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Question No 1

Solution:

Given that the pressure drop (Δp) is expected to depend upon the gate opening (h), the overal depth, velocity, density and viscosity (μ).

So the variables are

$$\Delta p = f(h, d, V, \rho, \mu)$$

$$f = (\Delta p, h, V, \rho, \mu) = 0$$

then the total number of variables (n) = 6

fundamental dimension = m = 3

$\Rightarrow n - m$

$\Rightarrow 6 - 3 = 3$

So $f(\pi_1, \pi_2, \pi_3) = 0$

The remaining variable are following

$(\Delta p, h, \mu)$

$$\pi_1 = \Delta p \, d^{a_1} V^{b_1} \rho^{c_1}$$

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(2)

$MLT = (ML^{-1}T^{-2})(L)^{a_1}(LT^{-1})^{b_1}(ML^{-3})^{c_1}$

Evaluating powers.

Power of T = $0 = -2 - b \Rightarrow b_1 = -2$

Power of L = $0 = -1 + a_1 + b_1 - 3c_1$

Power of M = $0 = 1 + c_1 \Rightarrow c_1 = -1$

$a_1 = 1 + 3c_1 - b_1 \longrightarrow (i)$

Now put the value of b_1 and c_1 in eq (i) so

$a_1 = 1 + 3(-1) - (-2)$

$a_1 = 0$

So $\pi = \frac{\Delta P}{\rho V^2}$

For π_2,

$\pi_2 = h, d^{a_3}, b^{b_2}, \rho^{c_2}$

$MLT = h\ (L)^{a_2}(LT^{-1})^{b_2}(ML^{-3})^{c_2}$

Power of M = $0 = c_2 = \boxed{c_2 = 0}$

Power of L = $0 = a_2 - b_2 - 3c_2$

$a_2 - b_2 - 3(0)$

$\Rightarrow \boxed{a_2 = b_2} \Rightarrow \boxed{\text{[illegible]}}$

Power of T = $0 - b_2 \Rightarrow b_2 = 0$

So

$\pi_2 = h d^{-1}$

$\pi_2 = h/d$

Now for π_3 -terms

$\pi_3 = \mu d^{a_3} V^{b_3} \rho^{c_3}$

$M^0 L^0 T^0 = (ML^{-1}T^{-1})(L)^{a_3}(LT^{-1})^{b_3}(ML^{-3})^{c_3}$

So

M power = $0 = 1 + c_3 \Rightarrow c_3 = -1$

L power = $0 = -1 + a_3 + b_3 - 3c_3$

$a_3 = 1 + 3c_3 - b_3$ — (3)

T power = $0 = -1 - b_3 + 0 = b_3 = -1$

put value of b_3 and c_3 in eq (3)

$a_3 = 1 + 3(-1) - (-1)$

$a_3 = -1$

So

$\pi_3 = \mu d^{-1} V^{-1} \rho^{-1}$

$$\boxed{\pi_3 = \frac{\mu}{\rho V d}}$$

So the relation ship shown as

$$f(\pi_1, \pi_2, \pi_3) = f\left(\frac{\pi p}{\rho v^2}, \frac{h}{d}, \frac{\mu}{\rho v d}\right)$$

By Reynold number $r = (R) = \frac{\mu}{\rho V D}$

then we know that

$$\pi_1 = \left(\frac{\pi p}{\rho v^2}\right)_p = \left(\frac{\pi p}{\rho v^2}\right)_m$$

$$\pi_3 = \left(\frac{\rho v d}{\mu}\right)_p = \left(\frac{\rho v d}{\mu}\right)_m$$

from the above equation we get

$$v_p = \left(\frac{\mu}{\rho}\right)_p \times d_m \quad \text{— (4)}$$

$$V_m = \left(\frac{\mu}{\rho}\right)_m \times d_p \quad \text{— (5)}$$

a) <u>velocity of Model in water:</u>

velocity of prototype $(v_p = 3 \cdot 0\, m/sec$

from eq 4 and 5 $\quad \therefore \rho = 800 kg/m^3$, $\frac{d_m}{d_p} = 1/5$, $\mu = 1.0 \times 10^{-6}$

$$\frac{v_p}{v_m} = \frac{(\mu/\rho)_p \times d_m}{(\mu/\rho)_m \times d_p} = \frac{\frac{0.002}{800}}{1.0 \times 10^{-6}} \times \frac{1}{5}$$

$$\boxed{\frac{v_p}{v_m} = 0.5}$$

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

$V_m = \frac{3.0}{0.5}$

$V_m = 6.0 \, m/sec$

B) Ratio of Quantities of flow in prototype and Model.

we know that

$Q = AV$

so $\frac{Q_p}{Q_m} = \frac{(A \cdot V)_p}{(A \cdot V)_m} = \frac{V_p}{V_m} \left(\frac{d_p}{d_m}\right)^2$

$= 0.5 \times (5)^2$

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

c) Finally for the pressure drop:

$\pi_1 = \frac{(\Delta P)_p}{(\Delta P)_m} = \frac{\rho_p (V_p)^2}{\rho_m (V_m)^2} = \frac{800}{1000} \times (0.5)^2$

$= 0.2$

so $= \frac{(\Delta P)_p}{(\Delta P)_m} = 0.2$

$\Rightarrow (\Delta p)_p = 0.2 \times (\Delta p)_p$

$= 0.2 \times 60 = \boxed{12.0\ kpa}$

Question No 2

Design of gravity Dam:

Given data:

- Max depth of ~~reservoir~~ water in Reservior = 78m
- specific gravity of Dam material = G = 2.7
- Allowable compression stress for the Dam masonry $S_{au} = 780 \frac{T}{m^2}$
- Height of wave (H_w) = 2.55m
- $\mu = 0.7$

No uplift pressure = $C_u = 0$

$\because \gamma_w = 1000\ kg/m^3$

Solution:

By formula

$$H_{limiting} = \frac{S_{au}}{\gamma_w (G - C_u + 1)}$$

$$= \frac{780 \times 1000}{1000(2.7 - 0 + 1)} = \boxed{210.81m}$$

Low gravity dam

2) Top width "a"

Free board = 1.5 hw

= 1.5 x 2.55

FB = 3.82 m

Height of dam = Hd = Hw + FB

= 78 + 3.82

Hd = 81.82

So a = 14 % of HD = $\frac{14}{100} \times 81.82$

$a = 11.45$

3) Base width with out offset

i) For no sliding criteria

By formula we have

$b' = \frac{Hw}{\mu . G} = \frac{78}{0.7 \times 2.7} = 41.26$

$b' = 41.26$

ii) **For No tension criteria:**

We know that

$$b' = \frac{H_{water}}{\sqrt{G}} = \frac{78}{\sqrt{2.7}} = \boxed{47.46}$$

$$\boxed{b' \cong 47.46}$$

4) Depth of vertical portion on upstream side

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

$$= 2(11.45)\sqrt{2.7 - 0}$$

$$\boxed{h' = 37.62}$$

5) upstream offset

$$\text{upstream offset} = a/16$$

$$= \frac{11.45}{16} = 0.71$$

$$\boxed{0.71\ m}$$

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6) Depth below the water Level to the end of inclined portion is u/s

$= 3.14\, a\sqrt{a}$

$= 3.14\, a\sqrt{G}$

$= 3.14 \times 11.45\sqrt{2.7}$

$= 59.07\ m$

7) (Now the total width of Dam)

$b = b' + \frac{a}{16} = 47.46 + \frac{11.45}{16}$

$\boxed{b = 48.17\ m}$

8) $\tan\theta = \frac{b'}{H} = \frac{47.46}{78}$

$\tan\theta = \frac{17}{26}$

$\theta = \tan^{-1}\left(\frac{17}{26}\right)$

$\theta = 3317^{\circ}$

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

$$\tan\theta = \frac{a}{d_1} = \frac{11.45}{d'}$$

$$\tan\alpha = \frac{11.45}{d_1}$$

$$\frac{17}{26}d' = 11.45$$

$$d' = \frac{11.45 \times 26}{17}$$

$$d' = 17.51$$

Depth on vertical portion

$$d = d' + fB$$

$$= 17.51 + 3.82$$

$$d = 21.33$$

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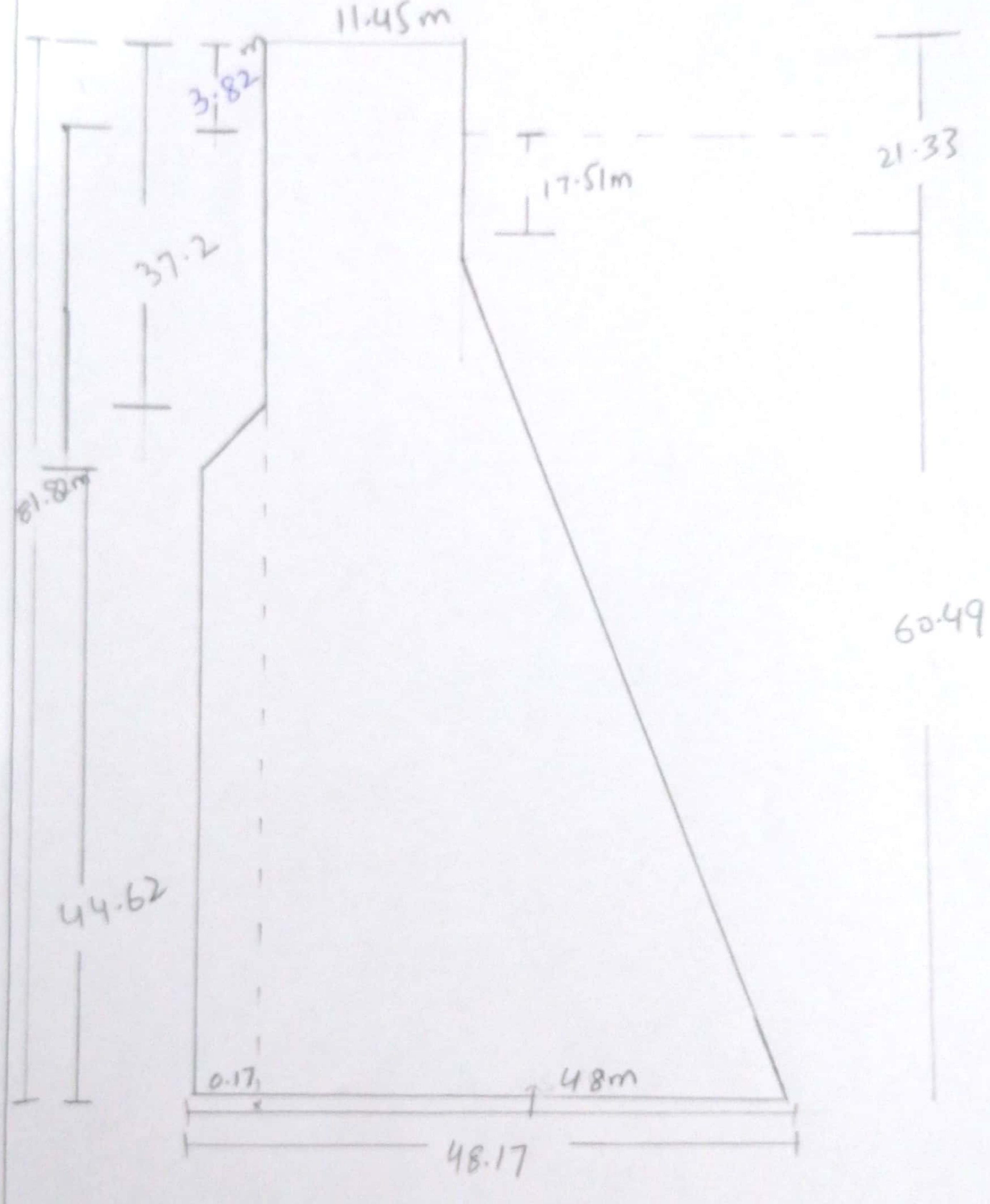

Question No 3

Using any hydraulic model and explain the concept of Dimensional analysis and similitude.

Dimensional analysis:

It is a mathematically technique making use of study of dimensions. It deals with the dimensions of Physical quantities involved in the phenomena.

for example.
how many ~~days~~ second in a day

$$\frac{24\,hr}{1\,day} \quad \frac{60\,min}{1\,hr} \quad \frac{60\,s}{1\,m} = \frac{86400\,s}{day}$$

86400/day

Similitude:

Similitude is a concept applicable to the testing of engineering models. A model is said to be have similitude with the real application if the two share geometric similarly kinematic similarity and dynamic similitude are inter changable in this content.

Advantages of dimensional analysis

- Experiments become inexpensive.
- The basic idea behind similitude shows the use of replica of actual model on small scale.

For example on site.

The power generation is 60KN per hour so we here we will generate its half or more lesser value, and then for actual results we will multiply with desire numbers.

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Question No4

Ans: Particle diameter: The diameter of the particle is directly proportional to the fast velocity because greater the size of the particle so it will be tends to move faster as compared to the particle of small size thus there will be more gravitational force on particle of greater size so it will fall quickly due to its weight. The diameter of a sphere particle has same specific gravity and the terminal uniform setily velocity as the given particle in the same sedimentation.

2) Particle density:

Particle density effect the setting fall velocity. As air density increases with decreasing altitude at about 2% per 80 meter for every 160 meter of fall the terminal speed decreases 1%.

3) particle shape,

Particle having regular shape which tends to be effected more than irregular shape since regular shape particles have even surfaces which offers very little. The non spherical analogue particle fall up to 75 % slower than equilent shape sphere model show non spherical particles travels 44% faster than sphere verticle structure of modelled volcanic ash cloud is sensitive to particle shape.

4) Viscosity of water:

Fluid ~~vis~~ velosity through porous media is approximated as inversly proportional to the kinematic viscosity. A decrease in viscosity therefore increase the velocity of a compound throug porous media.

5) Particle concentration:

when the suspended concentration of sediment increases, the setling velocity of each particle decreases due to the modification of the flow induced by previous particles.

6). Turbulance of water:

Turbulance occured in water also effect the fall velocity of the particle. The zig-zag path in the flow decreases the drag force and fall velocity of the Particle.

Fall velocity: when a grain fall 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.