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Section B

Semester 6th

Subject Hydraulic Engineering

QNO(01) :-

Given Data :-

- velocity OF paraffin is $3.0\ ms^{-1}$
- Density and viscosity are $800\ kg\,m^{-3}$ and $0.002\ kg\,m^{-1}s^{-1}$.
- Kinematic viscosity OF water $= 1.0 \times 10^{-6}\ m^2 s^{-1}$

Required :-

(a) velocity OF water in the model For dynamic Similarity.

(b) Ratio of the Quantities of flow in prototype and model.

(c) Pressure drop in prototype if 60Kpa in model.

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 relevant Variable"

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

write down dimensions:

$\Delta p = ML^{-1}T^{-2}$

$h \quad L$

$d \quad L$

$V \quad LT^{-1}$

$\rho \quad ML^{-3}$

$\mu \quad ML^{-1}T^{-1}$

⊙ Number of variable $n = 6$
Number of independent dimension $m = 3$ (M, L and T)

⊙ Number of non dimensional groups $n - m = 3$
Choose ($m = 3$) Scaling variables geometric (d) Kinematic/time dependent (V). dynamic/mass dependent (ρ).

From dimensionless groups by non demensionalising the remaining variables Δp, h and μ.

⊙ $\Pi_1 = \Delta p\, d^a V^b \rho^c$

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

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

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

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

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

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

⊙ $\Pi_1 = \Delta p V^{-2} \rho^{-1} = \Delta P / \rho V^2$

$\Pi_2 = h/d$ (By inspection, Since h is length)

⊙ $\Pi_3 = \mu d^{a} V^{b} \rho^{c}$

(~~p~~robably Obvious by now, but here goes anyway)

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

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

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

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

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

$b = -1$

$\Rightarrow \Pi_3' = \mu d^{-1} V^{-1} \rho^{-1} = \mu / \rho V d$

Recognition of the Reynold number Suggests that ~~rotation~~ replace Π_3 by Π_3'

$\Pi_3' = (\Pi_3)^{-1} = \rho V d / \mu$

$\Pi_3' = \left(\rho v d/\mu\right) = \left(\rho v d/\mu\right)_m$

From the last we have a velocity Ratio

$$V_p/V_m = \frac{(\mu/\rho)_p}{(\mu/\rho)_m} \times \frac{d_m}{d_p}$$

$$= \frac{0.002/800}{1.0 \times 10^{-6}} \times 1/5 = 0.5$$

Hence;

$$V_m = V_p/0.5 = 3.0/0.5 = 6.0\ ms^{-1}$$

(b) The ratio of Quantites of flow is

$$Q_p/Q_m = \frac{(\text{Velocity} \times \text{Area})_p}{(\text{velocity} \times \text{area})_m}$$

$$= V_p/V_m \times \left(d_p/d_m\right)^2 = 0.5 \times 5^2 = 12.5$$

(c) Finally For pressure drop.

$$\Pi_1 = \left(DP/\rho v^2\right) = \left(DP/\rho v^2\right)_m$$

$$\Rightarrow \frac{(\Delta P)_P}{(DP)_m} = \left(\rho_P/\rho_m\right)\left(V_P/V_m\right)^2 = \frac{800}{1000} \times 0.5^2$$

$$= 0.2$$

Hence

$$DP = 0.2 \times \Delta P_m{}^{Y} = 0.2 \times 60 = 12.0\,KPa$$

thus the Required results.

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QNO(02)

Given Data :-

- Maximum Depth(H) = 78m
- Specific gravity = G = 2.4
- Height of wave Hw = 1.2m
- f_{av} = 783 T/m^2

Solution :-

① "H" limiting = $\frac{f_{av}}{\gamma_w (G - C_u + 1)}$

put values

H limiting = $\frac{7830 * 1000}{1000 (2.4 - 0 + 1)}$

= $\frac{783000}{3400}$

H limiting = 230.29 m

② Top width "a"

Free board = 1.5 * h wave

= 1.5 * 1.2

= 1.8m

F.B = 1.8m

height of Dam = HD = Hw + F.B

$HD = 78 + 1.8$

$HD = 79.7$

$a = 14\%$ of HD

$a = 0.14 * 79.7$

$\boxed{a = 11.173\ m}$

③ <u>Base width 'b''</u> :-

$b' = \frac{Hw}{\mu G}$ put values

$b' = \frac{78}{0.7 * 2.4}$

$= 46.41\ m$

$\boxed{b' = 47\ m}$

④ <u>For no tension Criteria</u> :-

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

use $\boxed{b' = 50.33\ m}$

④ Depth of vertical portion u/s Side :-

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

$h' = 2 * 11.173\sqrt{2.4-0}$

$h' = 34.602$

$\boxed{h' = 35m}$

⑤ Upstream offset :-

$a/16 = \frac{11.173}{16} = 0.69m$

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

$= 3.14 * 11.173\sqrt{2.4}$

$= 54.332m$

⑦ Total width of base of Dam :-

$b = b' + a/16 = 50.33 + \frac{11.173}{16}$

$\boxed{b = 51.05m}$

(8) $\tan\theta = \frac{b'}{H} = \frac{50.33}{78}$

$\tan\theta = 0.64$

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

$\theta = 32.61°$

(9) Depth of vertical portion on D/s (formula on U/s side)

$\tan\theta = a/d' = \frac{11.173}{d_1}$

$\tan\theta = 11.173/d_1$

$d_1 = 11.173/\tan\theta$

$d_1 = 11.173/\tan(32.61)$ $\quad$ /88.24

$\boxed{d_1 = 0.126m}$

Now

(10) Depth of vertical portion:-

$d = d' + F.B$

$= 0.126 + 1.8$

$d = 0.22m$

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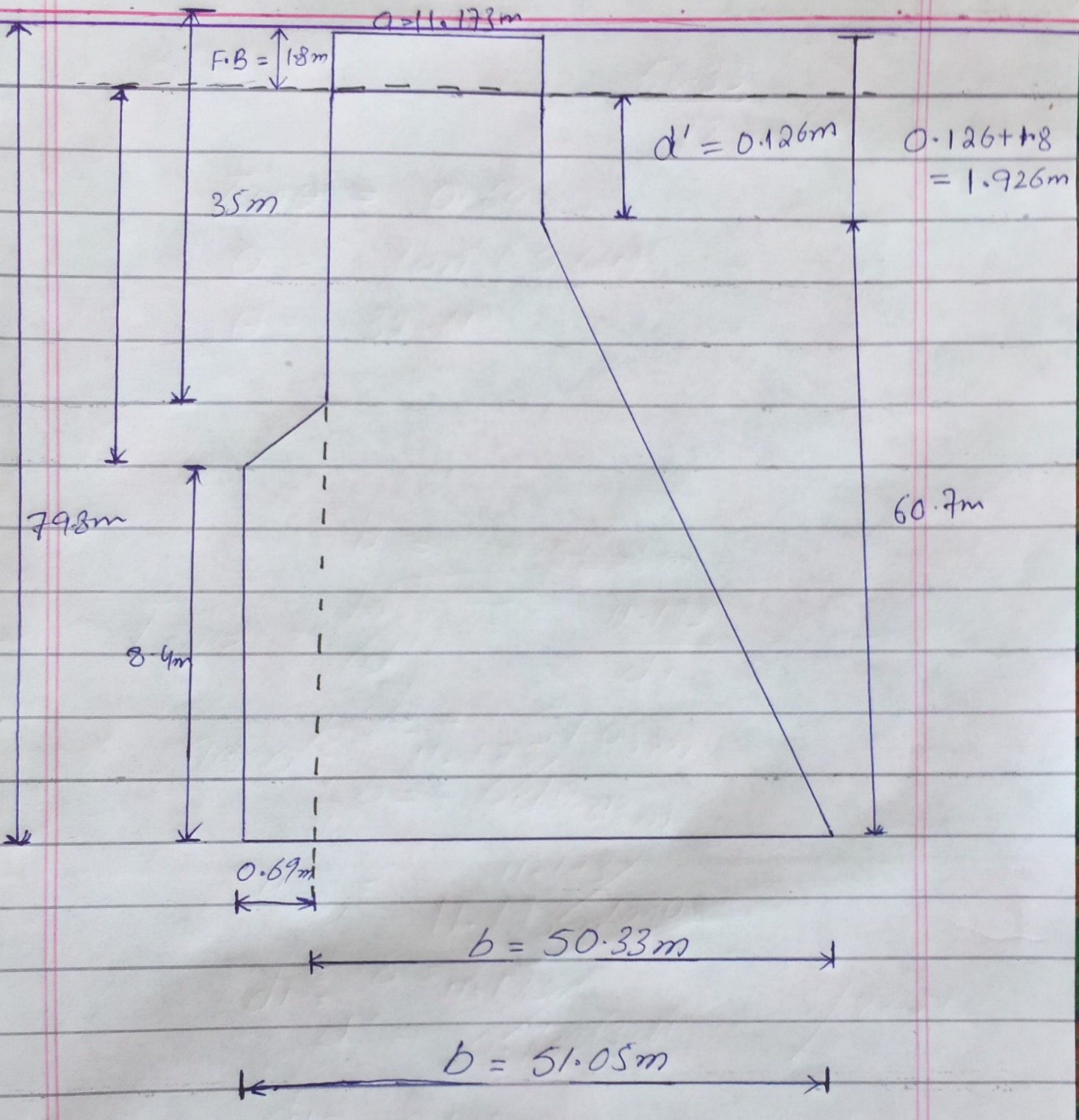


a=11.173m
F.B = 1.8m
35m
d' = 0.126m
0.126+1.8
= 1.926m
79.8m
60.7m
8.4m
0.69m
b = 50.33m
b = 51.05m

QNO(03):-

"Concept of Dimensional Analysis and Simititude"

Back Ground:-

Although many practical engineering problem involving hydroulic engineering Can be Solved equations and analytical procedure but yet a large number of problems rely on experimental data for Thair Solution.

- Similitude is used to express measurement on laboratory Can be used to describe The behaveour of Other System outside of labortary.

Dimensional Analysis:-

- Dimensional Analysis is a Mathematical technique making wise study of dimensions.

- It deal with dimension of Physical Quantities involved in the phenomeno
- It helpful in experimental World b/c It provided a guide to those things.
- Significant influence the phenomeno this mathematical technique is used in research work for design and for Conducting mode test.

Types of Dimensions:-

- Fundamental Dimension
- Secondary Dimension
  Those are derived Quantities
  e.g
  velocity = length/time

Model Analysis and Similitude:

"Similitude of hydroulic model exprement for tidal mixing"
The treatment of diffusion due to tidal current in near Shore and the Similitude in the hydrolic model exprenent are studies. In broad and Shallow tidal bays and in Coastle Seawatr near irregulr boundaries, horizontal oddy current induc geomtical and turbulance Caused by Floir Cascading have predominant effect on dispersion of river and wast watr These turbulent diffusion process Similarly reproduced in Froude model of turbulent

resume by adding the Simitidel fer self similar Structure of the Spectral desity of turbulence or eddy diffusity.
The Similitude mean take vertical length as two thirds power scal ratio of horizental power. In this special case their is no need satisfy Similitude for density differnce and verticl effect on despersion.

Kinematic Similarity :-
Ratio of velocity b/w ~~prototy~~ tidel and model

$$V_{P1}/V_{m1} = V_r = V_{P1}/V_{m2}$$

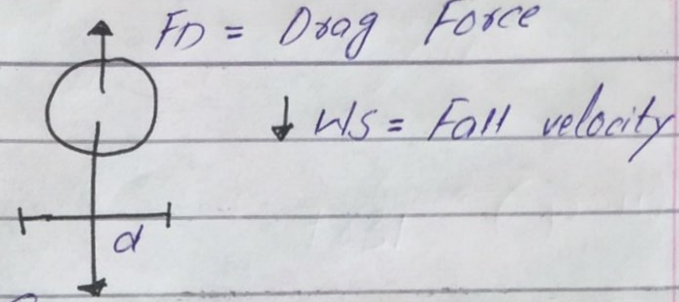
Kinametic Similarty depend on flow except Force.

QNO(04):-

- The downward velocity in a low dense fluid at eQuilibirium in which the Sam of the gravity force bouganoy force and fluid drage are evual to zero
- When a grain falls down in still water it obtain a Constant velocity when the upward fluid drage force on the grain is evual to the downward Submerged weight of grain This is also called Setting velocity.

Fall velocity effected due To the following terms.

- particles diameter
- particles density.
- particles Concentration
- particles Shape
- velocity of water (Temp)
- turbulence



Submerged weight

The Force balance b/w the drage force and the Submerged weight gives

FD = Submerged weight

$\frac{1}{2} \rho C_D \frac{\pi}{4} d^2 \omega_s^2 = (\rho_s - \rho) g \frac{\pi d^3}{6}$

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

C_D = Drage Co-efficent

ω_s = Fall velocity of Sediment.

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

ρ = Density of water (G)

ρ_s = Density of Sediment particles /m²

Particle Size (Diameter)

© particles Size is a notion in^tro^duce for Compairing demension of Solid particles, liquid particles or gaseous particles.

particles density:

The particles density of particular Solid or powder is density of particles that made up power.

particles Shap:-

It defined as;
The relative demension of long intermediate and Short axies of particles

vicosity of water:.
Define as;
A fluid internal resistence to flow and may be through of as a measure fluid friction.

Turbalence:. Turbulen flow is the fluid motion characterized by chaolic changes in pressure and flow velocity It is in contrast to lamminar flow.