QNO 01

Sol :→ The pressure drop Δp is expected to depend upon the gate opening h, the overall depth d, The velocity v, Density ρ & viscosity μ.

Now list the relevant variables:

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

Now write Dimensions:

Δp	=	$ML^{-1}T^{-2}$	=	kg/ms^2
h	=	L	=	Height
d	=	L	=	Depth
v	=	LT^{-1}	=	m/s
ρ	=	ML^{-3}	=	kg/m^3
μ	=	$ML^{-1}T^{-1}$	=	kg/ms

Number of variables $n = 6$

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;

Kinemetic/Time-dependent v;

Dynamic/Mass-dependent ρ;

From dimesionless groups by non-Dimesion lising veriables: 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 : $0 = -1 + a + b - 3c \Rightarrow a = 1 + 3c - b = 0$

$\Leftrightarrow \pi_1 = \Delta P v^{-2} \rho^{-1} = \Delta P / \rho v^2$

$\pi_2 = \dfrac{h}{d}$ (by inspection, since h is a length)

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

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

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

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

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

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

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

Recognition of Reynolds number suggest that replace π_3 by

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

Hence, dimensional analysis yields

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

i.e

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

a) Dynamic Similarity requires that all non-dimension 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 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

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

$$\Rightarrow 12.5$$

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

$$\Delta P_p = 0.2 \times \Delta P_m = 0.2 \times 60.$$

$$= 12.0\ kPa$$

Q no 02

Design a practical Profile of gravity dam with following Data.

Given Data:-

i→ Max Depth of water in the Reservior $= H = 77m$

ii→ Specific gravity of dam meterial $= G = 3.3$

iii→ Allowble Compression Stregth for The dam masonary

$$\sigma_{all} = 778\ T/m^2$$

iv→ Height of wave is $H_w = 1.7m$ Also $\mu = 0.5$

Solution:-

i→ $$H_{limiting} = \frac{\sigma_{all}}{\gamma_w (G - C_u + 1)} = \frac{778 \times 1000}{1000(3.3 - 0 + 1)}$$

$$H_{limiting} = 180.93m > H_w = 77m$$

So it is low gravity Dam.

ii → Top width "a"

Free board = $1.5 h_{wave}$ = 1.5×1.7

$F.B = 2.8 m$

Height of Dam = $H_D = H_w + F.B$

$= 77 + 2.8$

$H_D =$ ~~78.8~~ $200.2 m$

$a = 14\%$ of H_D

$a = 0.14 \times 200.2$

$a = 28.028 m$

iii → Base width "b'" (without off set)

i → for no Sliding Criteria

$$b' = \frac{H_w}{\mu G} = \frac{77}{0.5 \times 3.3}$$

$b' = 46.66$

use $b' \simeq 47$

ii → For no Tension criteria.

$$b' = \frac{H_w}{\sqrt{G}} = \frac{77}{\sqrt{3.3}}$$

$b' = 42.38$

~~use~~ $b' \simeq 42$

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iv → Depth of vertical portion on u/s side

$h' = 2a\sqrt{q - c_4}$

$h' = 2 \times 28.02\sqrt{3.3 - 0}$

$h' = 101.8\ m$

v → upstream off set $= \frac{a}{16}$

$= \frac{28.02}{16}$

$= 1.75\ m$

vi → Depth below the water level to the end of inclind portion u/s =

$= 3.14 a\sqrt{q}$

$= 3.14 \times 28.02\sqrt{3.3}$

$= 159.82\ m$

vii → Total width of the base of the dam

$b = b' + \frac{a}{16} = 47 + 1.75$

$b = 48.75\ m$

viii →
$$\tan\theta = \frac{b'}{H} = \frac{47}{77}$$

$$\theta = \tan^{-1}\frac{47}{77}$$

$$\boxed{\theta = 31.39^\circ}$$

ix → Depth of vertical portion on D/s (from WL on U/s side)

$$\tan\theta = \frac{a}{d'} = \frac{28.02}{d'} \Rightarrow \tan\theta = \frac{28.02}{d'}$$

As $\tan\theta = 47/77$

So
$$47/77 = \frac{28.02}{d'}$$

$$d' = \frac{77 \times 28.02}{47}$$

$$\boxed{d' = 45.90}$$

Depth of vertical portion

$$d = d' + FB = 45.9 + 2.6$$

$$d = 48.54$$

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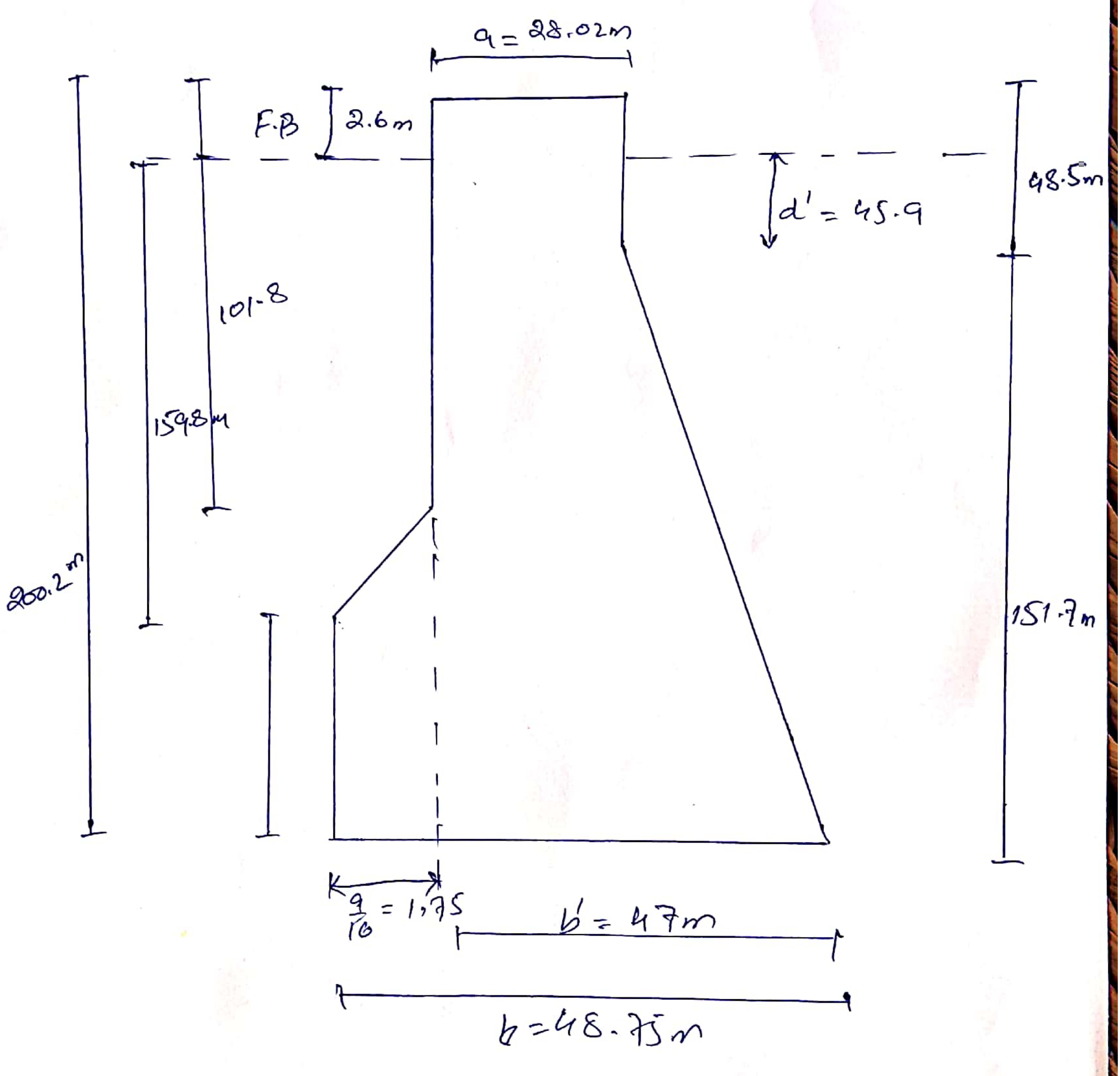

a = 28.02m
F.B
2.6m
d' = 45.9
48.5m
101.8
159.8m
200.2m
151.7m
a/16 = 1.75
b' = 47m
b = 48.75m

Quiz 03

Q.→ Ans :→

Dimesion Analysis :-

Dimension analysis is a methemathical Technique macking use of study of dimension.

→ Purpose of dimesion analysis :-

→ To obtain Scaling laws so that Prototype performance can be predicted from model performance.

→ To predict in the relatshenship between parameter.

→ To generate non-dimentional parameter that help in the design of Experiment and in reporting of Result.

→ Fundament dimension :-

There are the basic quantities.

For example.

Time, Distance, Length, Mass, T.

Secondary Dimension:-

Those quantity which posses more then one fundamental dimension velocity L/T Accelaration, L/T
Density, M/L^3

Similitude :-

Similitude is defined as Similarity b/w the model and Prototype in every respect which mean model and protype have Similar properties or model and protype are competabley Similar.

→ It is used in testing engineering models.

Example:-

Consider a turbine hydrolic model at 1/40th Scal. the application operate in sea water at 0.8°C. moving & operated 5m/s in model will be tested in fresh water at 20°C.

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Q no 04

Ans :→ **Fall velocity**:- 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 constant velocity is defined as the fall velocity of the grain this is also called setting velocity.

Falls velocity depends upon the following terms or factor.

i → Particles Diameter
ii → Particles Density
iii → Particles Consentration
iv → viscosity of water
v → viscosity of water
vi → Turbulence.

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Q no (04)

Ans i→ **Effect of Partical Diameter on fall velocity:-**

The Diameter of the particle is directly proportional to the fall velocity because greater the size of the particles so it will tends to more gravitational force on particles of greater size as compared to particles with less diameter. it will fall quickly due to its weight.

ii→ **Effect of particles Density on fall velocity:-**

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

iii → <u>Effect of particle Concentration of fall velocity</u>:-

Concentration of particles size will considerably effect its fall velocity as the section having greater concentration will be settled down at the place thus causing more fall velocity comparing with section of low concentrated.

iv → <u>Effect of viscousity of water on fall velocity</u>:-

Fluid velocity through porous media is approximetly as inversaly proportional to the kinametic viscosity.
of decrease in viscousity therefore increase the velocity of a compound through porous media.

v → Effect of partical shape on falling velocity.

→ Non-spherical analysis particles fall up to 78 %
slower then equilant shphere

→ model show 100 μm non-spherical

Particles Travel 44% further then Spheres,.

→ verticles structure of modelled volcanic ash clouds is Sensities to particle Shape.

vi-) <u>Turbulence of water</u>:-

Turbulence of water effect the fall velocity of water in Reservoir because the non-linearity & zig-zag path effect the flow of water & cause the variation in the flow.

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