CIVL 4151
Spring 2015
Homework 5

1. A medium-grained quartz sand (G_s = 2.70) is compacted to a dry unit weight of 15.29 kN/m^3 and tested in a constant head permeameter. The diameter of the specimen is 60 mm and its height is 130 mm. Under an applied head of 60 cm, 119 ml of water flows through the specimen in 5 min. Calculate (a) the hydraulic conductivity, (b) the discharge velocity, and (c) the seepage velocity. Express all of your answers in cm/sec.

$$A = \frac{\pi d^2}{4} = \frac{\pi}{4}(6\ cm^2) = 28.27\ cm^2$$

$$V = AL = (28.27\ cm^2)(13\ cm) = 367.6\ cm^3$$

$$k = \frac{QL}{Aht} = \frac{(119\ cm^3)(13.0\ cm)}{(28.27\ cm^2)(60\ cm)(300\ sec)} = 0.003\ cm/sec$$

$$v = ki = (0.003\ cm/sec)\left(\frac{60\ cm}{13\ cm}\right) = 0.0138\ cm/sec$$

$$W_s = V\gamma_d = (3.676 \times 10^{-4}\ m^3)(15.29\ kN/m^3) = 0.00562\ kN$$

$$V_s = \frac{W_s}{G_s\gamma_w} = \frac{0.00562\ kN}{2.70(9.81\ kN/m^3)} = 0.000212\ m^3 = 212.2\ cm^3$$

$$V_v = V - V_s = 367.6 - 212.2 = 155.4\ cm^3$$

$$n = \frac{V_v}{V} = \frac{155.4}{367.6} = 0.423$$

$$v_s = \frac{v}{n} = \frac{0.0138\ cm/sec}{0.423} = 0.0326\ cm/sec$$

2. During a falling-head permeability test, the head fell from 49 cm to 28 cm in 4.7 min. The specimen was 80 mm in diameter and had a length of 85 mm. The area of the standpipe was 0.45 cm^2. What is the permeability of this soil (in cm/sec)?

$$A = \frac{\pi d^2}{4} = \frac{\pi}{4}(8\ cm^2) = 50.27\ cm^2$$

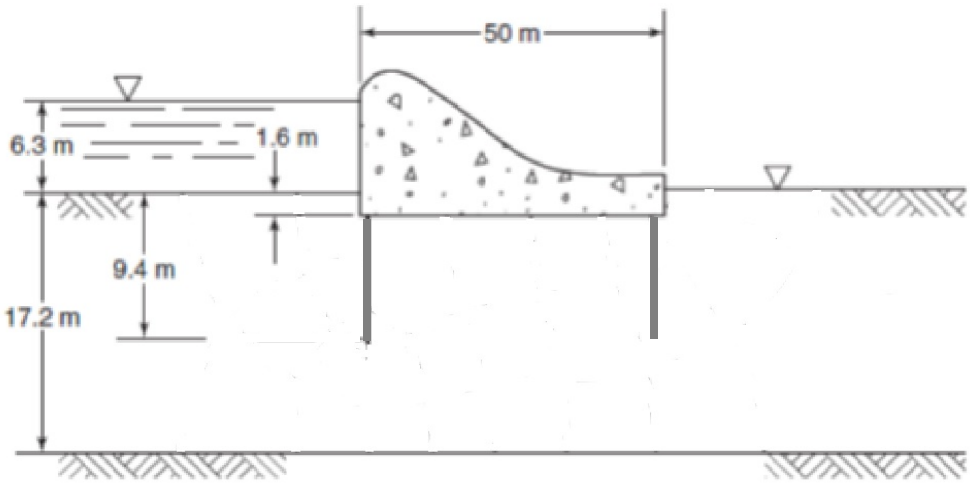
$$k = 2.303\frac{aL}{At}\log_{10}\frac{h_1}{h_2} = \frac{2.303(0.45\ cm^2)(8.5\ cm)}{(50.27\ cm^2)(4.7\ min)(60\ sec/min)}\log_{10}\frac{49}{28} = 6.56\ \times 10^{-5} cm/sec$$

3. If the test in the previous problem was run at the U.S. standard of 20°C, what would the permeability be under the Indian standard of 25°C?

$$k_{20°C} = \left(\frac{\eta_{25°C}}{\eta_{20°C}}\right) k_{25°C} = 0.889 k_{25°C} = 6.56 \times 10^{-5} cm/sec$$

$$k_{25°C} = \frac{6.56 \times 10^{-5} cm/sec}{0.889} = 7.38 \times 10^{-5} cm/sec$$

4. Draw a flow net for the dam below and calculate the flow rate under the dam per meter width of dam. Assume a coefficient of permeability of 8.4×10^{-4} cm/s and express your answer in m^3/day per meter width of dam. (NOTE: Because the two cutoff walls are the same length, the flow net will be symmetrical from left to right, which should make it a bit easier to draw.)



$$q = kH\frac{N_f}{N_d} = (8.4 \times 10^{-6}\ m/s)(6.3\ m)\frac{3}{12} = 13.23 \times 10^{-6}\ m^2/s = 1.14\ m^2/day \text{ per meter of width}$$