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Section " "A"

Subject " Hydraulic-engineering

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QNo # 01

Ans Solution:-

The pressure drop ΔP is expected to depend upon gate opening h, the overall depth d, the velocity V, density ρ and viscosity μ

List the relevent variables.

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

write down dimension

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

Number of variable $n=6$

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

Number of non-dimensional group: $n-m=3$

Choose m (=3) scaling variables:

geometric (d); Kinematic / time-dependent (V)

dynamic / mass-dependent (ρ)

2

from dimenssionless group by non-dimension ~~groups by non di~~ the remaining variable : Δp, h and M

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

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

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

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

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

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

$$\Rightarrow \pi_1 = \Delta p V^{-2} \rho^{-1} = \frac{\Delta p}{\rho V^2}$$

$\pi_2 = h/d$ (by Inspection, since h is length)

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

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

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

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

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

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

$\Rightarrow \pi_3 = M d^a V^b \rho^c$ (probably obvious

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

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

M; $0 = 1+c$ $\qquad c = -1$

T; $0 = -1-b+0$ $\qquad b = -1$

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 Reynold number ~~strength~~ suggests that we replace π_3 by

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

Hence, dimensional analysis yields

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

i.e.

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

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

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

$$\pi_2 = \left[\frac{h}{d}\right]_p = \left[\frac{h}{d}\right]_m \quad \text{(automatic}$$

(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

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

$$= 0.5$$

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.

$$\pi_1 = \left[\frac{\Delta p}{\rho V^2}\right]_p = \left[\frac{\Delta p}{\rho V^2}\right]_m \Rightarrow \frac{(\Delta p)_p}{(\Delta p)_m} =$$

(5)

$$\frac{\rho_p}{\rho_m}\left[\frac{V_p}{V_m}\right]^2 = \frac{800}{1000} \times 0.5^2 = 0.2$$

Hence :-

$$\Delta\rho_p = 0.2 \times \Delta\rho_m = 0.2 \times 60 = 12.0 \text{ kPa}$$

(c

Q No# ~~Q#~~ 02

Ans

Given data:-

Maximum depth $H_w = 78$

specific gravity of dam $G = 2.8$

compression stress $= 781\ T/m^2$

Height of wave $= 3.8\ m$

$C_u = 0$

(1) Limiting:-

$$\frac{\sigma_{all}}{\gamma_w (G - C_u + 1)}$$

$$= \frac{781 \times 1000}{1000(2.8 - 0 + 1)} = 205.5 > 78$$

So it is low gravity dam

(2) Top width "a":-

Free board $= 1.5 \times 3.8$

$= 5.7\ m$

Hight of dam $= H_D = H_w + F.B$

$= 78 + 5.7$

$H_D = 83.7\ m$

$a = 14\%$ of H_D

$a = 0.14 \times 83.7 = 11.718\ m$

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

For No sliding criteria

$$b = \frac{H_w}{\mu G} = \frac{78}{0.7 \times 2.8}$$

$= 39.79$ m $\approx$ 40m

Maximum depth $H_w = 78$

ii) For No tension criteria

$$b' = \frac{H_w}{\sqrt{G}} = \frac{78}{\sqrt{2.8}} = 47$$

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

$$h' = 2q\sqrt{G - CU}$$

$$= 2 \times 11.7 \sqrt{2.8 - 0}$$

$h' = 39.15$ m

(5) Up stream offset $= q/16$

$$= \frac{11.7}{16} = 0.73\text{m}$$

(6) depth below water level to end of Inclined portion in US =

$$US = 3.14\, q\sqrt{G}$$

$$= 3.14 \times 17.78 \sqrt{2.8}$$

(8)

$= 61.56\,m$

(7) Total width of base of dam

$$b = b' + a/16$$
$$= 47 + 11.7/16 = 47.7\,m$$

(8) $\tan\theta = \frac{b'}{H} = \frac{47}{78} = 31.07$

9) $\tan\theta = a/d' = 11.7/d'$, $\tan\theta = 11.7/d$

$47/78 \; d' = 11.7 = d' = \frac{11.7 \times 78}{47}$

~~$d' = 46m$~~ ~~depth of vertical portion~~

~~$d' = 1$[illegible]m~~ ~~$d - d' + FB =$ [illegible]~~

$$d' = 46m$$

depth of vertical portion

$$d - d' + FB = 46 + 6.3$$

$$d = 52.3m$$

QNo# 04

Particle diameter:-

The diameter of the the particle is directly proportional to the fall velocity because greater the size of particale so it will tends to move faster as compared to the partical of small size thus there will be more gravitational force on particle of greater size so it will fall quickly due to its weight

Particle density:-

density of the partical is directly proportion to the rate of fall velocity since partical ~~down~~ ~~early~~ with high density tends to settle down early compared with particle of density

Partical concentration:-

concentration of particall size will considerable effect its fall velocity as the section having greater concentration will be sattled down at the place thus causing the more fell velocity comparing with section of low concentration.

Partical shape:~

Particale having regular shap tends to the effected more then irrigular shape since regular shap. particles have been surface which offer very little or no friction while friction as the particle with smaller surface area are more likely to the effected due to their less resistance.

Viscosity of water:-

Fluid velocity through porous media is approximated as inversly perportional to the

Kinematic viscosity. A decrease in viscosity therefore increase the velocity of a compound throu porous media.

Turbulance of water:-

Turbulance 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

QNo# 03

Dimensional ANAYSIS

Dimensional analysis is a methemical technique making use of study of dimension. its deal with the dimension of physical quantities Involved in the phenomenon.

In dimensional analysis, one first predict the physical parameter that will influence the flow and then by grouping these ~~parag~~ ~~these~~ parameter ~~that~~ with in dimensionless combinations a better understanding of the flow phenomenon is made possible.

Type of dimensions

→ Fundamental dimension or Fundamental Quantities

→ Secondary Dimension or Derived Quantites

Fundamental dimension

These are basic Quantities

- Time, T   Time T
- Distance, L → Distance, L
- Mass, M   Force, F

(13)

Force = Mass x Acceleration = MLT^{-2}

Second dimensions :-

The are those quantities which posses more than one fundamental dimensions.

For example:

- Velocity denoted by distance per unit time L/T

Methodology of Dimensional Analysis

The basic principle is dimensional Homogenous which mean the dimensional of each term in an equation on both side are equal

Dimensional Homogenous Equation:

such equation are indepent of system of unit for example Lets consider the equation

$$V = (2gH)^{1/2}$$

- Dimension of LHS = $V = L/T = LT^{-1}$

(14)

- Dimensions of LHS = $V = L/T = LT^{-1}$
- Dimension of RHS = $(2gH)^{1/2} = L/T$

Similitude Analysis:-

~~It is defined as simil~~

Is a concep used In testing of engieering Models.

Usually it is impossible to obtain a pure theortical solution of hydraulic phenomenon.

The for expermental Investiagtion are often performed on small Scale models, called Modal analysis.

A few example where modal may be used are ship in towing basin, air planes in wind torben. etc and to study such phenomenon as the action of wave.

of wave and tides on beaches ; Soil erosions and transportation of sediment etc