ID#7879

Question #1

=> Given data:-

1/5 Scale model

velocity Paraffin in prototype = 3.0 m/s

density / viscosity of Paraffin = 800 Kg/m^3 / 0.02 Kg m/s

Kinematic viscosity of water = $1.0 \times 10^{-6}\ m^2/s$.

=> To find:-

velocity of water = ?

Ratio of the Quantity of flow = ?

pressure drop = ?

=> Sol:-

The pressure drop ΔP is expected to depend upon the gate opening h, the overall depth d, the velocity V, density ρ and viscosity μ.

list the relevant variables:

$\Delta p, h, d, V, \rho, \mu$

write their dimensions:

ΔP $\quad ML^{-1}T^{-2}$

h $\quad L$

d	L
V	LT^{-1}
ρ	ML^{-3}
μ	$ML^{-1}T^{-1}$

Number of variables, $n = 6$

Number of independent dimensions: $m = 3$ (M, L and T)

Number of non dimensional group: $n - m = 3$

Chose m(=3) Scaling variable:

Geometric (d): Kinematic/time-dependent (V): dynamic/mass-dependent (ρ).

From dimensionless groups by non-dimensionalising the remaining variables: Δp, h and μ

$\Pi_1 = \Delta p d^a V^b \rho^c$

$M^0 L^0 T^0 = (ML^{-1}T^{-2})(L)^a (LT^{-1})^b (ML^{-3})^c$

$= M^{1+c} L^{-1+a+b-3c} T^{-2-b}$

M: $0 = 1 + c \Rightarrow c = -1$

T: $0 = -2 - b \Rightarrow b = -2$

L: $0 = -1 + a + b - 3c \Rightarrow a = 1 + 3c - b = 0$

$\Pi_1 = \Delta p V^{-2} \rho^{-1} = \dfrac{\Delta p}{\rho V^2}$

$\Pi_2 = \dfrac{h}{d}$ (by inspection, Since h is a length)

$\pi_3 = \mu d^a V^b \rho^c$ (probably obvious by now, but here goes anyway)

$M^0 L^0 T^0 = (ML^{-1}T^{-1})(L)^a (LT^{-1})^b (ML^{-3})^c$

$= M^{1+c} L^{-1+a+b-3c} T^{-1-b}$

M: $0 = 1+c \Rightarrow c = -1$

T: $0 = -1-b+0 \Rightarrow b = -1$

L: $0 = -1+a+b-3c \Rightarrow a = 1+3c-b = -1$

$\Rightarrow \pi_3 = \mu d^{-1} V^{-1} \rho^{-1} = \frac{\mu}{\rho V d}$

Recognition of the Reynolds Number suggest that we replace π_3 by

$\pi_3' = (\pi_3)^{-1} = \frac{\rho v d}{\mu}$

Hence dimensional analysis yields

$\pi_3' = \left(\frac{\rho v d}{\mu}\right)_p = \left(\frac{\rho v d}{\mu}\right)_m$

From the last, we have a velocity ratio

$\frac{v_p}{v_m} = \frac{(\mu/\rho)_p}{(\mu/\rho)_m} \frac{d_m}{d_p} = \frac{0.002/800}{1.0\times10^{-6}} \times \frac{1}{5} = 0.5$

Hence,

$v_m = \frac{v_p}{0.5} = \frac{3.0}{0.5} = 6.0\,ms^{-1}$

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b) the ratio of the quantities of flow is

$$\frac{Q_p}{Q_m} = \frac{(\text{velocity} \times \text{area})_p}{(\text{Velocity} \times \text{area})_m} = \frac{V_p}{V_m}\left(\frac{d_p}{d_m}\right)^2 = 0.5 \times 5^2 = 12.5$$

c) Finally, for the pressure drop,

$$\pi_1 = \left[\frac{\Delta P}{\rho V^2}\right]_p = \left[\frac{\Delta P}{\rho V^2}\right]_m \Rightarrow \frac{(\Delta P)_p}{(\Delta p)_m} = \frac{\rho_p}{\rho_m}\left(\frac{V_p}{V_m}\right)^2$$

$$= \frac{800}{1000} \times 0.5^2 = 0.2$$

Hence

$$\Delta p = 0.2 \times \Delta p_m = 0.2 \times 60 = 12.0 \text{ kpa}$$

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⇒ **Question #02:**

⇒ **Given Data:-**

⇒ Maximum Depth of water in reservoir $(H_w) = 78m$

⇒ Specific Gravity of Dam material $(G) = 4.4$

⇒ Allowable compressible strength for the dam masonary $(\sigma_{all}) = 787 T/m^2$

⇒ Height of wave $(H_w) = 3.2m$

⇒ $\mu = 0.7$

No of uplift pressure $(C_u = 0)$.

⇒ **Required:**

Design a practical profile of a dam

⇒ **Solution:**

(1) $H = \dfrac{\sigma_{all}}{\gamma_w (G - C_u + 1)} = \dfrac{787 \times 1000}{1000(4.4 - 0 + 1)}$

$H = 145.74m > H_w = 78m$

So it is low Gravity dam.

(2) Top width (a):-

Free board $= 1.5 h_{wave} = 1.5 \times 3.2$

$F.B = 4.8m$

Scanned with CamScanner

78.79

Height of Dam = $H_D = H_W + F.B$

$= 78 + 4.8 \Rightarrow 82.8m$

$H_D = 82.8m$.

$a = 14\%$ of H_D

$a = 0.14 \times 82.8$

$a = 11.59m$

③ Base width "b'" (without offset)

i) For No sliding criteria:

$$b' = \frac{H_W}{\mu G} = \frac{78}{0.7 \times 4.4}$$

$b' = 25.32$

$b' \cong 26m$.

ii) For No tension criteria:

$$b' = \frac{H_W}{\sqrt{G}} = \frac{78}{\sqrt{4.4}}$$

$b' = 37.32$

use $b' \cong 34m$.

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4) Depth of vertical portion on U/s side.

$h' = 2a\sqrt{G - CU}$

$h' = 2 \times 11.59 \sqrt{4.4 - 0}$

$h' = 48.24 m$

$h' = 48 m$

5) upstream offset $= \frac{a}{16}$

$= \frac{11.59}{16} \Rightarrow \boxed{0.72 m}$

6) Depth below the water level to the end of inclined portion is u/s $= 3.14 a\sqrt{G}$

$= 3.14 \times 11.59 \sqrt{4.4}$

$\boxed{76.33 m}$

7) Total width of the base of the dam.

$b = b' + \frac{a}{16} = 26 + \frac{11.59}{16}$

$= 26 + 0.72$

$\boxed{b = 26.72 m}$

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8) $\tan\theta = \frac{b'}{H} = \frac{26}{78}$

$\theta = \tan^{-1}(1/3)$

$\theta = 18.43^\circ$

9) Depth of vertical portion on D/s (from WL on u/s side.

$\tan\theta = \frac{9}{d'} = \frac{11.59}{d'} \Rightarrow \tan\theta = \frac{11.59}{d'}$

$\frac{1}{3} d' = 11.59$

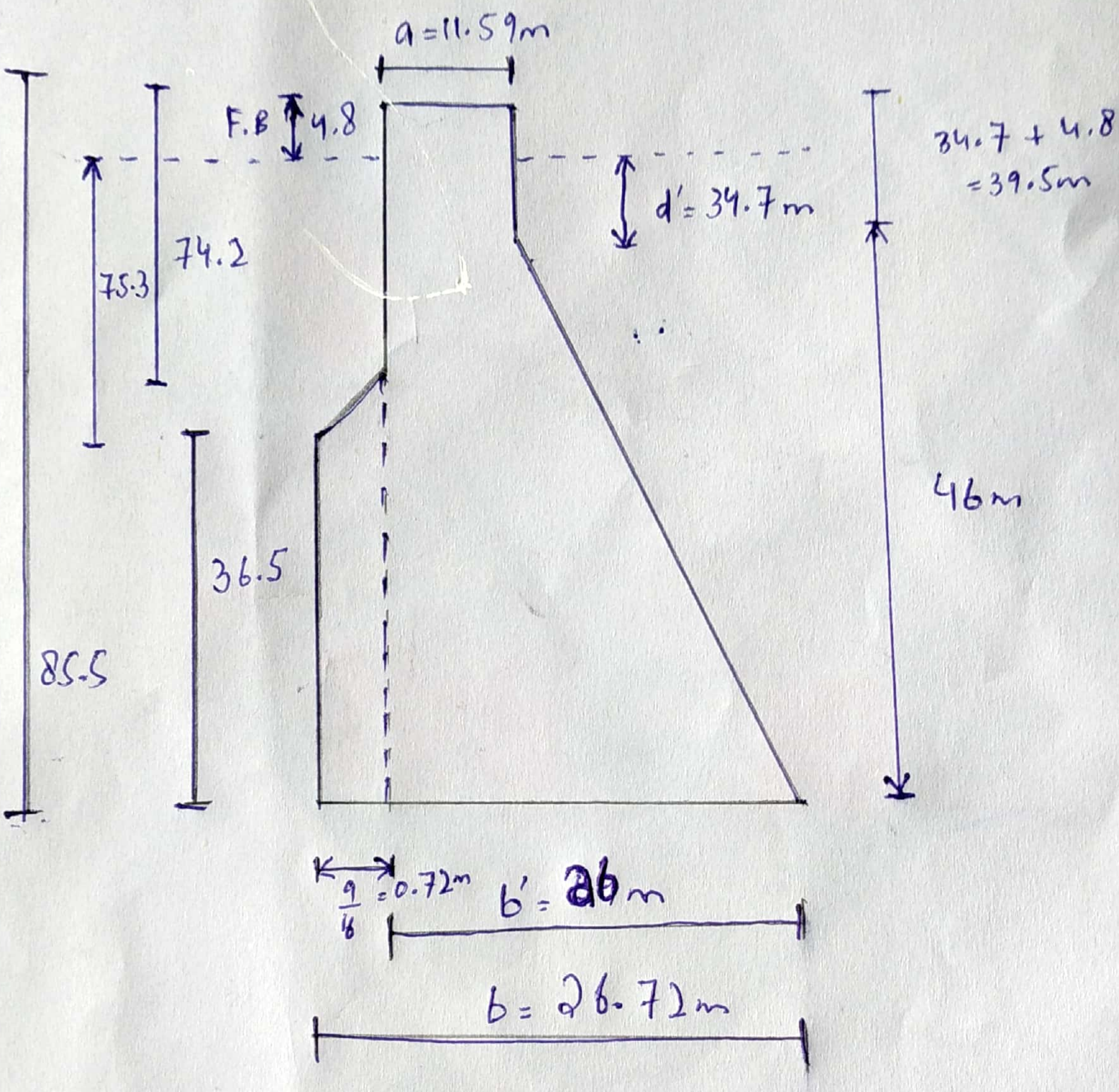
$d' \frac{11.59 \times 3}{1}$

$d' = 34.7m$

depth of vertical portion

$d = d' + FB = 34.7 + 4.8.$

$d = 39.5m$


a = 11.59m
F.B
4.8
d' = 34.7m
34.7 + 4.8
= 39.5m
75.3
74.2
36.5
85.5
46m
a/16 = 0.72m
b' = 26m
b = 26.72m

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Question #4:

1- PARTICLE DIAMETER:-

As we have the formula:

$$w_s = \sqrt{\frac{4gd}{3C_D} \frac{(\rho_s - \rho)}{\rho}}$$

From the above equation we can say that fall velocity is directly proportion to the square of diameter so by increasing dia fall velocity will be increase.

2- PARTICLE DENSITY:

Particle Density is directly proportional to the rate of fall velocity particle with high density tends to settle down early compared with the particle density.

3- PARTICLE CONCENTRATION:

Concentration of particle size will considerably effect its fall velocity as the section having greater concentration will be settled down at the place thus causing the more fall velocity comparing with section of low concentration.

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4. PARTICLE SHAPE:-

Particle having regular shape tends to be effected more then irregular shaps since regular shape particles have even surface which offer very little or no friction while particles with irregular shape offers more friction as the particle with smaller surface area are more likely to be effected due to their less Resistance.

5. VISCOSITY OF WATER:

Fluid velocity through porous media is approximated as inversely proportional to the kinematic viscosity. A decrease in viscosity therefore increase the velocity of a compound through porous media.

6. TURBULANCE OF WATER:

Turbulance of water effect the fall velocity of water in reservoir because the non-linearity & zig zag path effect the flow of water & cause variation in the flow.