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CIVIL ENGINEERING
18/ENG03/012

i) $D_1 = 150mm \rightarrow 0.15m$
$D_2 = 75mm \rightarrow 0.075m$
$Q = 40l/s \rightarrow 0.04m^3/s$
$C_d = 0.96$
$g = 9.81\ m^2/s$
$h_1 - h_2 = 0.15$

$A = \frac{\pi d_1^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.0178m^2 \approx 0.018m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.0044m^2$

$Q = \frac{C_d \times A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$0.04 = \frac{0.96 \times 0.018 \times 0.0044 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{0.018^2 - 0.0044^2}}$

$0.04 = \frac{0.96 \times 0.018 \times 0.0044 \times \sqrt{2 \times 9.81 \times h}}{0.0175}$

$0.00007 = 0.000076032 \times \sqrt{2 \times 9.81 \times h}$

both sides by
Divide 0.000076032

$\frac{0.00007}{0.000076032} = \sqrt{2 \times 9.81 \times h}$

$9.21 = \sqrt{2 \times 9.81 \times h}$

square both sides.

$84.8241 = 2 \times 9.81 \times h$
$84.8241 = 19.62h$
Divide both sides by 19.62
$\frac{84.8241}{19.62} = h$
$4.32m = h$

$h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right)$

$h = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (z_1 - z_2)$

$4.32 = \left(\frac{P_1}{w} - \frac{P_2}{w}\right) + 0.15$

$4.32 + 0.15 = \frac{P_1 - P_2}{w}$

$w(4.32 + 0.15) = P_1 - P_2$

$P_1 - P_2 = (0.8 \times 1000 \times 9.81)(4.32 + 0.15)$
$P_1 - P_2 = (7848) \times (4.47)$
$P_1 - P_2 = 35080N/m^2$
$= 35KN/m^2$

ii) $D_1 = 300mm \rightarrow 0.3m$
$D_2 = 150mm \rightarrow 0.15m$
~~S.g = 13.6~~
S.g of heavy liquid = 13.6
S.g of liquid = 0.7
$y = 250mm \rightarrow 0.25m$
$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.071m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.15^2}{4} = 0.018m^2$

$h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right)$

$= y\left[\frac{S_{hl}}{S_l} - 1\right]$

$= 0.25\left[\frac{13.6}{0.7} - 1\right]$

$= 3.53m$

iii) $Q = \frac{C_d \times A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$Q = \frac{0.98 \times 0.071 \times 0.018 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.071^2 - 0.018^2}}$

$Q = 0.149m^3/s$

iv) $h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right) = 3.53$

$\left(\frac{P_1}{w} - \frac{P_2}{w}\right) - (z_1 - z_2) = 3.53$

$\frac{P_1 - P_2}{w} - 0.3 = 3.53$

$\frac{P_1 - P_2}{w} = 3.53 + 0.3$

$\frac{P_1 - P_2}{w} = 3.83$

$P_1 - P_2 = 3.83w$

$P_1 - P_2 = 3.83 \times 9.81 \times 0.9$

$= 33.8KN/m^3$