FINL TERM

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Section: "B"

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Question # 01

Solution:

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 relevent variables:

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

Write down dimensions:

Δp	$ML^{-1}T^{-2}$
h	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 groups: $n-m=3$

Choose m (m3) scaling variables:

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

$$\Rightarrow \Pi_1 = \Delta p v^{-2} \rho^{-1} = \frac{\Delta p}{\rho v^2}$$

$\Pi_2 = \frac{h}{d}$ (by inspection, since h is a length

$\Pi_3 = \mu d^a v^b \rho^c$ (Probably obvious by now, but here goes anyway...)

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

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

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

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

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

$$\Rightarrow \Pi_3 = \mu d^{-1} v^{-1} = \frac{\mu}{\rho v d}$$

Recognition of the Reynold number suggests that we replace Π_3 by

$$\Pi_3 = (\Pi_3)^{-1} = \frac{\rho v d}{\mu}$$

Hence dimension analysis yields

i.e $\Pi_1 = \phi(\Pi_2, \Pi_3)$

$$\frac{\Delta p}{\rho v^2} = f\left(\frac{h}{d}, \frac{\rho v d}{\mu}\right)$$

* Dynamic similarity requires that all non-dimensional group to be the same in mode and prototype i.e

$$\Pi_3 = \left[\frac{\Delta p}{\rho v^2}\right] = \left[\frac{\Delta p}{\rho v^2}\right]_m$$

$\Pi_2 = \left[\frac{h}{d}\right]_p = \left[\frac{h}{d}\right]_m$ (Automatic of similar shape i.e "geometric similarity).

$\Pi_3 = \left(\frac{\rho v d}{\mu}\right)_p = \left(\frac{\rho v d}{\mu}\right)_m$

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

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

(b) The ratio of the quantities of flow is

$$\frac{Q_p}{Q_m} = \frac{(\text{velocity} \times \text{area})_p}{(\text{velocity} \times \text{area})_m} = \frac{v_p}{v_m}\left(\frac{d_p}{d_m}\right)^2 = 0.5\times5^2 = 12.5$$

(c) Finally, for the pressure drop

$$\Pi_1 = \left(\frac{\Delta p}{\rho v^2}\right)_p = \left[\frac{\Delta p}{\rho v^2}\right]_m \Rightarrow \frac{(\Delta p)_p}{(\Delta p)_m} = \frac{\rho_p}{\rho_m}\left(\frac{v_p}{v_m}\right)^2 = \frac{800}{1000}\times0.5 = 0.2$$

Hence

$$\Delta p_p = 0.2\times\Delta p_m = 0.2\times60 = 12.0\,kPa$$

Question # 02

Given data:

max depth length = 78m

specific gravity = 2.4

f_{ar} = 785 T/m^2

Heigh of wave = 1.2m

Solution:

1) H limiting $= \dfrac{f_{av}}{\gamma_w(G - w + 1)}$

$= \dfrac{785 \times 1000}{1000(2.4 - 0 + 1)}$

H Limiting = 230.88

2) Top width "a"

Free board = 1.5 x h x wave

= 1.5x1.2

= 1.8

Heigh of dam = Hw + 1.8

= 78 + 1.8

HD = 78.9

a = 14% of HD

= 0.14 × 79.8

= 11.172m

3: Base width:

$b' = \frac{Hw}{\mu G} = \frac{78}{0.7 \times 2.4}$

= 46.42m

= 47

4: For no tension criteria:

$b' = \frac{Hw}{\sqrt{G}} = \frac{78}{\sqrt{2.4}}$

=> 50.34

Depth of vertical portion on U/s side.

$h = 2a\sqrt{G - w}$

$= 2 \times 11.172\sqrt{2.4 - 0}$

$= 34.60$

$= 3.5m$

Up stream off set.

$$\frac{a}{16} = \frac{11.172}{16}$$

$$= 0.6$$

Depth of below the water level to the end of inclined portion U/S $= 3.14 a \sqrt{a}$

$$= 3.14 \times 11.172 \cdot \sqrt{2.4}$$

$$= 54.33$$

Total width of the base of the dam

$$b = b' + \frac{a}{16} = 50.34 + \frac{11.172}{16}$$

$$= 51.03$$

$$\tan \phi = \frac{b'}{H} = \frac{50.34}{78}$$

$$\phi = \tan^{-1}(0.64)$$

$$\boxed{\phi = 32.8^\circ}$$

Depth of verticle portion D/s

[from we on u/s side]

$$\tan\phi = \frac{a}{d} = \frac{11.172}{d'}$$

$$\tan\phi = 11.172 / d_1$$

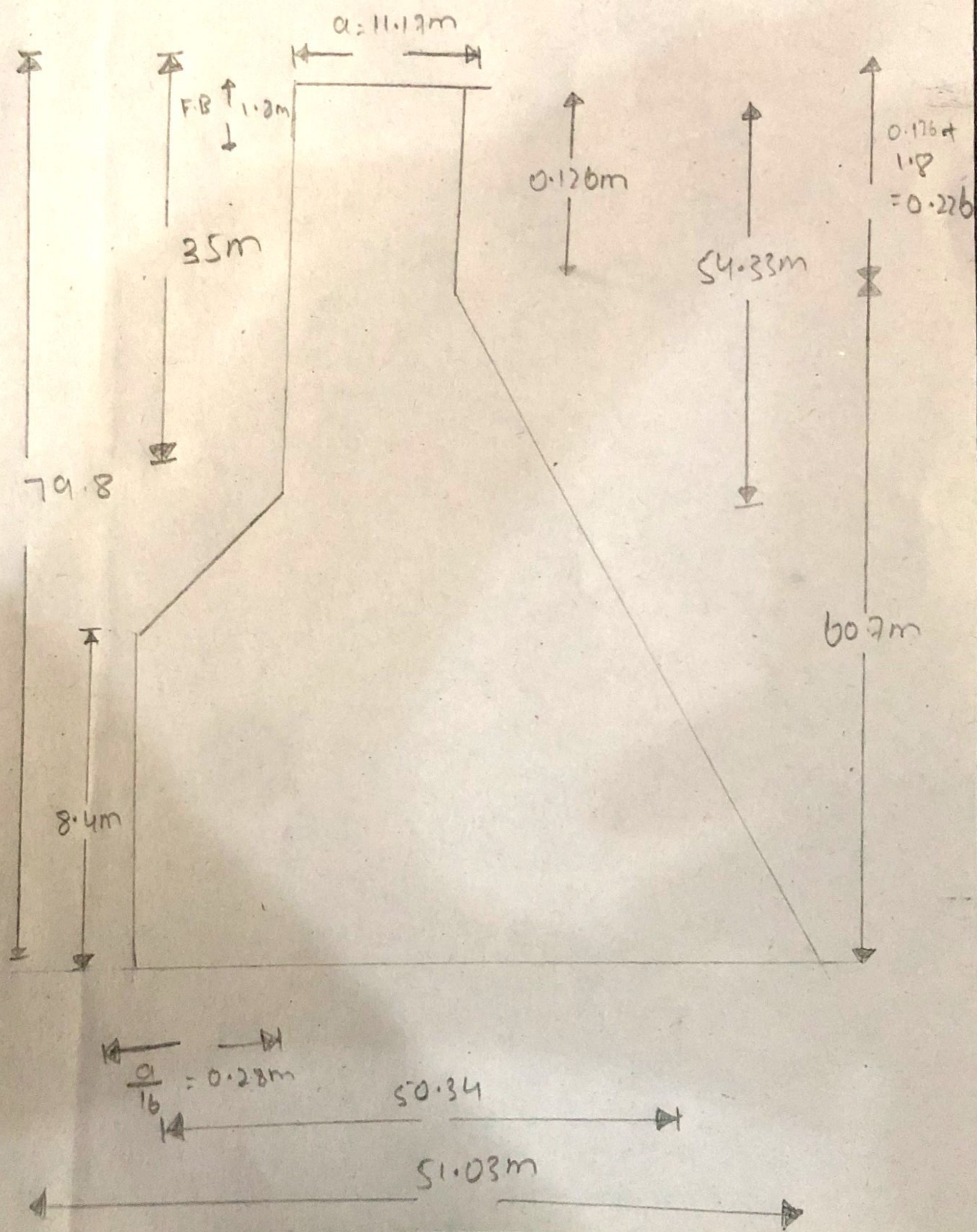
$$\boxed{d' = 0.126}$$

Depth of verticle portion

$$d = d' + FB$$

$$d = 0.126 + 1.8$$

$$\boxed{d = 0.2268m}$$



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Question # 03

Answer:

Model Analysis and similitude:

The Prototype that I will take for my analysis is "Dam" By means of model Analysis or Dimensional analysis we take replica of prototype. On that model we conclude tests so whenever we constructing actual "Dam" we will know the requirement for the considered Dam.

Dimensional Analysis is an research work due to which we gathered information. By means of similitude is similarities b/w model and prototype. There are three types of similarities.

1: Linear similarity
2: Kinematic Similarity
3: Dynamic Similarity

Linear Similarity:

It is an reaction between length of prototype and length of model.

Mathematically:

$$\frac{Lp}{Lm} = Lr = \frac{Wp}{Wm} = Lr$$

$$\frac{Ap}{Am} = \frac{Lp \times bp}{Lm \times bm}$$

Kinematic Similarity:

It is the ratio of velocity between prototype and model.

$$= \frac{Vp_1}{Vm_1} = Vr = \frac{Vp}{Vm_2}$$

Kinematic similarity depends on the flow except forces.

Dynamic Similarity:

Dynamic similarity is the ratio of force between prototype and Model page = 13 (7855)

$$\frac{Fip}{Fim} = Fr$$

$$= \frac{Frp}{Fim}$$

$$Fr = \frac{Fgp}{Fgm}$$

Question # 04

Answer:

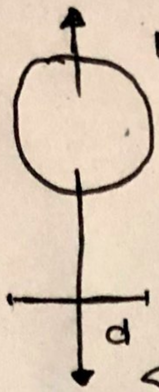
The downward velocity in a low dence fluid at equilibrium in which the sum of the gravity force. buoyancy force and fluid drag force and equal to zero.

When a grain falls down in still water it obtains a constant velocity when the upward fluid drag force on the grain is equal to the downward submerged weight of the grain. This is also called setting velocity.

Fall velocity effected due to:

The following are the terms:-

(a) Particle diameter
(b) Particle density
(c) Particle concentration
(d) Particle shape
(e) viscosity of water (Temprecture)
(f) Turbulance.



F_D = Drag force
↓ w_s = fall velocity

The force balance between the drag force and the submerged weight gives.

F_D = Submerged weight

$\frac{1}{2} = \frac{\pi d^2}{4}$ = projected area

C_D = Drag co-efficient

w_s = fall velocity of sediment

$$= \frac{4gd}{3C_D}\left(\frac{\rho_s - \rho}{\rho}\right)$$

ρ = Density of water

ρ_s = Density of sediment particles $/m^2$