SOLUTIONS, ASSIGNMENT #5

1. Flow net is attached (see fig 1, page 2)

(a) intrinsic Permeability $\bar{K} = 1 \times 10^{-13}\ cm^2$

Hydraulic conductivity coefficient $k = \frac{\gamma_w}{\eta_w} \bar{K}$

η_w = viscosity of water = 1 cP (at normal temperature ≃ 20°C)

1 cP (centiPoise) = $0.1 \frac{N\text{-}sec}{m^2}$

$\therefore \eta_w = 0.001 \frac{N\text{-}sec}{m^2}$

$k = \frac{1000 \times 9.81}{0.001} * 1 \times 10^{-17} = 9.81 \times 10^{-11}\ m/sec$

or $9.81 \times 10^{-9}\ cm/sec$

$q = kh \left(\frac{N_f}{N_d}\right)$; $\left.\begin{array}{l} N_f = 4.2 \\ N_d = 14 \end{array}\right\}$ from flow net

$q = 9.81 \times 10^{-11} \times 3.5 \times \frac{4.2}{14}$

$q = 1.03 \times 10^{-6}\ cm^2/sec$ or

$1.03 \times 10^{-10}\ m^2/sec$

Therefore total water flowing under the dam per unit length $= 1.03 \times 10^{-10}\ m^3/sec$

(b) If $L = 50\ m$,

$Q = qLt = 1.03 \times 10^{-10} * 50 * \underbrace{60 * 60 * 24 * 365}_{1\ sec\ to\ 1\ yr}$

$Q = 0.162\ m^3/yr$

CIVE 353 - Geotechnical Engineering I
ASSIGNMENT 5

University of Waterloo
Department of Civil Engineering

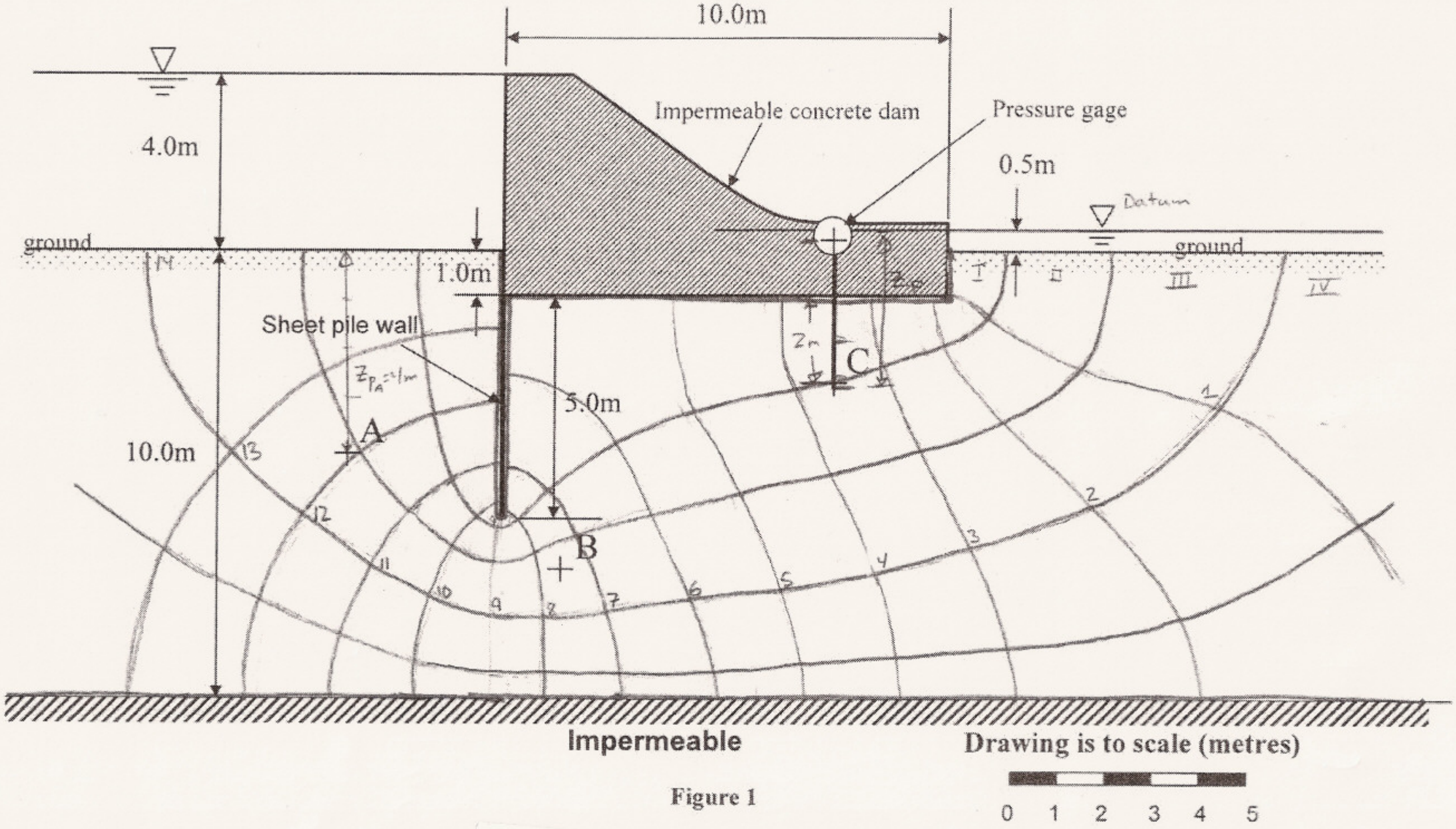


Figure 1

$N_f = 4.2$
$N_d = 14$

Figure 1: Flow net for question #1.

N

(c) Porewater pressure @ A, B, and C

$h_A = \frac{n_d}{N_d} \Delta h = \frac{12}{14} \times 3.5 = 3.0\ m$

$h_B = \frac{7.5}{14} \times 3.5 = 1.86\ m$

$h_C = \frac{3.5}{14} \times 3.5 = 0.875\ m$

Total head $(h) = \frac{u}{\gamma_w} + z$

$\therefore\ u_A = \gamma_w (h_A - z_A) = 9.81(3-(-4)) = 68.7\ kN/m^2$

$u_B = \gamma_w (h_B - z_B) = 9.81(1.86-(-6.5)) = 82\ kN/m^2$

$u_C = \gamma_w (h_C - z_C) = 9.81(0.875-(-3.5)) = 42.92\ kN/m^2$

(d) $h_c = 0.875$ (from c)
↑ Head above datum
⇒ Pressure gauge is located 0.25 m below the datum, $\therefore$ total head $h_T = 0.875 - (-0.25)$
$= 1.125$

This corresponds to $\gamma_w h_T = 9.81 \times 1.125$
$= 11.04\ kPa.$

(e) Darcy's velocity $v = ki$
$i = \Delta h / L$
$\therefore$ The maximum velocity will occur in the area of the highest gradient which occurs across the smallest square on the flow net.
In fig. At the downstream end, smallest square is labelled as I

$v = ki$

seepage velocity $v_s = v/n$

$i = \frac{\Delta h}{\Delta s}$, Δh, $h/N_d = \frac{3.5}{14} = 0.25\,m$

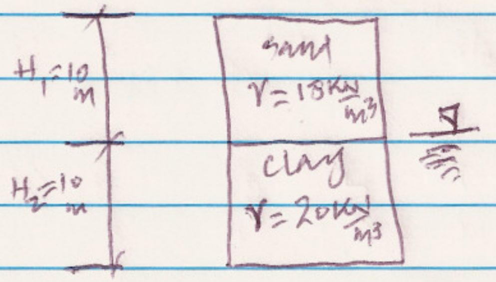
$\Delta s \simeq 1.1\,m$ (scaled from flow net)

$\therefore i = 0.25/1.1 = 0.227$

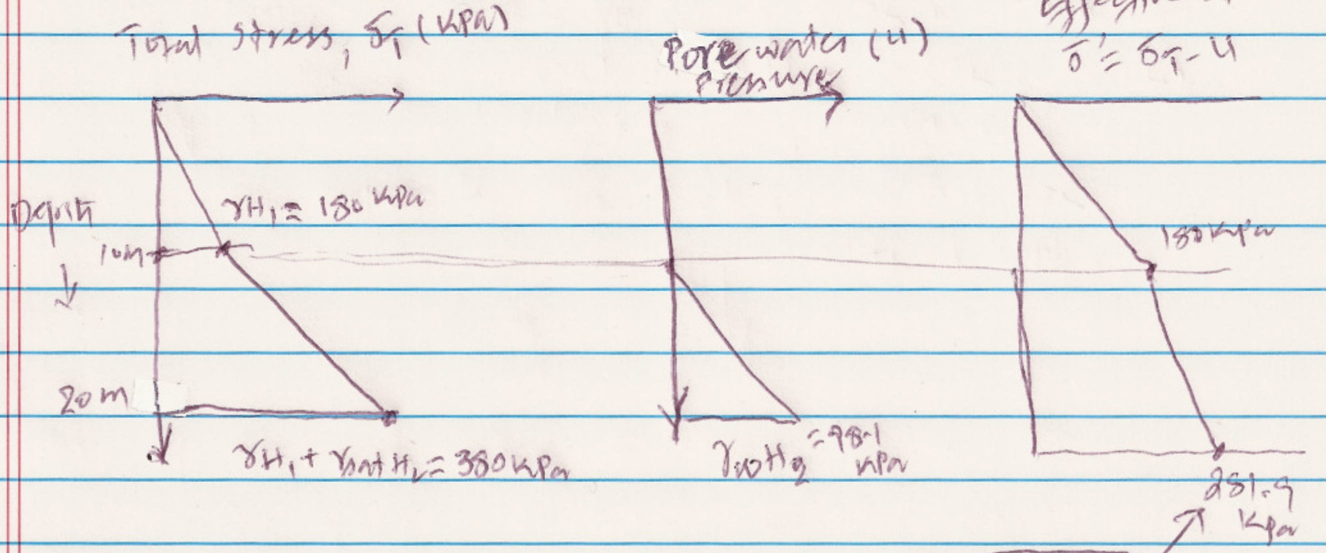
$v = 9.81 \times 10^{-9} \times 0.227 = 2.2 \times 10^{-9}$ cm/sec

$$\boxed{v_s = v/n = \frac{2.2 \times 10^{-9}}{0.32} = 6.87 \times 10^{-9} \text{ cm/sec}}$$

Q.2



Since clay layer is below water table, we'll assume the given unit wt. is γ_{sat}.



$\sigma' = \sigma_T - u = \gamma H_1 + \gamma_{sat} H_2 - \gamma_w H_2$

$\sigma' = \gamma H_1 + (\gamma_{sat} - \gamma_w) H_2 = \gamma H_1 + \gamma' H_2$