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Name: ShahZeb-Khan Section - 'A'

Q NO! 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 visocosity μ.

List the relevent variables:

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

Dimensions

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

Number of variable $n=6$

Number of independent dimensions: $m=3$ (M.L and T)

Number of non-dimensions groups: $n-m=3$

Choose m (= m) Scaling variables:

Geometric (d); kinematric / time - depentent (V);

dynamic / mass - dependent (ρ).

From dimensionless group by non dimensionalising the remaining variable : Δp, h and μ.

$$\pi_1 = \Delta p d^a V^b \rho^c$$

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

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

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

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

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

$\Rightarrow \pi_2 = \frac{h}{d}$ (by inspection since h is length)

$\pi_3 = \mu d^a V^b \rho^c$ (probably obvious by now, but here goes anyway)

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

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

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

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

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

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

Recognition of the Reynolds number suggests that we replace π_3 by $\pi_3' = (\pi_3)^{-1} = \frac{\rho v d}{\mu}$

Hence dimension analysis yields

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

i-e

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

(a) Dynamic similarity required that all non-dimensional groups be the same and prototype; i-e

$$\pi_1 = \left(\frac{\Delta P}{\rho v^2}\right) = \left(\frac{\Delta P}{\rho v^2}\right)_m$$

$$\pi_2 = \left(\frac{h}{d}\right)_n = \left(\frac{h}{d}\right)_m$$ (Automatic if 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

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

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

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

(C) Finally for the pressure drop:

$$\pi_1 = \left(\frac{\Delta P}{\rho v^2}\right)_p = \left(\frac{\Delta P}{\rho v^2}\right)_m \Rightarrow \frac{(\Delta P)_p}{(\Delta P)_m} = \frac{\rho_p}{\rho_m}\left(\frac{v_p}{v_m}\right)^2 = \frac{800}{1000}\times0.5^2 = 0.2$$

Hence

$$\Delta P_p = 0.2 \times \Delta P_m = 0.2\times60 = 12.0 \ \text{Kpa}.$$

Q No! 02 :

Given data:

maximum depth of water of The reservoir =

$H = 69 m$

Specific Gravity of Dam material = $G = 2.5$

Allowable Compressive Stress for The Dam mosonary

$\delta_{all} = 693 \, T/m^2$

Height of waves = $H_w = 1.4 m$

$\mu = 0.7$

No uplift pressure = $C_u = 0$

Solution:

① $$H_{limiting} = \frac{\delta_{all}}{\gamma_w (G - C_u + 1)} = \frac{693 \times 1000}{1000 (2.5 - 0 + 1)}$$

$$H_{limiting} = 198 m > H_w = 69 m$$

So it is low gravity dam.

(2) Top width "a"

Free board $= 1.5 \times h_w = 1.5 \times 1.4$

$\boxed{F.b = 2.1\,m.}$

height of the Dam $= H_D = H_w + F.b = 69 + 2.1$

$H_D = 71.1\,m$

$a = 14\%$ of H_D

$a = 0.14 \times 71.1$

$\boxed{a = 9.95\,m}$

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

(i) for No sliding Criteria

$$b' = \frac{H_w}{\mu G} = \frac{69}{0.7 \times 2.5} = 39.43$$

$\boxed{b' = 39.43}$

ii for No tension Criteria

$$b' = \frac{H_w}{\sqrt{G}} = \frac{69}{\sqrt{2.5}} = 43.64$$

$\boxed{b' = 43.64}$

$\boxed{\text{use } b' = 43.64}$

(4) Depth of vertical portion on u/s side

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

$h = 2 \times 9.95\sqrt{2.5 - 0}$

$\boxed{h' = 31.46\,m}$

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

$= \frac{9.95}{16}$

$\boxed{= 0.62\,m}$

(6) Depth below the water level to the end of inclined portion in U/S $= 3.14\,a\sqrt{G}$

$= 3.14 \times 9.95\sqrt{2.5}$

$\boxed{= 49.4\,m}$

(7) Total width of the base of the dam

$b = b' + \frac{a}{16} = 43.64 + \frac{9.95}{16} = 44.26$

$\boxed{b = 44.26}$

$$\tan Q = \frac{b'}{H} = \frac{43.64}{69}$$

$$Q = \tan^{-1}(0.632)$$

$$\boxed{Q = 32.31^\circ}$$

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

$$\tan Q = \frac{a}{d'} = \frac{9.95}{d'} \Rightarrow \tan Q = \frac{9.95}{d'}$$

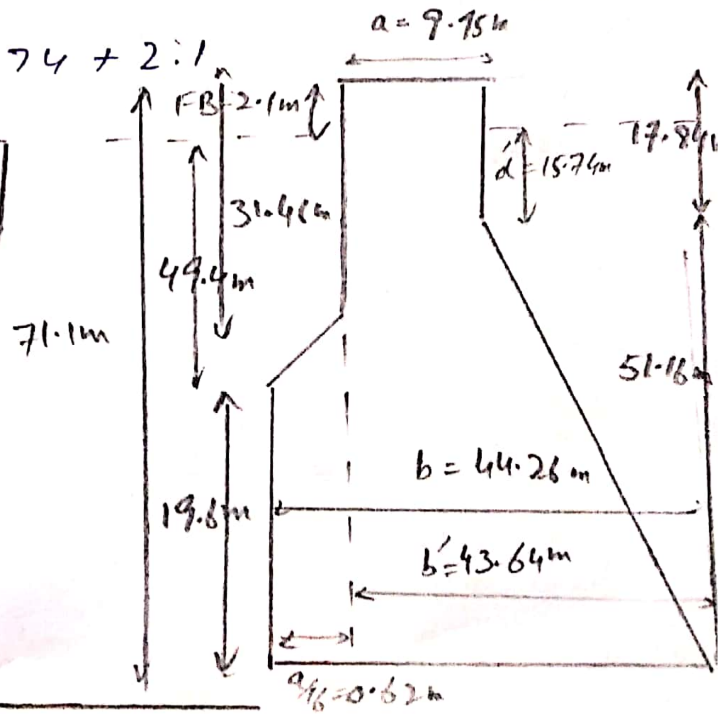
$$0.632 \times d' = 9.95$$

$$\boxed{d' = 15.74\,m}$$

depth of vertical portion

$$d = d' + F.B = 15.74 + 2.1$$

$$\boxed{d = 17.84\,m}$$



Q NO! 03 :-

Answer : **Dimensional analysis :**

Dimensional Analysis is a mathematical technique making use of study of dimensions.

* It deals with the dimensions of physical quantities involved in the phenomenon.

* "In dimensional analysis, one first predicts the physical parameters that will influence the flow, and they by grouping these parameters in dimension less combinations a better understanding of the flow phenomension is made possible".

It is particularly helpful in experimental work because it provide a guide to those

Things that significatiy influence the phenomenon.

* This mathematical Technique is used in research work for design and for conducting model tests.

Case Study :

Next, using the dimension analysis the relationship b/w Reynolds number, density ρ, kinemtic viscosity ν, fluid velocity v of a fluid and characteristic length l shall be expressed.

Using dimensional analysis to establish the relationship b/w the Reynolds number and the listed size, we start from the fact that Reynolds number is defenent on ρ, u, ν, and l:

$$Re = f(\rho, \vartheta, v, l)$$

Dimensional analysis is based on the fact that a relationship b/w physical dimension must be dimensionally homogeneous. We use The Reyleigh method which assumes that the resultant size in our case The Re number, can be written as Proportional to a product of The magnitude of The power that determine it that is:

$$Re = K \cdot \rho^a \cdot \vartheta^b \cdot v^c \cdot l^d$$

Where K is The Coefficient of proportionally. The Powers a,b, c, d are found to impose The condition that This relationship be dimensionally homogeneous:

$$M^0 \cdot L^0 \cdot T^0 = K\,(M \cdot L^{-3})^a$$

$$(L^2 \cdot T^{-1})^b \cdot (L \cdot T^{-1})^c \cdot L^d$$

$$M^0 \cdot L^0 \cdot T^0 = K \cdot M^a \cdot L^{-3a+2ab+c+d} \cdot T^{-b-c}$$

That is, to have the following equality:

$$\begin{cases} 0 = a \\ 0 = -3a + 2b + c + d \\ 0 = -b - c \end{cases}$$

By solving the system of equations we obtain

$$\begin{cases} a = 0 \\ c = -b \\ d = -b \end{cases}$$

that:

$$Re = K \cdot \rho^{0} \cdot \mu^{0} \cdot V^{-b} \cdot l^{-b} = K \left(\frac{V \cdot l}{\mu}\right)^{-b}$$

value of K and b are determined by experimental analyis. In the condition of application presented $K = 1$ and $b = -1$, Case where the Reynolds number (Re) obtains the relation:

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Similitude :-

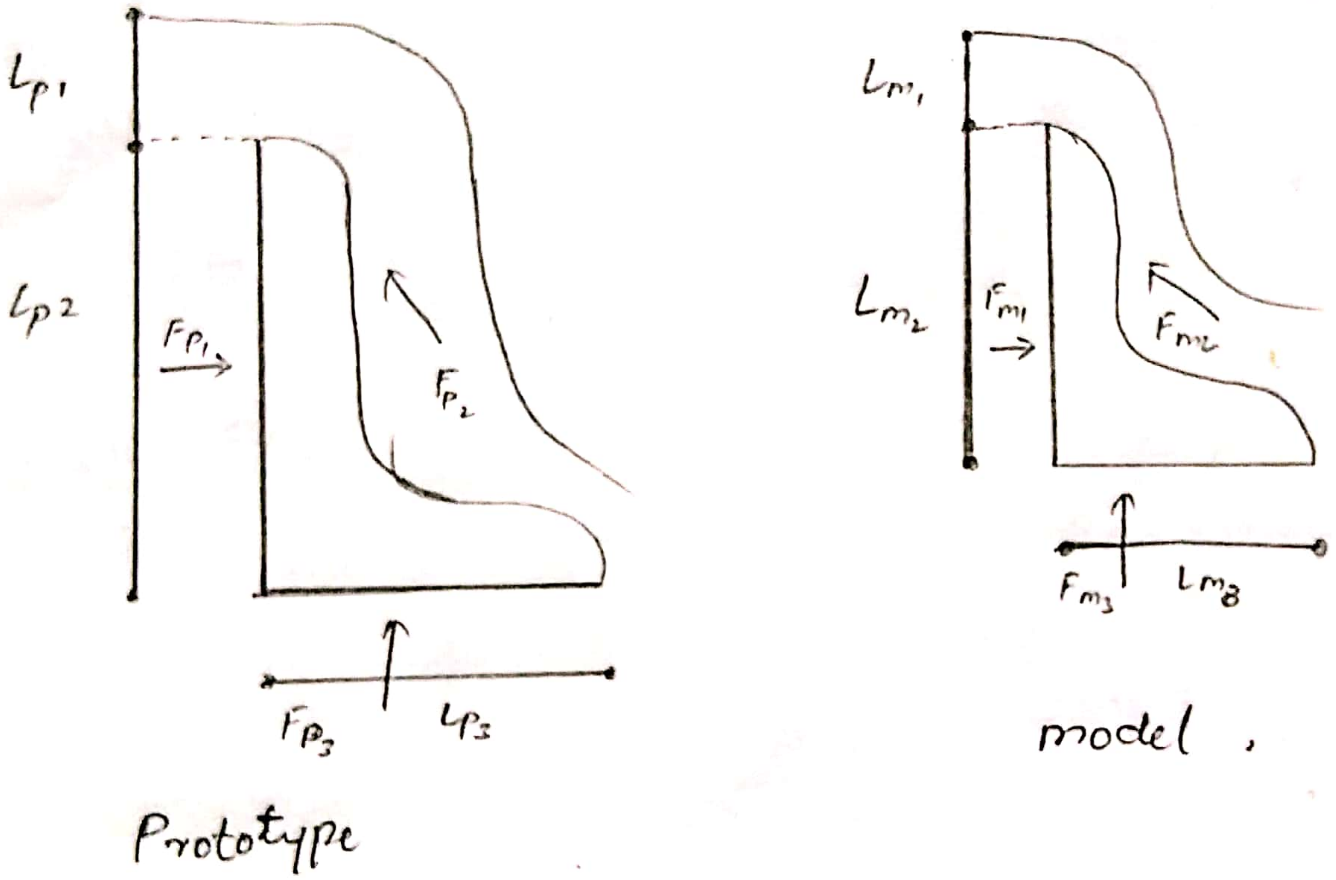
Simititude is a Concept using in testing of engineering models.

usually, it is impossible to obtain a Pure Theoretical Solution of Hydraulic phenomenon

Therefore, experimantel investigation are often Performed on small scale models, called model analysis.

A few example: where model may be used are Ships in ~~towkaf~~ towing basins, air planes in wind tunnel, hydraulic turbines, centrifugule pumps spillways of dam, river Channel etc. and to

Study such phenomenon as the action of waves and tides on beaches, soil erosion and transportion of sediment etc.



model: is the smaller scale replica of the actual Structure.

Prototype: is the actual structure or machine.

QNo! 04 :

Effect of following on fall velocity

1. <u>Particle diameter</u> :

As particle diameter increases fall velocity will be increases.

2- <u>Particle density</u> :

As particle density increases fall velocity decreases.

3- <u>particle consentration</u> :

As particle consentration increases fall velocity will be decreases.

4- <u>particle shape</u> :-

Particle shape affects the drag coefficient. Which in turn affects the fall velocity. This is normally accounted for the classification particles according to an equivalent fall diameter.

5- <u>viscosity of water</u> :-

Fluid velocity Through parous media is approximated as inversely proportional to The kinematic viscosity. ~~A~~ decrease in viscosity Therefore increase. The velocity of a compound Through porous media.

6- <u>Turbulence</u> :-

The effects of turbulence on Settling velocity are somewhat mixed. Turbulence reduces the drag coefficient C_D by

Changing The boundary layer around the Particle from laminar to tubulent. For smaller Particles, This is offset by the tendency of turbulente to diffuse the particles from a zone of higher Concentration near The Surface. No completely acceptable method for accounting for turbulence is presently available.

The End of paper: