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Subject :- Hydraulic Engg

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:- 2 CR. HRS

Final Term

⇒ Qno1 :- A prototype gate value which will control ....

Solution:-

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

List the relevant 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 $m (=3)$ scaling variables:
geometric (d): Kinematic / Time-dependent (V); dynamic/mass dependent (ρ).
From dimensionless groups by non dimensionalising the remainig variables: Δp, h a μ.

$$\Pi_1 = \Delta p d^a V^b \rho^c$$
$$M^0 L^0 T^0 = (ML^{-1}T^{-2})(L)^a(LT^{-1})^b(ML^{-3})^c$$
$$= M^{1+c} L^{-1+a+b-3c} T^{-2-b}$$

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

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

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

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

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

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

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

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

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

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

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

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

Recognition of the reynolds number suggests that we replace Π_3 by

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

Hence dimensional Analysis yields

$\Pi_1 = f(\Pi_2, \Pi_3')$

ie

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

(a) Dynamic similarity requires that all non-dimensional groups be the same in model and prototype: ie

$$\Pi_1 = \left[\frac{\Delta P}{\rho V^2}\right]_p = \left[\frac{\Delta P}{\rho V^2}\right]_m$$

$$\Pi_2 = \left[\frac{h}{d}\right]_p = \left[\frac{h}{d}\right]_m$$ (automatic similar shape ie "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.

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

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

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

$$= 12.5$$

(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

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

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

Q no 2

Design a Practical Profile of gravity dam with the following data

1. Maximum Depth of water in reservior is (74 m)
2. Specific gravity of dam materal (2.5)
3. Allowable compressive strength for the dam masonary (748 T/m²)
4. Height of wave is Hw (1.5)
5. G and Hw is your own choice but should be differ from one another. G

=> Solution:-

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

$$= \frac{748 \times 1000}{1000(2.5 - 0 + 1)}$$

$$= 213.714 > Hw = 74m$$

So it is low gravity dam

(2) Top width 'a'

Free board = 1.5 h wave

= 1.5 x 1.5

F.B = 2.25 m

height of dam = $H_D = H_w + F.B$

= 74[illegible] + 2.25

H_D = [illegible] 76.25

a = 14% of H.D

a = 0.14 x [illegible] 76.25

a = 10.668 m

(3) Base width "b'" (without offset)

(i) for No sliding Criteria

$$b' = \frac{H_w}{\mu G} = \frac{74}{0.7 \times 2.5}$$

b' = 42.28

(ii) for No Tension Criteria

$$b' = \frac{H_w}{\sqrt{G}} = \frac{74}{\sqrt{2.5}}$$

$b' = 46.80$

$\boxed{b' = 47}$

④ Depth of vertical portion on U/S side

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

$h' = 2 \times 10.67\sqrt{2.5 - 0}$

$h' = 33.52$

$\boxed{h' = 34m}$

⑤ up stream off set $= \frac{a}{16}$

$= \frac{10.67}{16}$

$= 0.66m$

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

$= 3.14 \times 10.67 \sqrt{2.5}$

$= \boxed{52.97 m}$

⑦ Total width of the base of the dam

$b = b' + \frac{a}{16} = 47 + 0.66 m$

$\boxed{b = 47.66}$

⑧ $\tan \theta = \frac{b'}{H} = \frac{47}{74}$

$\theta = \tan^{-1} \left(\frac{47}{74} \right)$

$\theta = \boxed{32.42^\circ}$

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

$\tan \theta = \frac{a}{d'} = \frac{10.67}{d'}$

$$\frac{47}{74} d' = 10.67$$

$$d' = \frac{10.67 \times 74}{47}$$

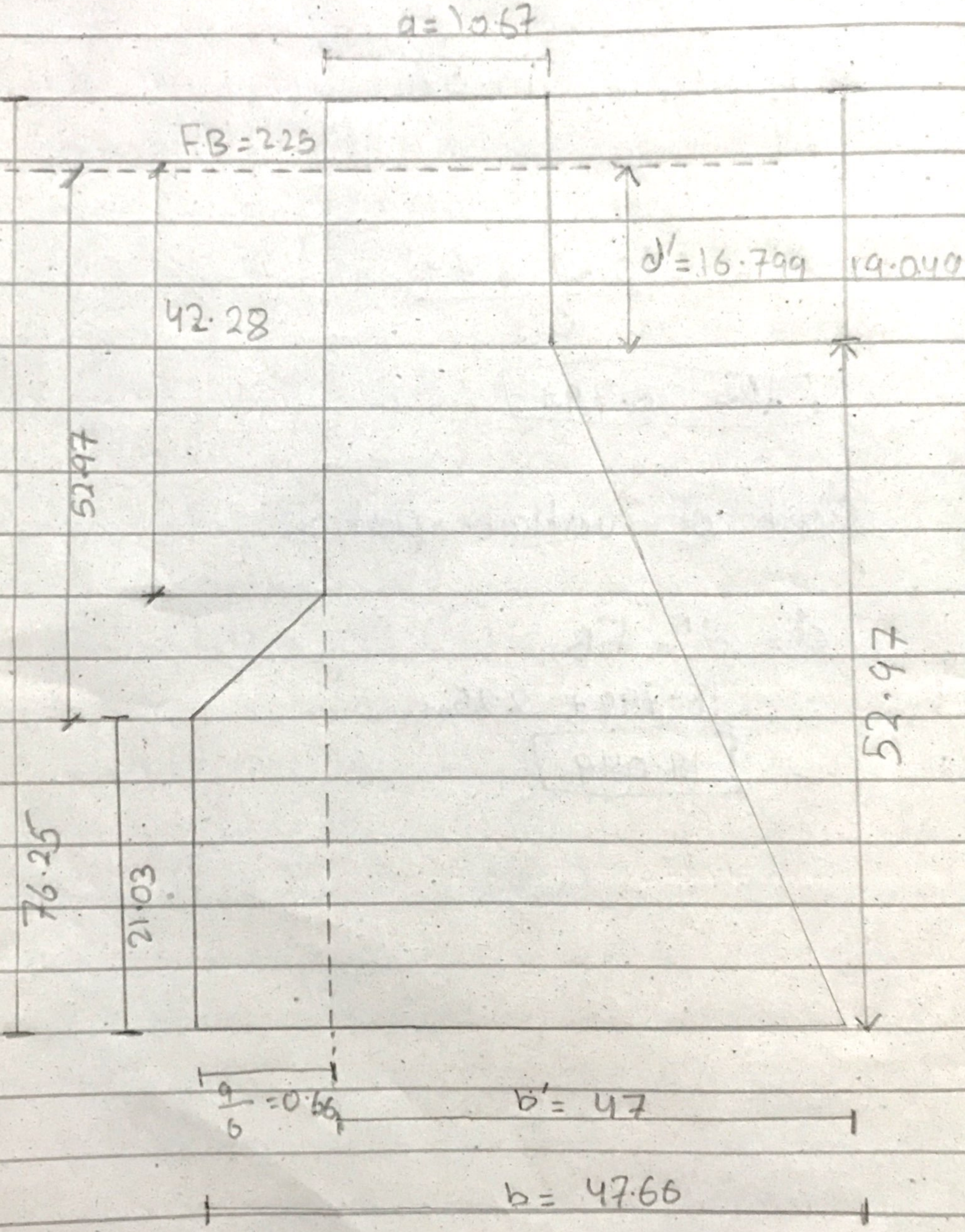
$$\boxed{d' = 16.799}$$

depth of vertical portion

$$d = d' + FB$$

$$= 16.799 + 2.25m$$

$$= \boxed{19.049}$$


a = 10.67
FB = 2.25
42.28
d' = 16.799
19.049
52.97
52.97
76.25
21.03
a/b = 0.66
b' = 47
b = 47.66

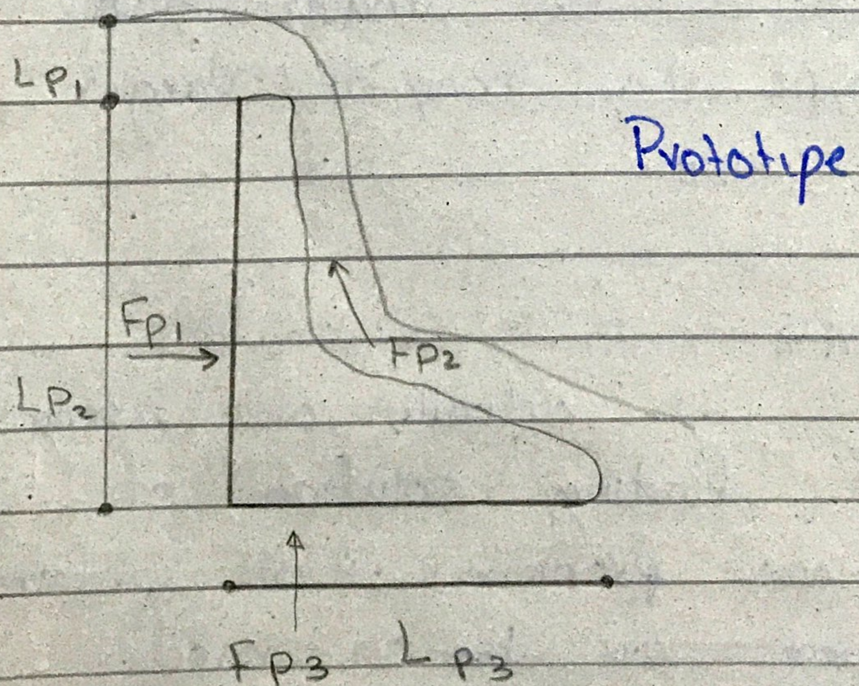
Q no 3 :-

Using any hydralic model and explain the concept of dimensional analysis and simitude.

Ans

Model :- It is a small scale replica of the actual structure

Proto type :- The actual structure or machine



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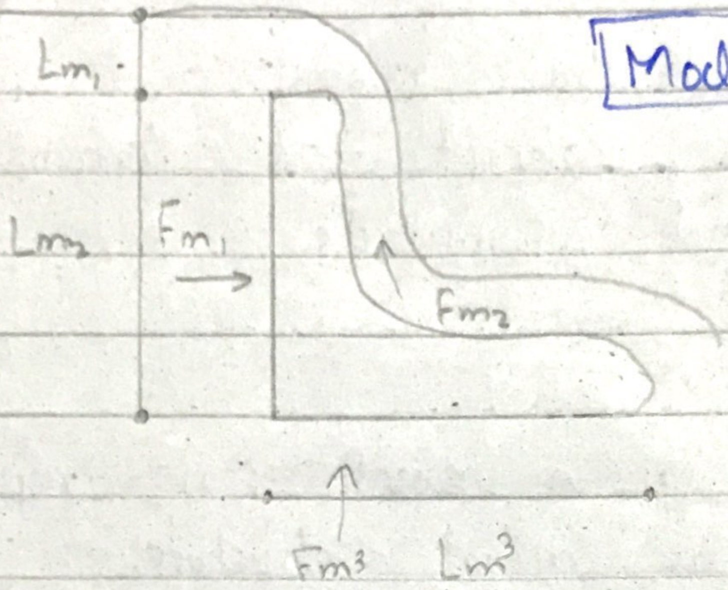

Model

It is not necessary that the model should be smaller that the prototype, they may be larger than it also.

Model Analysis :-
is actually an experimental method of finding solution of complex flow problems. Tests performed ~~The following are the~~ on model analysis to can be utilized for obtainig, in advance, useful

information about the performance of prototype only it a complete similarity exits between the model and prototype

Dimensional Analysis :-

In dimensional analysis first predicts the physical parameters that will influence the flow, and then by grouping these parameters in dimensionless combinations a better understanding of flow phenomenon is made possible

There are two types of dimensions:-

- Fundamental Dimensions or fundamental Quantites
- Secondary Dimensions or Derived Quantites

=> Fundimental Dimensions or fundimental Quantites

There are basic quantities. For Example

- Time, T → Time, T
- Distance, L → Distance, L
- Mass, M → Force, F

Force = Mass x Acceleration = MLT^{-2}

⇒ Secondary Dimensions or Derived Quantities

Those Quantities which posses more than one fundamental dimensions

For Example

- Velocity is denoted by distance per unit time L/T
- Acceleration is denoted by distance per unit time square L/T^2
- Density is denoted by mass per unit volume M/L^3

Similitude:-

It is defined as Similarity between the model and protype prototype in every respect, which mean model and prototype are completly similar.

There are three types of similarities must exist between model and prototype.

- Geometric Similarity
- Kinematic Similarity
- Dynamic Similarity

Basic idea behind model testing

For present case study $F_v = \psi \left[\frac{V}{\sqrt{gh^3}} \right]$

Since the relation holds for similar model and prototyp tanks

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

then $(F_v)_{model} = (F_v)_{prototype}$

Qno 4

What will be the effect of sediment particle diameter, particle density, particale concentration, particle shape, viscosity of water, turbulence of water flowing in reservoir on fall velocity.

Ans ① Particle diameter:-

The diameter of the particle will be directly to the falling velocity, Larger or biger is going to be the size of the particle will fall faster and smaller the size vise versa. When the size of the particle is greater it will tend to move down quickly because of the gravitional force.

② Particle ~~Size~~ Density:-

Higher the density is going to be

much faster will be fall of velocity. Density of the particle is directly proportional to the rate of fall velocity. So the particle with high density will settle down much faster as compared to particle of low density. This is the effect of particle density on fall of velocity.

③ Particle Concentration:-

Particle concentration is going to have an effect on the fall velocity. A section which will is going to have a greater concentration is going to settle down at the place and will be causing more fall of velocity as compared with section of low concentration

④ Viscosity of water:-

~~A decrease in the velocity of a compound~~ Water 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.

⑤ Turbulance of water :-

Turbulance of water is going to have an effect on the fall of velocity in reservoir because of the Zig Zag path will affect the flow of water and which will be going to effect in diffect type of variation and disturbace in the flow of water.

⑥ Particle Shaps:-

Particle shape is going to have an effect on fall of velocity. If its more veticle type the fall of velocity will be more and its round and sphare fall of velocity is going to be much slower.