

# CVEN 3698 Engineering Geology

## Homework Assignment # 4

Due Wednesday February 4, 2009

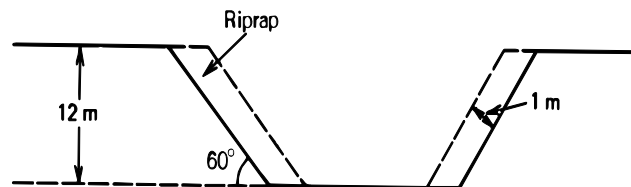
- 1) How would you determine the volume of a rock specimen with irregular shape?
- 2) Based on the physical properties introduced in class, show that the dry density  $\rho_d$ , the saturated density  $\rho_{sat}$  and the wet density  $\rho$  are such that

$$\rho_d = (1-n)\rho_s$$

$$\rho_{sat} = \rho_d + n\rho_L$$

$$\rho = (1+w)\rho_d$$

- 3) The banks of a river channel need riprap for erosion protection. The protected area is 500 m long and requires 1 m thick riprap extending down the bank to the bottom of the channel. What is the volume of rock needed knowing that the riprap was placed with an overall porosity of 25%? The rock is a sandstone with a bulk density of 2.7 g/cm<sup>3</sup>.



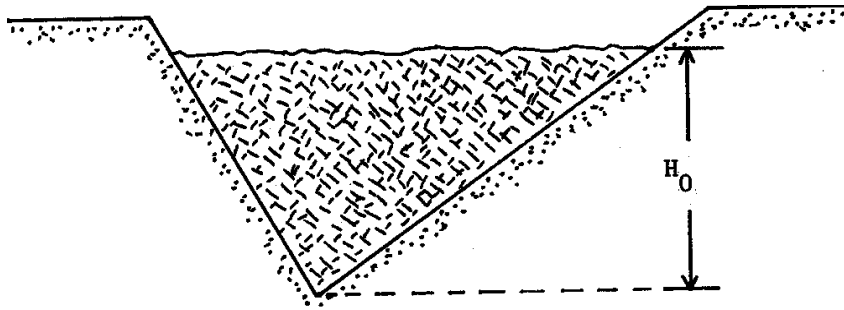
- 4) Solve the following problems (from *Computational Engineering Geology*, by E. Derringham, Prentice Hall, 1998).

1. A cylindrical sample of rock has a length of 37.7 cm and a diameter of 7.50 cm. The mass of the sample is 4747 g. Find the unit weight of the rock, in kN/m<sup>3</sup>.
2. A block of rock has edge lengths 1.22 m, 2.40 m, 1.81 m. When dry its mass is 14.7 Mg; when saturated with water its mass is 16.6 Mg. Find the porosity of the rock. (The SI prefix M stands for 1 X 10<sup>6</sup>)
3. A rock saturated with oil has a unit weight of 29.3 kN/m<sup>3</sup>. When dry the rock has a unit weight of 26.4 kN/m<sup>3</sup>. The porosity of the rock is 0.370. Determine the density of the oil.
4. Calculate the porosity of a 92.0 cm<sup>3</sup> sample of rock containing 1270 spherical pores, each with

a diameter of 3.82 mm.

5. A cube of chalk with porosity 38.4% has an edge length of 1.40 m. The chalk is crushed, closing all the pores, and then reshaped into a cube. What is the edge length of the new cube?
6. A cylindrical sample of rock has a diameter of 8.48 cm and a length of 14.6 cm. When dry it weighs 22.8 N; when saturated with water it weighs 28.0 N. (a) Find the porosity of the rock. (b) What is the volume of the water in the sample when saturated with water?
7. Mine spoils of porosity  $n_0$  are dumped into a triangular trench to depth  $H_0$ , as shown below. Over time, the spoils become compacted under their own weight until the porosity is reduced to  $n$ . Show that the subsidence  $\Delta H$  of the surface of the spoils is given by the following expression

$$\Delta H = H_0 \left[ 1 - \sqrt{\frac{1-n_0}{1-n}} \right]$$



8. A block of dimension stone has edge lengths 1.13 m, 2.26 m, 1.30 m. When dry the mass of the block is 10,300 kg. The porosity of the stone is 26.4%. Find the mass of the block when it is saturated with liquid mercury.
9. A dry oil shale has a unit weight of 26.3 kN/m<sup>3</sup>. When saturated with oil of unit weight 5.80 kN/m<sup>3</sup>, the shale has a unit weight of 28.9 kN/m<sup>3</sup>. How many gallons of oil can be extracted from 4.72 X 10<sup>6</sup> m<sup>3</sup> of saturated oil shale?
10. A block of oil shale with a volume of 0.774 m<sup>3</sup> is saturated with 0.311 m<sup>3</sup> of oil. The unit weight of the saturated oil shale is 27.8 kN/m<sup>3</sup>. After all of the oil has been driven out of the rock, the unit weight of the rock is 25.2 kN/m<sup>3</sup>. Find the specific gravity of the oil.
11. A dry oil shale has a unit weight of 25.8 kN/m<sup>3</sup>. When saturated with oil of specific gravity 0.650, the shale has a unit weight of 29.3 kN/m<sup>3</sup>. How many barrels of oil can be extracted from 7400 m<sup>3</sup> of this saturated oil shale? (1 barrel = 119,300 cm<sup>3</sup>.)
12. A block of rock saturated with water has edge lengths of 1.20 m, 1.47 m, 1.35 m. The

porosity of the rock is 28.4%. Find the volume of water squeezed out of the rock when it is crushed so that all the pores are closed.

13. Clay sediment of porosity 48.2% is deposited into a triangular trench to a depth equal to 7.26 m. (a) Find the porosity of the clay when it has settled by 54.4 cm. (b) Find the greatest possible settlement that can occur due to compaction.

14. Material with a porosity  $n_o$  is stored in a rectangular trench, filling the trench to depth  $H_o$ . Show that the porosity  $n$  of the material after settling a distance equal to  $0.5H_o$  is given by  $n = 2n_o - 1$ .

15. Calculate the porosity of a rock that is 50% quartz, 50% muscovite, and that has a bulk density of  $2.00 \text{ g/cm}^3$  when saturated with water.