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"Question no 1"

Solution:-

The Pressure drop ΔP is expected to depend upon the gate openning h, the overall depth d. the velocity v. density ρ and viscosity μ.

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 non-dimensional groups: $n-m=3$

Number of variables : $n=6$

number of independent dimension: $m(M,L,T)$

Choose m (=3) scaling variables:

From dimensionles groups by non-dimensionalising the remaining variables ΔP, h and μ.

$$\Pi_1 = \Delta P d^a v^b \rho^c$$

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

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

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

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

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

$$\Rightarrow \Pi_1 = \Delta P v^{-2} \rho^{-1} = \frac{\Delta P}{\rho v^2}$$

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

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

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

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

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 the Reynolds number suggests that we replace Π_3 by

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

Hence dimensional analysis yields

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

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

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

$$\Pi_1 = \left(\frac{\Delta P}{\rho v^2}\right)_p = \left(\frac{\Delta P}{\rho v^2}\right)_m$$

$$\Pi_2 = \left(\frac{h}{d}\right)_p = \left(\frac{h}{d}\right)_m$$

$$\Pi_3 = \left(\frac{\rho v d}{\mu}\right)_p = \left(\frac{\rho v d}{\mu}\right)_m$$

From the last we have a velocity ratio

$$\frac{V_p}{V_m} = \frac{(\mu/\rho)_p}{(\mu/\rho)_m} \frac{d_m}{d_p} = \frac{0.008/800}{1.0 \times 10^{-6}} \times \frac{1}{5} = 0.5$$

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

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

$$= 0.5 \times 5^2 = 12.5$$

(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

$$\Delta P_p = 0.2 \times \Delta P_m = 0.2 \times 60 = 12.0\ kPa.$$

"Question No 2"

Given data:-

Depth of water => $H = 78m$

Specific gravity => $G = 3$

Compressive strength => $S_{all} = 786\ T/m^2$

Height of wave => $H_w = 2m$

$\mu = 0.7$

No uplift pressure = $G_u = 0$

Given Requirement:-

Design of practicle profile of gravity dam.

Solution:-

$$H\ limiting = \frac{S_{all}}{\gamma_w(G - G_u + 1)}$$

$$= \frac{786 \times 1000}{(1000)(3 - 0 + 1)}$$

$$\boxed{H\ limiting = 196.5\ m}$$

⇒ Hence the dam is low gravity dam

(2) Top width (a):

Free board = 1.5 x Hw

Free board = 1.5 x 2

Free board = 3 m

Height of Dam = HD = H + F.B

HD = 78 + 3

HD = 81.

a = 14 % of HD

$a = \frac{14}{100} \times 81$

a = 11.34

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

(1) For no sliding criteria:-

$b' = \frac{H}{\mu \cdot G} = \frac{78}{0.7 \times 3}$

$b' = 37.142$ m

(ii) For no tension criteria

$$b' = \frac{H}{\sqrt{G}} = \frac{78}{\sqrt{3}}$$

$b' = 45.03$

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

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

$$h' = 2 \times (11.34)\sqrt{3 - 0}$$

$h' = 39.28$ m

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

$$= \frac{11.34}{16}$$

$= 0.70$

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

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

$= 3.14 \times 11.34 \sqrt{3}$

$= 61.67\ m$

(7) total width of the base of dam

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

$b = 45.03 + \frac{0.70}{16}$

$b = 45.07\ m$

(8) $\tan\theta = \frac{b'}{H} = \frac{45.03}{78}$

$\theta = \tan^{-1}\left(\frac{45.03}{78}\right)$

$\theta = 29.99'$

(9) Depth of verticle Portion on D/s (from WL on U/s side)

$\tan\theta = \frac{a}{d'} = \frac{11.34}{d'}$

$$\frac{45.03}{78} = \frac{11.34}{d'} \Rightarrow (d')(0.6324) = 11.34$$

$$d' = \frac{0.6324}{11.34}$$ ~~$d' = 0.055\,m$~~

$$d' = \frac{11.34}{0.6324}$$

$$d' = 17.931$$

Depth of verticle Portion

$$d = d' + F.B = 17.93 + 3$$

$$d = 20.93\ m$$

"Question No 3"

Concept of Dimensional analysis and Simititude:-

Back ground :-

Although many Practicle engineering Problem involving hydralic engineering can be solved by equation and Analyticle procedure. similitude is used to expressed measure in Laborating and can be use to describe the behavior of other system out side the laboratory.

Dimensional Analysis:-

Dimensional analysis is a ~~method~~ methematical techique making woe of stady of dimension.

Deal with dimension of physical quantity solved in the Phenomenon.

It is helpfull in experimental work because it provides a guide to those things that significantly influnce the phenomenon.

This mathematical techique is used in research work for designing and for conducting model test

Types of dimension:-

- Fundamental dimension / Quantities
- Secondry dimension

Derivation:-

$$P = E/t$$

$$P = F.v$$

$$P = V.I$$

$$P = \tau.\omega$$

$$ML^2T^{-3}$$

Electric resistant Dimensionary

$$\text{Electric resistant} = V/I$$

$$[R] = \frac{[V]}{[I]}$$

$$R = \frac{[L^2 M^1 T^3 I^{-1}]}{(I^1)}$$

$$R = [L^2 M^1 T^3 I^{-2}]$$

"Question No 4"

The following will be the effect of sediment on the fall velocity.

Particle Diameter:-

The Particle diameter or size of Particle have a significant effect on the fall velocity.

The larger particles will settle more quickly as compared to the particles having small size.

Particle Density:-

Those particles which have hight density will settle down more faster then those particles of low density. with same sizes, will settle slower.

=> when Pulp density is below 8.% Solids free settling behavior accors and settling is much faster then when Pulp density is high (Hindered sittling). These terms also apply the centrifugal classification in hydro cyclones and centrifuge.

Particle shape:-

Particle shape has a major effect on setting a sphere settles much faster than a cube of the same relative size and specific Gravity some particles are shaped like flakes - these settles much slower then a particle of some relative size and specific Gravity.

=> The greater the setting of a particle the greater will be the fall velocity.

viscousity of water:-

The water having high viscousity will offer more resistance to the particles to settle down and hence there will be less particles settled in more viscous water and hence the fall velocity will be low due to high viscousity of water

Particle concentration:-

when a suspended concentration of sediment increase, the settling velocity of each particle decreases due to the modification of the flow induced by pervious particles.

=> Hence particle concentration have direct relation with fall velocity.

Turbulance of water:-

At high turbulence intensity the relative settling velocities increases with the increasing relative turbulance intensity regardless of the stroke number. At the intermediate turbulance intensity. it seems that the settling bifurcate.