Final Term Exame

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Section 6 "A"

Subject Hydraulic Engineering

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Q.01 A prototype gate valve which will control the flow in pipe ------
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Solution:

We should have to find the relevent variable and its diamension

* $\Delta P \Rightarrow ML^{-1}T^{-2}$
* $h \Rightarrow L$
* $V \Rightarrow LT^{-1}$
* $\rho \Rightarrow ML^{-3}$
* $\mu \Rightarrow ML^{-1}T^{-1}$
* $d \Rightarrow L$

So

The total number of variable $= 6 = n$

number of independent variable

$= m = 3\ [MLT]$

Number of non diamensional group

$= n - m = 6 - 3$
$= 3$

Select $m=3$ sealing variable

→ geometric (d)

→ Kinematic/time dependent (v)

→ Dynamic/mass dependent (ρ)

Now we have to form diamensionless group by non diamensionalising the remaining variable which are ΔP, h an μ

Thus write the π term :-

$$\pi_1 = \Delta P\, d^a v^b \rho^c$$

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

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

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

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

$$a = 1+3c-b = 0$$

$a = 1 + 3c - b$

$a = 1 + 3(-1) - (-2)$

$a = 1 - 3 + 2$

$a = 0$

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

$\pi_1 = \Delta p\, d^0 v^{-2} \rho^{-1}$

$= \Delta p\, v^{-2} \rho^{-1}$

$$\boxed{\pi_1 = \frac{\Delta p}{\rho v^2}}$$

$\Rightarrow \pi_2 = \frac{h}{d}$

$\Rightarrow \pi_3 = \mu\, d^a v^b \rho^c$

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

$=$

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

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

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

$a = 1 - (-1) + 3(-1)$

$a = 1 + 1 - 3$

$a = 2 - 3$

$a = -1$

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

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

$$\boxed{\pi_3 = \frac{\mu}{\rho v d}}$$

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

Hence diamensional analysis yield

$\pi_1 = z(\pi_2, \pi_3')$

$$\Rightarrow \frac{\Delta P}{\rho V^2} = f\left(\frac{h}{d}, \frac{\rho V d}{\mu}\right)$$

a) As for the dynamic simalarities all non diamensional group must be same in model as well as prototype so

$$\pi_1 = \left[\frac{\Delta P}{\rho V^2}\right]_p = \left[\frac{\Delta P}{\rho V^2}\right]_m$$

$$\pi_2 = \left[\frac{h}{d}\right]_p = \left[\frac{h}{d}\right]_m$$

$$\pi_3 = \left[\frac{\rho V d}{\mu}\right]_p = \left[\frac{\rho V d}{\mu}\right]_m$$

From Π_3 we have the following velocities ratio

$$\frac{V_P}{V_m} = \frac{(\mu/\rho)_P}{(\mu/\rho)_m} \cdot \frac{d_m}{d_P}$$

$$= \frac{0.02/800}{1.0 \times 10^{-6}} \times \frac{1}{5}$$

$$\frac{V_P}{V_m} = 0.5$$

Hence

$$V_m = \frac{V_P}{0.5} = \frac{3.0}{0.5}$$

$$V_m = 6 \text{ m/s}$$

b) The ratio of Quantities of flow is

$$\frac{Q_P}{Q_m} = \frac{(\text{Velocity} \times \text{Area})_P}{(\text{Velocity} \times \text{area})_M}$$

$$= \frac{V_P}{V_m} \cdot \left[\frac{d_P}{d_m}\right]^2$$

$$= 0.5 \times 5^2$$

$$\Rightarrow \frac{Q_P}{Q_m} = 12.5$$

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c) Now the pressure drop in the prototype

As

$$\pi_1 = \left[\frac{\Delta P}{\rho V^2}\right]_p = \left[\frac{\Delta P}{\rho V^2}\right]_m$$

$$\Rightarrow \frac{(\Delta P)_p}{(\Delta P)_m} = \frac{\rho_p}{\rho_m} \cdot \left(\frac{V_p}{V_m}\right)^2$$

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

$$\frac{(\Delta P)_p}{(\Delta P)_m} = 0.2$$

$$\Rightarrow (\Delta P)_p = 0.2 \times \Delta P_m$$

$$= 0.2 \times 60$$

$$\boxed{\Delta P_p = 12\ \text{kPa}}$$

Q.02 Given Data:

Max depth of water in Reservoir = 78m

Specific Gravity of Dam Material = G = 2.35

Allowable Compression stress for the Dam Masonary $\sigma_{all} = 781 \frac{T}{m^2}$

Height of wave = 1.35m

$\mu = 0.7$

No uplift pressure, $C_u = 0$

Solution:

1) $H_{limiting} = \frac{\sigma_{all}}{\gamma_w (G - C_u + 1)}$

$= \frac{781 \times 1000}{1000(2.35 - 0 + 1)}$

$H_{limiting} = 233.134 > H_w = 78$

So it is low gravity Dam

2) Top width "a"

Free board = 1.5 hwave

= 1.5 x 1.35

F.B = 2.02m

Hight of Dam = HD = Hw + F.B

= 78 + 2.02

= 80.02m

a = 14% of HD

a = 0.14 x 80.02

a = 11.20

3) Base width = b' (with out off set)

1) for no sliding criteria

$$b' = \frac{Hw}{\mu G} = \frac{78}{0.7 \times 2.35}$$

b' = 47.5 m

ii) For no tension crit...

$$b' = \frac{H_w}{\sqrt{G}} = \frac{78}{\sqrt{2.35}}$$

$$b' = 51 m$$

use $b' = 51 m$

4) Depth of vertical Portion on u/s side

$$h' = 2a\sqrt{G - C_4}$$

$$h' = 2 \times 11.20 \sqrt{2.35 - 0}$$

$$h' = 34.338 m$$

5) up strem ~~slope~~ off set

$$\Rightarrow \frac{a}{16} = \frac{11.20}{16}$$

$$= 0.7 m$$

6) Depth below the water level to the end of inclind Portion is $4/5 = 3.149\sqrt{q}$

$$= 3.149\sqrt{q}$$

$$= 3.14 \times 11.20\sqrt{2.35}$$

$$= 53.91$$

$$\cong 54\,m$$

7) Total width:

$$b = b' + \frac{q}{16} = 51 + \frac{11.20}{16}$$

$$= 51 + 0.7$$

$$= 51.7\,m$$

8) $\tan\theta = \frac{b'}{H} = \frac{51}{78}$

$$\tan\theta = \left(\frac{17}{26}\right)$$

$$\theta = \tan^{-1}\left(\frac{17}{26}\right)$$

$$\theta = 33.17^{\circ}$$

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

$$\tan\theta = \frac{9}{d'} = \frac{11.20}{d'}$$

$$\Rightarrow \tan\theta = \frac{11.20}{d'}$$

$$\frac{17}{26} d' = 11.20$$

$$d' = \frac{11.20 \times 26}{17}$$

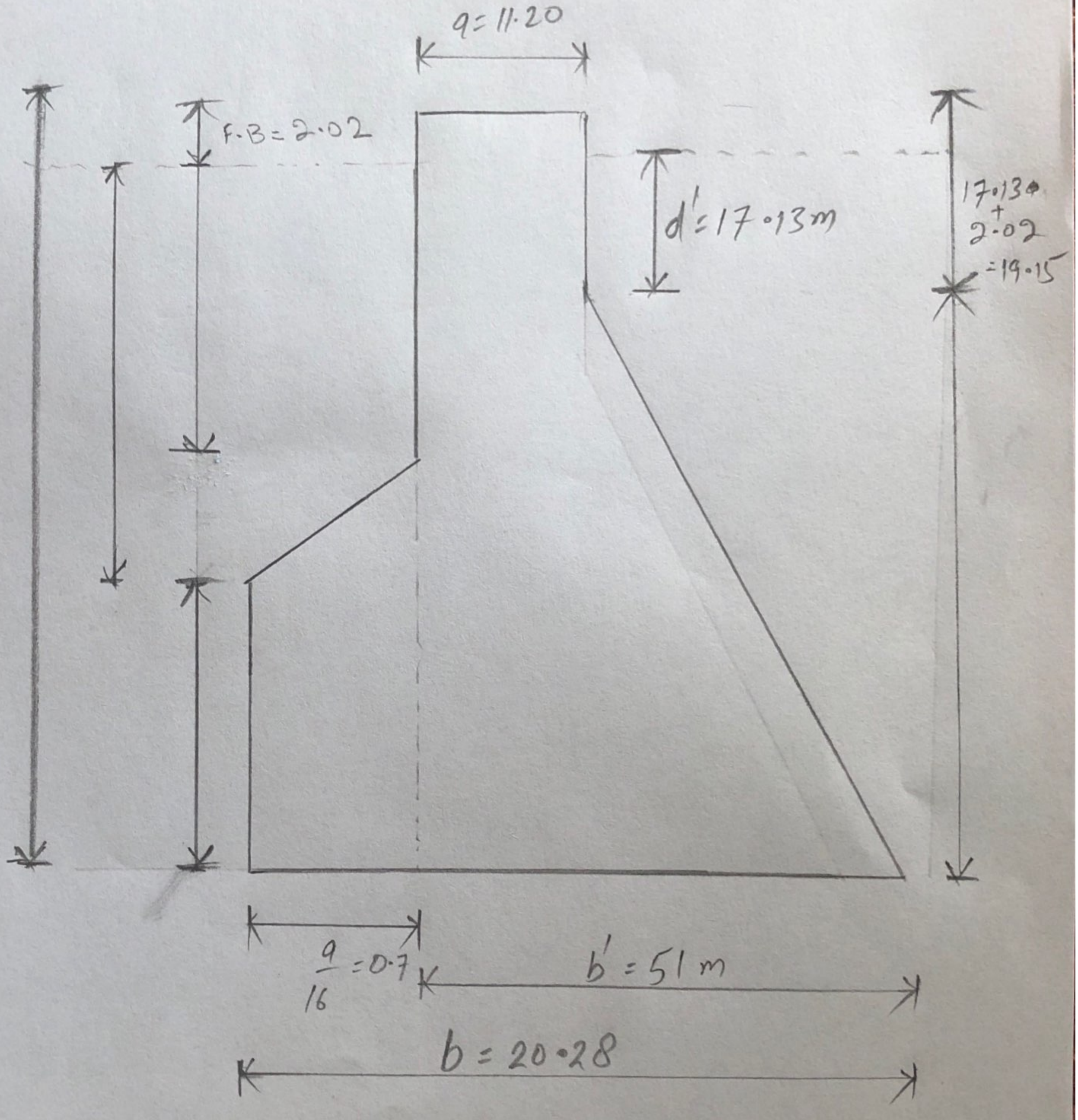
$$d' = 17.13 \text{ m}$$

Depth on vertical portion:-

$$d = d' + F.B$$

$$d = 17.13 + 2.02$$

$$\Rightarrow d = 19.15$$


a = 11.20
F.B = 2.02
d' = 17.13m
17.13 + 2.02 = 19.15
a/16 = 0.7
b' = 51 m
b = 20.28

Q:04 What will be the effect of sediment particles, diameter, particals density partical concentration, partical shape viscosity of water, turbulence of water flowing in reservoir on fall velocity? Explain in detail.

Ans **Particale diameter:**

The diameter of particle is directly proportional to the fall velocity become greater the size of particle so it will be tends to more faster as compare to the particle of small size thus their will be more gravitative force on particle of greater size so it will be fall quickly due to its weight.

Particle Density:

Density of particle is directly proportional to the rate of fall velocity since partical with high density tends to settle down early compare with particle of low density.

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

particle shape:
Non-sphericle analogue particle fall up to 75% slower then equilant sphere model show 100 μmm non ~~shper~~ spherical partile travil 44% further then spherical

Viscosity of water:
Fluid velocity through porous media is approximated as inversly

P.T.O

proportional to the kinematic viscosity
A decrease in viscosity therefore
increase the fall velocity

Turbulence of water::

Turbulence of water effect the fall velocity of water in reservious becuse the non-linearity and non uniform path ~~of~~ effect the flow of water and cause the variation in the flow.