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ENG 382 Assignment Mechanical Engineering.

Question 1A

a) The three conditions for a couttle flow.

- Pressure Gradient is constant
- The flow is uniform
- The flow is steady

b) four conditions that can be used to determine the nature of flow are

- The velocity of flow (m/s)
- The fluid viscousity (Ns/m^3)
- The cross sectional diameter of the pipe (m)
- The density of the fluid passing through the pipe.

c) The differences between aerofoil and hydrofoil are enlisted below:

Aero foil	Hydro foil
1.) It is mainly used to lift airplanes and jets	It is mainly used to overcome drag and make machines move with a highvelocity in water.
2.) It is a lifting device mainly used in gaseous fluid (air in particular)	The hydrofoil is a lifting device mainly utitized in liquids fluids (like water)

Question 1B

solution

Data $\mu = 0.9$ centipoise $= 0.9 \times 10^{2}$ poise $= 0.9 \times 10^{-3} Ns/m^2$

$u = 1m/s$

$b = 10mm = 0.01m$

$dp = 60KN/m^2$

$dx = 60m$

pressure difference gradient $= \frac{\delta p}{\delta x} = \frac{-60000}{60} = -1 \times 10^3 N/m^3$

i. velocity distribution $= u = \dfrac{Uy}{b} - \dfrac{1}{2\mu}\left(\dfrac{\delta p}{\delta x}\right)(by - y^2)$

$u = 100y + 5565.56y - 555555.56y^2$

$u = (5.65556 \times 10^3)y - (5.556 \times 10^5)y^2$

ii) Discharge per unit width $= q = \dfrac{Ub}{2} - \dfrac{b^3}{12\mu}\left(\dfrac{\delta p}{\delta x}\right)$

$q = 0.005 + 0.09259$

$= 0.09759\, m^3/s/m$

iii) Shear stress at upper plate is @ $y = b$

$t = \dfrac{\mu U}{b} - \dfrac{1}{2}\left(\dfrac{\delta p}{\delta x}\right)(b - 2y)$

$= t = \dfrac{\mu U}{b} - \dfrac{1}{2}\left(\dfrac{\delta p}{\delta x}\right)(-b)$

$t = 0.09 - 5 = -4.91\, N/m^2$

Question 2

Data

$\mu = 0.9\, Ns/m^2$

$\rho = 1260\, kg/m^3$

$U = -1.5\, m/s$

$b = 10mm = 0.01m$

$P_1 = 250\, kN/m^2$

$P_2 = 80\, kN/m^2$

But $P.1 = P_1 + \rho g z$ (piezometric)

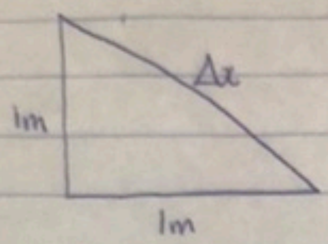
$250000 + (1260) \times (9.81) \times (1)$

$= 262.36\, kN/m^2$

and $P.2 = P_2 + \rho g z$ (piezometric)

$80000 + (1260) \times (9.81) \times (0)$

$80\, kN/m^2$



Because the two plates are aligned at an angle of 45°, the above diagram can be used to calculate the change in x,

By pythagoras theorem,

$\Delta x = \sqrt{1^2 + 1^2} = \sqrt{2}\,m$

Therefore,

$$\frac{\delta p}{\delta x} = \frac{-(P.1 - P.2)}{\Delta x} = \frac{-(262.36 - 80)}{\sqrt{2}} = -128.948 kN/m^3$$

a) i) Velocity distribution $= u = \frac{Uy}{b} - \frac{1}{2\mu}\left(\frac{\delta p}{\delta x}\right)(by - y^2)$

$$u = -150y + 716.38y - 71637.8y^2$$

$$u = -(7.16378 \times 10^4)y^2 + 565.62y$$

ii) Shear distribution $= \tau = \frac{\mu U}{b} - \frac{1}{2}\left(\frac{\delta p}{\delta x}\right)(b - 2y)$

$$\tau = -135 + 644.74 - 128948y$$

$$\tau = 509.74 - (1.289 \times 10^5)y$$

b) Maximum flow velocity

At maximum flow $\frac{\delta u}{\delta y} = 0$

$0 = -(1.4328 \times 10^5)y + 565.62$

$y = 3.9476 \times 10^{-3} m$

$U_{max} = -(7.16378 \times 10^4)(3.9476 \times 10^{-3})^2 + 565.62(3.9476 \times 10^{-3})$

$U_{max} = 1.12 m/s$

c) Shear stress at upper plate is @ $y = b$

Therefore, $\tau = 509.74 - (1.289 \times 10^5)y$

$\tau = 509.74 - (1.289 \times 10^5)(0.01)$

$\tau = -779.26 N/m^2$