NAME :- MALIK Muhammad Afnan

I.D :- 7839

Section :- "B"

Subject :- Hydraulics Engineering.

Department :- Civil Engineering

Semester :- "Six"

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QNo1
Ans:-

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

write the down dimensions.

ρ	ML^{-3}
V	LT^{-1}
h	L
μ	$ML^{-1}T^{-1}$
Δp	$ML^{-1}T^{-2}$
d	L

Number of independent dimension
: $m=3$ (M.L and T)
Number of non-dimensional group: $n-m=3$
Number of variable: $n=6$
Choose $m(=3)$ Scaling variable
geometric (d); Kinematic/time-dependent
(v); dynamic/mass-dependent (ρ).

From dimensionless groups by non-dimensionlising the remaining variable: Δp, h and μ

$$\pi_1 = \Delta p d^a v^b \rho^c$$
$$M^0 L^0 T^0 = (M L^{-1} T^{-2})(L)^a (L T^{-1})^b (M L^{-3})^c$$

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

$T: 0 = -2-b \Rightarrow b = -2.$
$M: 0 = 1+c \Rightarrow c = -1$
$L: 0 = -1+a+b-3c \Rightarrow a = 1+3c-b = 0$

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

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

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

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

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

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

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

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

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

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

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Recognition of the Reynolds number suggests that we replace π_3 by

$$\pi_3 = (\pi_5)^{-1} = \frac{\rho v d}{\mu}$$

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

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

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

$$\boxed{\frac{V_p}{V_m} = 0.5}$$

Hence,

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

$V_m = 6.0 ms^{-1}$

(b) The ratio of the quantities of flow is:

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

$$= 0.5 \times 5^2$$

$$\frac{Q_p}{Q_m} = 12.5.$$

(c) Finally, for the pressure drop.

$$\Lambda_1 = \left[\frac{\Delta p}{\rho v^2}\right]_p = \left[\frac{\Delta p}{\rho v^2}\right]_m \Rightarrow \frac{(\Delta p)_p}{(\Delta p)_m} = \frac{\rho_p}{\rho_m}\left[\frac{V_p}{V_m}\right]^2$$

$$\Lambda_1 = \frac{800}{1000} \times 0.5^2 = 0.2$$

$$\boxed{\Lambda_1 = 0.2}$$

Hence

$$\Delta p_p = 0.2 \times \Delta p_m = 0.2 \times 60$$

$$\boxed{\Delta p_p = 12.0 \text{ kPa}}.$$

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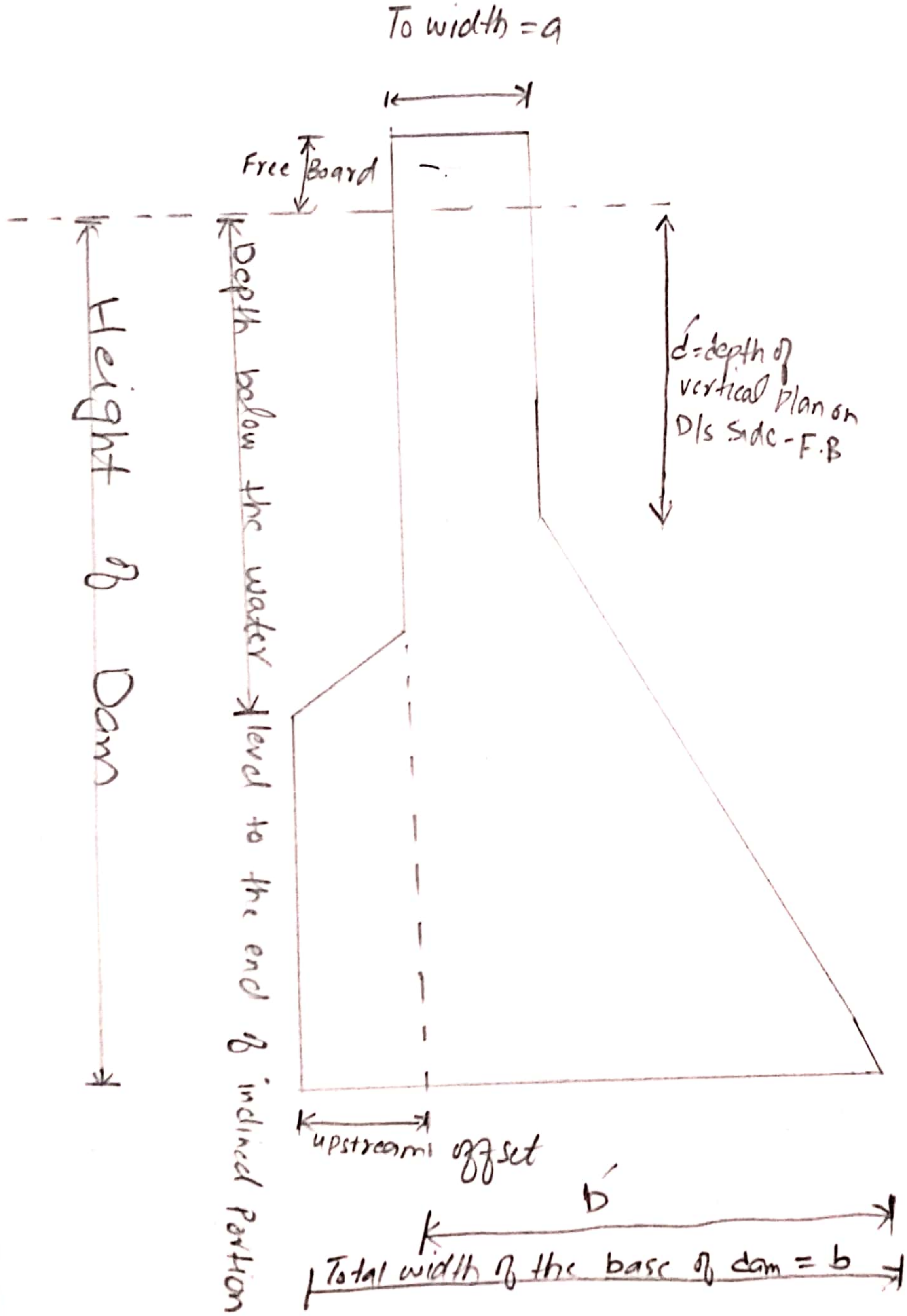
Q No 2
Ans

Design of Gravity Digram



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Q NO 2

Ans:

Design of Gravity Dam:-

Design Practical Profile for a gravity Dam with the following data:-

Maximum Depth of water in the Reservior = H = 78

Specific gravity of Dam Material = G = 2.5

Allowable Compressive stress for the Dam Masonary

$$\sigma_{all} = 783 \frac{T}{m^2}$$

Height of wave = 3.5 m

$$\mu = 0.7$$

No uplift Pressure $C_u = 0$

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Solution:-

① $H_{limiting} = \frac{G a u}{\gamma_w (G - C_u + 1)} = \frac{783 \times 1000}{1000(2.5 - 0 + 1)}$

$H_{limiting} = 223.71 \text{ m} > H_w = 78 \text{ m}$

So it is low gravity Dam.

②

Top Width "a"

Free board $= 1.5\, h_{wave} = 1.5 \times 3.5$

$\boxed{F.B = 5.25 m}$

height of Dam $= H_D = H_w + F.B = 78 \times 5.25$

$\boxed{H_D = 409.5 m}$

$a = 14\%$ of H_D

$a = 0.14 \times 409.5$

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$$\boxed{a = 57.33 \text{ m}}$$

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

i)- For No Sliding Criteria

$$b' = \frac{H_w}{\mu G} = \frac{78}{0.7 \times 2.5}$$

$$b' = 278.57$$

$$\boxed{b' \simeq 279 \text{ m}}$$

ii). For No tension Criteria

$$b' = \frac{H_w}{\sqrt{G}} = \frac{78}{\sqrt{2.5}}$$

$$\boxed{b' = 50 \text{ m}}$$

(4) Depth of veritical Portion on u/s Side:-

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

$h' = 2 \times 57.33\sqrt{2.5 - 0}$

$h' = 18.93\,m$

$\boxed{h' = 19\,m}$

(5) upstream off set $= \frac{9}{16}$

$= \frac{57.33}{16}$

$\boxed{= 3.5\,m}$

(6) Depth below the water level to the end of inclined portion in u/s $= 3.14 \times 57.33\sqrt{G}$

$= 3.14 \times 57.33\sqrt{2.5}$

$\boxed{= 284.6\,m}$

(7) Total width of the base of the dam

$b = b' + \frac{9}{16} = 50 + 3.58$

$\boxed{b = 53.58\,m}$

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

$$\theta = \tan^{-1}\left(\frac{50}{78}\right) = \tan^{-1}(0.64)$$

$$\boxed{\theta = 32.61^\circ}$$

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

$$\tan\theta = \frac{a}{d'} = \frac{57.33}{d'} \Rightarrow \tan\theta = \frac{57.33}{d'}$$

$$0.64d' = 57.33$$

$$d' = \frac{57.33 \times 3}{2}$$

$$d' = 85.9$$

$$d' = 85.9 \text{ m}$$

depth of vertical portion

$$d = d' + FB = 85.9 + 5.25$$

$$\boxed{d = 91.15 \text{ m}}$$

x = x = x

x = x

QNo4

Ans: The downward velocity in a low dense fluid at equilibrium in which the sum of the gravity force, buoyancy force and fluid drag force are 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.

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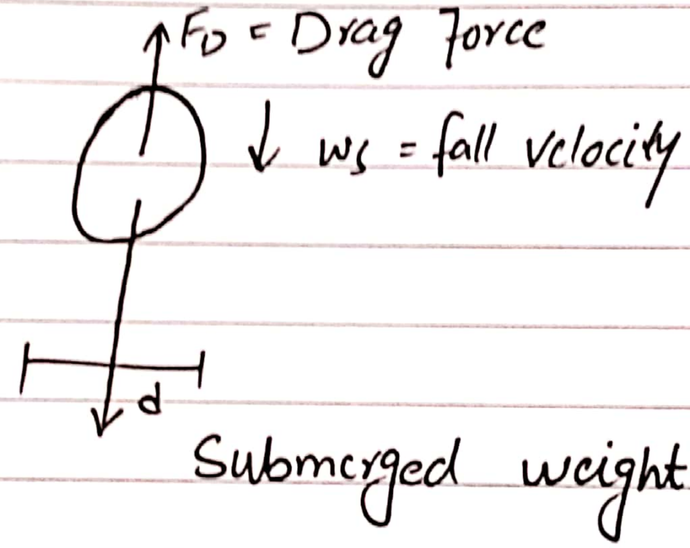
a) Particle diameter
b) Particle density
c) Partical Concentration
d) Partical shape
e) Viscosity of water [temperature]
f) Turbulance.



The force balance b/w the drag force and the Submerged weight gives.

$$F_D = \text{Submerged weight}$$

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

$A = \frac{\pi d^2}{4}$ = Projected Area

C_D = Drag Co-efficient

W_s = fall velocity of Sediment

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

ρ = Density of water

ρ_s = Density of Sediment Particle

Particle Diameter:-

The diameter of the particle is directly proportional to the velocity because greater the move faster as compared to the particles of small size thus where will be more gravitational force on particles of greater size it will fall quickly due to its weight.

Particle Density:-

Density of the particles is directly porotion to the rate of fall velocity since particle with high density tends to settle down early compared with the particle of density.

Particle Concenteration:-

Concentration of particles size will considerally effect its fall velocity as the section having greater concentration will be settle down at the place down causing the more fall velocity compacting with section of slow concentration.

Particles shape:-

Particle having vegular shaps tends to be effected more then irrigular shape since vegular shape particles have even surface which are the friction while particles with irregular shape offers more friction as the particles with smaller surface

Smaller due to their less resistance.

Velocity of water:- The Speed at which water Flows is Called as the velocity of water. This online Calculator is used to Find the velocity of water in a pipe with the Flow rate and diameter of the Pipe. Flow rates are usually measured by the volume of water that Passes each minute.

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QNo 3

Ans: Dimensional Analysis:-

· less number of experiment are necessary as opposed to the dimensional system.

· Experiment become inexpensive

· Data reducation becomes easier

Single plot is sufficient to show the result

Dimensional Analysis shows:-

$$F_r = \psi (F_r / R_e)$$

we would like to do a laboratory experiment now. we can vary h and measured V for few cases.

· Nature of curve is arbilary in this case actual curve may look slightly different

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Similitude: Basic idea behind Model testing:-

For the present Case Study

$$F_r = \psi\left[\frac{V}{\sqrt{gh^3}}\right]$$

Since the relation holds for Similar model and prototype tanks

$$\text{if } \left[\frac{V}{\sqrt{gh^3}}\right]_{model} = \left[\frac{V}{\sqrt{gh^3}}\right]_{Prototype}$$

$$\text{then } (F_r)_{model} = [F_r]_{Prototypes}$$

Dynamic Similarity:-

A model and Prototype are dynamically Similar if ratio of any two force are Same for model and Prototypes.

Model Studies (similitude) :-

Certain Fluid mechanical Phenomenon is governed by $f(\bar{\pi}_1, \bar{\pi}_2 \cdots \bar{\pi}_n) = 0$ where $\bar{\pi}_i$ are non-dimensional.

when the model is similar to the Prototypes

$$(\bar{\pi}_i)_{model} = (\bar{\pi}_i)_{Prototype}, \ i = 1, 2 \cdots n$$

Complete Similarity requires.

Geometric Similarity + Kinematic Similarity + Dynamic Similarity

Dimensional Analysis :- if Certain Physical Phenomenon is governed by $f(x_1, x_2, \cdots x_n) = 0$ where some/all the variable (x) are dimensional

Then the above Phenomena Can be represented as $\psi(\bar{\pi}_1, \bar{\pi}_2, \cdots \bar{\pi}_m) = 0$ where all the variable are non-dimensional

The nature of "f" and "ψ" may be obtained from experiment.