Mass Wasting - Angle of Repose Exercises
ENV 601

Complete the following exercises.

I a) Which material will have a steeper angle of repose, a dry granular material or the same material damp? Discuss why.

b) Relate to equation 4 in the online notes.

c) What happens to the angle of repose for granular material that is saturated with water? Discuss why.

d) Relate to equation 4.

II Beaty (1956) counted landslides on hillslopes near San Francisco. *(from Rahn, 1996)*

Exposure Direction	Number of Slides
NW	30
NE	24
SW	15
N	14
E	10
SE	10
S	5
W	4
	total = 112

a) In what general direction do most of the landslides occur in this area? (realize that this is a limited data set and the pattern might be more clear with more data)

b) Explain why. (assume that the geology is homogeneous)

III Determine the relative magnitudes of the shear stress and normal stress in dry fine sand with an angle of repose (approximately the angle of internal friction) of 35 degrees. See discussion in the online notes. To compare the relative magnitudes all you need to calculate are the sin and cos functions.

a) Record both of these and then give the final answer as the ratio of shear stress over normal stress. Calculate the ratio.

b) Which is larger, the shear stress, normal stress, or neither?

c) In general, for typical angles of repose, at the angle of repose, why are shear stress and normal stress not equal? (relate to equation 5 in the notes)

d) What quantities are always equal at the angle of repose?

e) At what slope angle does shear stress equal normal stress?

f) What is the coefficient of friction for a material with an angle of repose that you determined in **e** above?

IV For a chalkboard eraser sliding (no cohesion) down an inclined board: the eraser is about 0.25 lb (the precooked weight of the all beef patty in a MacDonalds Quarter Pounder) and the contact surface is about 5" by 2"; the angle of repose is about 38˚ (depending on how fuzzy it is).

Calculate the actual shear stress and normal stress in pounds per square inch.

(remember: pounds are units of force, not of mass)

V a) Determine the relative magnitude of shear stress vs. normal stress on planes inclined at 0, 15, 30, 45, 60, 75, and 90 degrees (as in III above). Prepare a table with sin ø, cos ø, and the ratio of shear to normal stress (sin ø / cos ø) for each slope angle.

b) To help you recognize how the shear and normal stress vary as the angle of repose increases make a graph of shear stress vs. normal stress. Make a graph with normal stress (cos ø) on the y axis and shear stress (sin ø) on the x-axis. Plot each shear stress/normal stress pair for each angle in part a. Draw a smooth curve through the plotted points and label each point with its slope. You may plot this on the computer in Excel or some other program if you prefer.

c) Draw diagrams showing an object on a sloping plane with vectors for gravitational stress, normal stress, and shear stress for angles of repose (slope angles) of 15, 45, and 75 degrees (see diagram in mass wasting notes: online). Give the gravitational stress a standard length. To determine the proper length of the shear stress and normal stress vectors just multiply the length of your standard gravitational vector by the sin or cos of the slope. For each, label either Fs = Fn, Fs > Fn, or Fn > Fs. Make your drawings large (1 per page). Use ruler and protractor to get the lengths and angles right.