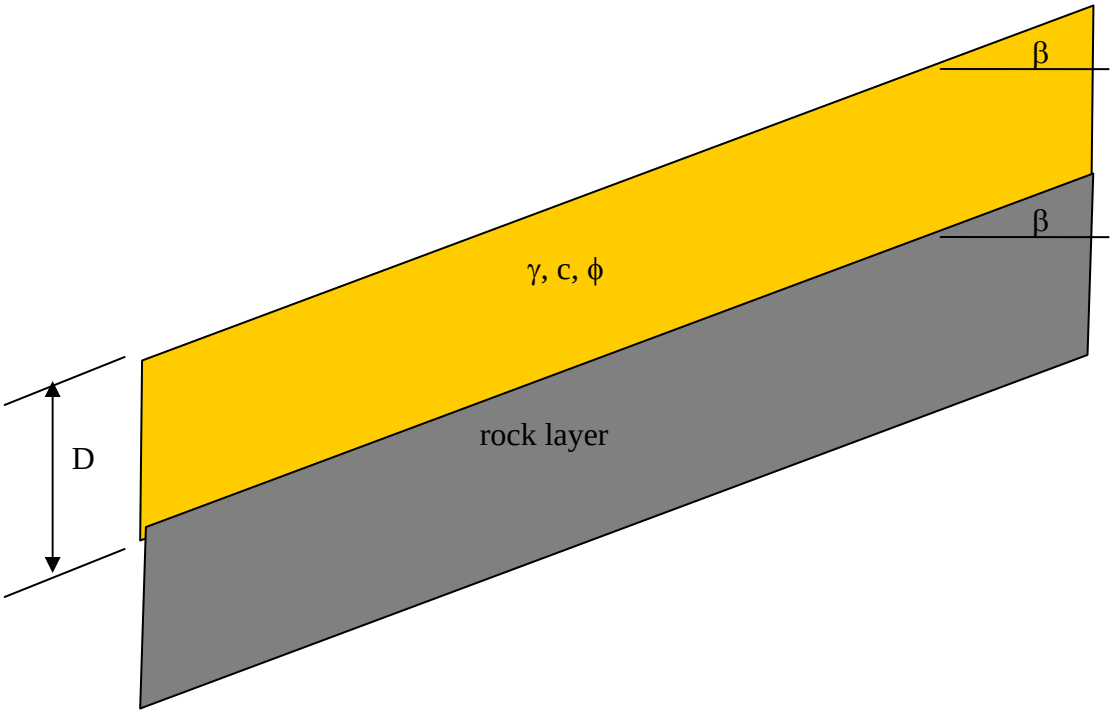
ASSIGNMENT #2: **DUE: 4 February 2009**

1. For the slope shown below, find the critical thickness D of the soil layer that yields shear failure along the soil-rock interface. Given $\beta=20°$; $\gamma=17.3$ kN/m^3; $\phi=15°$; and $c=12$ kPa.



2. For the figure shown above with the same soil parameters, assume that the soil is saturated ($\gamma_{sat}=19.5$ kN/m^3) and that seepage is occurring parallel to the slope face. What is the factor of safety against shear failure along the interface?

3. Soil of properties $c=80$ kPa; $\phi=25°$; $\gamma=18$kN/m^3 comprises a steep slope of height $H=20$m and $\beta=72°$.
    a. What is the factor of safety along a planar mechanism passing through the toe at an inclination of 35° with respect to the horizontal?
    b. What is the slope system's critical factor of safety against shear failure?
    c. What angle does the critical failure mechanism make with respect to the horizontal?
    d. What height of the slope would yield a critical factor of safety of one against failure?

4. In Culmann's method, the critical failure mechanism passing through the toe of the slope is approximated by $\theta_{cr} = (\beta + \phi_d)/2$. For the soil and slope properties of Problem #3, write a program to compute and plot $FS(\theta)$ vs. θ. Compare and briefly discuss the values of θ_{cr} from your plot and from the approximate formula $\theta_{cr} = (\beta + \phi_d)/2$. Are they roughly the same or far apart? Is the approximation acceptable in this case?

5. A cut slope is to be excavated in a saturated clay soil with $c=c_u=500$ psf and $\phi_u=0°$ and γ_{sat} = 110 pcf. Answer the following questions using the Mass Method.
   a. If the slope angle is to be 56°, how deep can the slope be excavated?
   b. Where would the critical circular mechanism intersect the slope system?
   c. How deep could the same slope be excavated while maintaining a FS=2.5?
   d. If the slope angle were reduced to 45°, how deep could the slope be excavated?
   e. With a slope angle of 45°, identify where the circular mechanism will intersect the slope system.

6. A cut slope ($\beta=40°$) was excavated in a saturated clay soil ($\gamma_{sat}=18.5$ kN/m^3) and the slope experienced failure when depth of the excavation reached H=8.5m. Previous subsurface site exploration indicated the presence of a rock stratum 12 m beneath the original ground surface.
   a. Estimate the undrained cohesion of the saturated clay soil.
   b. What would be the expected nature of the critical circle?
   c. With reference to the top of the slope, at what distance did the surface of sliding intersect the bottom of the excavation?

7. A slope of height 4m is cut in a saturated clay deposit in which the undrained cohesion increases linearly with depth as follows: c_u(kPa) = 5kPa +3kNm^{-3}*z where z is the depth beneath the original ground surface. If $\beta=27°$ and $\gamma_{sat}=18.5$kN/m^3, what is the factor of safety for the slope system?

8. A sandy soil has a unit weight of 17kN/m^3 and a friction angle 35° makes a slope of height 30m and angle $\beta=20°$. For the mechanism shown in the Figure below, compute the factor of safety against shear failure: For each case, divide the slope system into 10 slices, each having an equal lateral dimension.

   a. Using the ordinary method of slices;
   b. Using Bishop's simplified method of slices.

Drawn to scale