Subject :: Hydraulic Engineering

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Section :: A

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Note attempt all Question:-

Q1 Sol:-

The pressure drop $\Delta p$ is expected to depend upon the gate opening h, the overall depth d, the velocity V, density $\rho$ & viscosity $\mu$

List of relevant variables

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

Write down dimension

| | |
|---|---|
| $\Delta p$ | $ML^{-1}T^{-2}$ |
| h | L |
| d | L |
| V | $LT^{-1}$ |
| $\rho$ | $ML^{-3}$ |
| $\mu$ | $ML^{-1}T^{-1}$ |

Number of variables: $n = 6$

Number of Independent dimension

$m = 3$ (M, L & T)

Number of non-dimensional groups

$n - m = 3$

Choose ($m = 3$) Scaling variables: geometric ($d$); kinematic/time-dependent ($v$); dynamic/mass-dependent ($\rho$)

From dimensionless groups by non dimensionalising the remaining variable : $\Delta p$, $h$, $\varepsilon$, $\mu$

$$\Rightarrow \Pi_1 = \Delta p d^a v^b \rho^e$$

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

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

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

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

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

$a = 0$

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

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

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

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

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

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

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

$a = -1$

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

Recognition of the Reynold number suggests that we replace $\pi_3$ by

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

Hence, dimension less 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-dimensional groups be the same in model & prototype

i-e

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

$$\pi_2 = \left(\frac{h}{d}\right)_p = \left(\frac{h}{d}\right)_m$$

(automatic if Similar Shape i-e geometric Similarity)

$$\pi_3' = \left(\frac{Pvd}{\mu}\right)_p = \left(\frac{Pvd}{\mu}\right)_m$$

From the last we have a velocity ratio.

$$\frac{v_p}{v_m} = \frac{(\mu/P)_p \ (d_m)}{(\mu/P)_m \ (d_p)}$$

$$\frac{V_P}{V_m} = \frac{0.002/800}{1.0 \times 10^{-6}} \times \frac{1}{5} = 0.5$$

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

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

$$\frac{Q_P}{Q_m} = 0.5 \times 5^2 = 12.5$$

(c) Finally, for the pressure drop

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

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

$$\pi_1 = 0.2$$

Hence

$$\Delta P_a = 0.2 \times \Delta P_m = 0.2 \times 60$$

$$\Delta P_a = 12.0 \text{ kPa}$$

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Q2 Given data:-

$H = 78m$

$G_1 = 3.4$

$\sigma_{all} = 782 T/m^2$

$H_w = 1.8m$

$\mu = 0.7$

$C_u = 0$

Sol:-

$$H_{limiting} = \frac{\sigma_{all}}{\gamma_w (G_1 - C_u + 1)} = \frac{782 \times 1000}{1000 (3.4 - 0 + 1)}$$

$$177.727 H = 78$$

So it is low gravity dam

(2) Top width "a"

Free board = $1.5 \times h_w = 1.5 \times 1.8$

$F.b = 2.7m$

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

$= 78 + 2.7$

$H_D = 80.7m$

$a = 14\% \text{ of } H$

$= 0.14 \times 80.7\,m$

$a = 11.29\,m$

(3) Base width "b" (without offset

(i) For no sliding criteria

$$b' = \frac{Hw}{\mu G} = \frac{78}{0.7 \times 3.4}$$

$b' = 32.7$

$b' \approx 33$

(ii) For no tension criteria

$$b' = \frac{Hw}{\sqrt{G}} = \frac{78}{\sqrt{3.4}}$$

$b' = 42.3$

$b' = 42m$

(4) Depth of vertical portion on b/s

$$h' = 2a\sqrt{G - C_4}$$

$h = 2 \times 11.29 \sqrt{3.4 - 0}$

$h = 41.6$

$h \approx 42\ m$

(5) Upstream offset $= \frac{q}{16}$

$= \frac{11.29}{16}$

$= 0.70\ m$

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

$= 3.14 \times 11.29 \sqrt{3.4}$

$y_s = 65.36\ m$

(7) total width of the base of the dam

$b = b' + \frac{q}{16} = 42 + \frac{11.29}{16}$

$b = 42 + 0.70 = 42.7\ m$

$b \approx 43\ m$

(8) $\tan\alpha = \frac{b'}{H} = \frac{43}{78}$

$\alpha = \tan^{-1}\left(\frac{43}{78}\right) = 28.86°$

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

$\tan\alpha = \frac{a}{d'} = \frac{11.29}{d'}$

$\frac{43}{78} d' = 11.29$

$d' = 20.47\ m$

depth of vertical portion

$d = d' + FB = 20.47 + 2.7$

$d = 23.17\ m$

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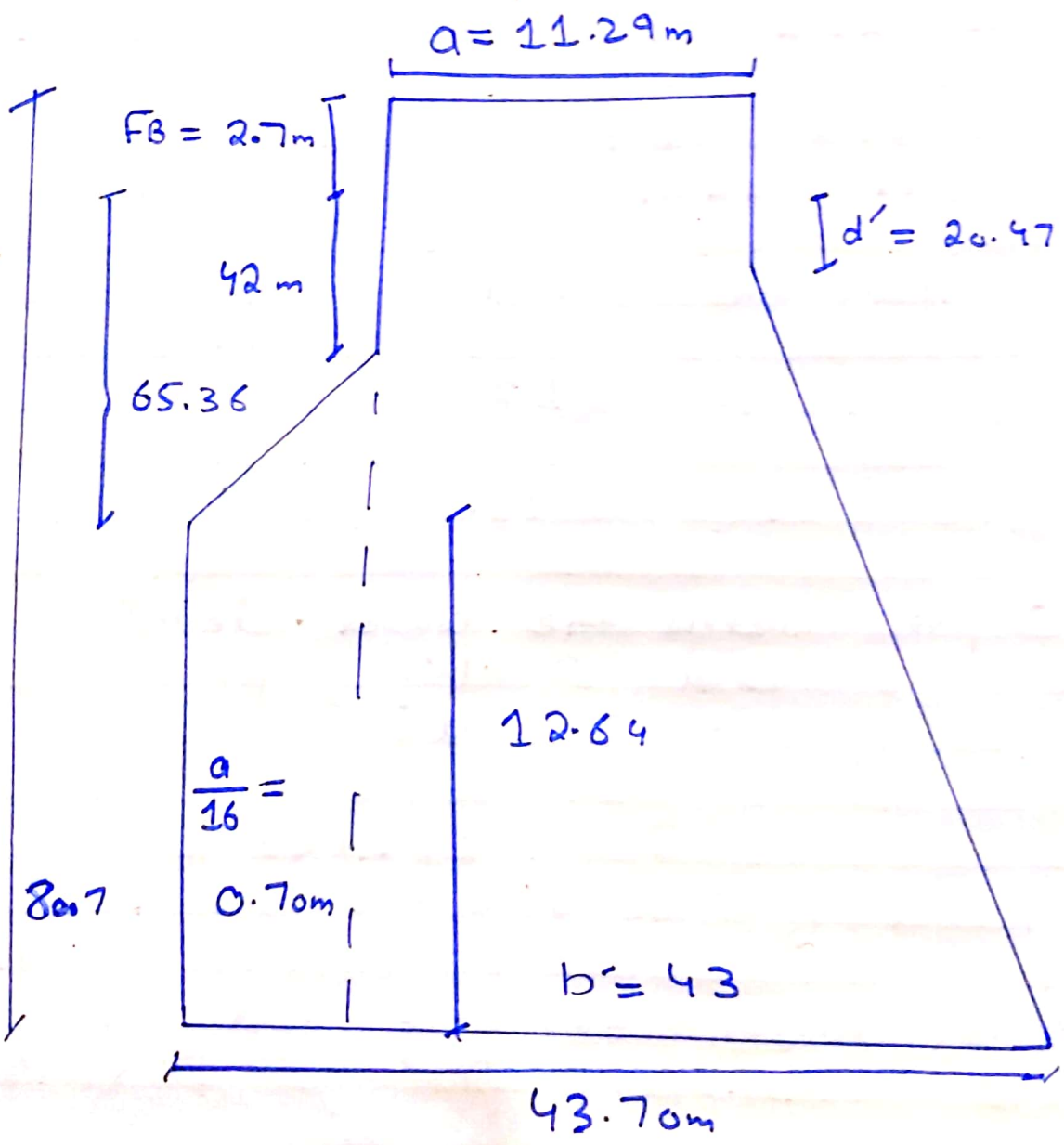

Q3 Using any hydraulic model & explain the concept of Dimensional analysis & Similitude .?

Ans Under water Highway tunnel :-

Abstract :-

Under water has always been attractive & curiosity for human being. Exploring, Emplying & being part of under water has been a challenge for them at all time. The under water Highway tunnel.

Introduction :-

The vision of living in water has recently become a professional focus among Civil engineering & urban planner. climate change, the rise of the sea level, & the constantly increasing global population are issue that renders treating water surface as settlement areas as never before.

## Aim:-

To research on the building of underwater passage as a Submarine.

## Objective:-

The main objective of this project is to provide a way for the human being to travel from one place to another where it is difficult to Construct a bridges etc.

## Advantages:-

(1) Caisson are economical.
(2) There are less Sound pollution & vibration.
(3) Best inspirational view for the outsider viewing the glass tunnel.
(4) Caisson having great high horizontal & lateral loading Capacity.
(5) Minimum handling equipment is required for reinforcement glass cage.

## Disadvantages :-

(1) The Construction procedure is extremely Sensitive & troublesome.
(2) It is not good for polluted Sites.
(3) It needs expert Engineer to design the Construction.
(4) The help of divers may be required.

## Methodology:-

Tunnel built across the bottom of the river, Bays & many others water bodies. By using Cut & Cover method, block the water from both the side of the river which involves impressing a tube in a trench & Covering it with the required material at right place.

## Equipments:-

(1) Cutter Suction Dregers.
(2) Immessed glass tube tunnel.
(3) Submarine multi purpose excavators etc.

Result & Conclusion:-

Is to built the better & economical under water passage

Recomandation:-

(1) Japan & korea undersea tunnel with distance of 128 kilometer.

**Dynamic Analysis:-** Dimensional analysis refers to the investigation of connection between various physical amount by distinguishing their major measurement e.g (length, mass, time & electricity charge) & unit of measure e.g miles versus kilometer. Tracking these measurement as estimations or correlation are performed in dimensional analysis.

$$v = \frac{d}{t}$$

$$v = \frac{L}{T}$$

$$v = LT^{-1} \Rightarrow M^{0}.LT^{-1}$$

where $M^{0} = 1$ d= distance, t= time

**Similitude :-** It is a concept of estimating the behavior of a prototype from model measurement. It is generally used to test engineering model. the concept of similitude is mainly used is aeroscope & hydraulics applications to check the condition of fluid flow with regard to scaled models.

Q4 What are the effects of the following on fall velocity in reservoir Explain it:-

Ans Particle diameter:- The diameter of a sphere particle has same Specific gravity and the terminal uniform Setling velocity as the given particle in the same Sedimentation

Particle density:- Particle density effect the setting fall velocity. As Air density increases with decreasing altitude at about 1% per 80 meter (260 ft) for every 160 meter of fall the terminal Speed decrease 1%.

Particle Concentration:- When the Suspended Concentration of Sediment increases, the Setting velocity of each particle decreases due to the modification of the flow induced by previous particles.

Particle Shape:- NoN- Spherical analogue particle fall up to

75% slower than equivalent sphere Model show 100 μm - non spherical particles travels 44% further than sphere vertical structure of modelled volcanic ash cloud is sensitive to particle shape.

Viscosity of water:- Fluid 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.

Turbulance of water:- Turbulance of water effect the full velocity of water in reservoir because the non-linearity & zig zag path effect the flow of water & cause the variation in the flow