Mulhaar ID# 7789
Section:- A
Date:- 25th June, 2020
Semester:- 6th.

Question No:- 1

Given Data:-

paraffin in prototype = 3 m/s.
pressure ~~d~~ = 60 KPa.
density = 800 kg/m³
viscosity paraffin = $0.002\ kg\ m^{-1} s^{-1}$
kinematic viscosity = $1 \times 10^{-6}\ m^2/sec$.

Solution:-

Variables	dimension
μ	$ML^{-1}T^{-1}$
ΔP	$ML^{-1}T^{-2}$
d	L
h	L
V	LT^{-1}
ρ	ML^{-3}

=> No. of variables = 6
=> No. of independent dimensions m = 3 (M, L & T)
=> No. of non-dimensional groups, n - m = 3.

Now we have to select $m = 3$ (2) <u>7789</u>
(scaling variables).

We select = d, V, ρ

Unselected remaining variables = $\Delta p, h$ & μ

So;

$$\pi_{(1)} = \Delta p \, d^{a} V^{b} \rho^{c}$$

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

$\therefore \Delta p = ML^{-1}T^{-2}$

$d = L$

$V = LT^{-1}$

$\rho = ML^{-3}$

↳ $M^0 L^0 T^0 = M^{1+c} L^{-1+a+b-3c} T^{-2-b}$

For $M \Rightarrow 0 = 1 + c \Rightarrow \boxed{c = -1}$

$T \Rightarrow 0 = -2 - b \Rightarrow \boxed{b = -2}$

$L \Rightarrow 0 = -1 + a + b - 3c \Rightarrow \boxed{a = 1 + 3c - b}$

↳ $\pi_{(1)} = \Delta p V^{-2} \rho^{-1} = \dfrac{\Delta p}{\rho V^2}$

$$\boxed{\pi_{(1)} = \frac{\Delta p}{\rho V^2}}$$

We now take;

↳ $\pi_2 = \dfrac{h}{d}$ (over here we will take the length as "h").

For

↳ $\pi_3 = \mu \times d^{a} V^{b} \rho^{c}$

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

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

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

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

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

So value of π_3 will be.

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

$\pi_3 = \dfrac{\mu}{\rho V d}$

$(\pi_3)^{-1} = \dfrac{\rho V d}{\mu}$ (For reynold's number).

we can also write it as.

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

So, this gives the analysis as;

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

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

Since values of $\pi_2 = \dfrac{h}{d}$ & $\pi_3' = \dfrac{\rho V d}{\mu}$. so we have put the values.

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

$\pi_2 = \left[\frac{h}{d}\right]_p = \left[\frac{h}{d}\right]_m$

$\pi_3' = \left[\frac{\rho V d}{\mu}\right]_p = \left[\frac{\rho V d}{\mu}\right]_m$.

These are "geometric similarities".

↳ From the velocity ratio.

$$\frac{V_p}{V_m} = \frac{(\mu/\rho)_p}{(\mu/\rho)_m} \times \frac{d_m}{d_p}$$

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

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

So therefore; by cross multiplication.

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

$$V_m = \frac{3}{0.5}$$

$$\boxed{V_m = 6 m/sec}$$

Now

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

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

$$\boxed{\frac{Q_p}{Q_m} = 12.5}$$ → "Ratio of flow quantities"

Now we find the pressure drop;

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

$$\frac{(\Delta p)_p}{(\Delta p)_m} = \frac{\rho_p}{\rho_m}\left(\frac{V_p}{V_m}\right)^2$$

$$\Rightarrow \frac{800}{1000} \times 0.5^2 = \boxed{0.2}$$

$$\Delta p_p = 0.2 \times \Delta p_m$$

$$= 0.2 \times 60$$

$$\boxed{\Delta p_p = 12\ kPa}$$ Answer.

Question No:- 2

Given Data:-

⇒ Maximum depth of water in reservoir = $H_w = 77m$

⇒ Specific gravity of dam material is $G = 2.6$

⇒ Allowable compressive strength for the dam masonary is = $778 \frac{T}{m^2}$.

Height of wave $H_{wave} = 1.3m$.

μ = ~~0.6~~ 0.7

No uplift pressure $C_u = 0$.

Solution:-

① $$H_{limiting} = \frac{\sigma_{all}}{\gamma_w(G - C_u + 1)} = \frac{778 \times 1000}{1000(2.6 - 0 + 1)}$$

$$H_{limiting} = 216.11 > H_w = 77m.$$

so, its a low gravity dam

② Top width "a"

Free board = $1.5\, h_{wave} = 1.5 \times 1.3$

$$\boxed{F.B = 1.95m}$$

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

$= 77m + 1.95$

$$\boxed{H_D = 78.95m}$$

$a = 14\%$ of HD

$a = 0.14 \times 78.95$

$a = 11.05m$

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

i) For No sliding Criterria

$$b' = \frac{Hw}{\mu G} = \frac{77}{[0.7 \times 2.6]}$$

$b' = 42m$

ii) For No Tension Zone Criteria :-

$$b' = \frac{Hw}{\sqrt{G}} = \frac{77}{\sqrt{2.6}}$$

$b' = 48m$

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

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

$h' = 2(11.05)\sqrt{2.6 - 0}$

$h' = 35.63m$

$h' = 36m$

⑤ Upstream off set

$$\Rightarrow \frac{a}{16}$$

$$= \frac{11.05}{16}$$

$$= \boxed{0.69m.}$$

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

$$\Rightarrow 3.14 \times 11.05 \sqrt{2.6}$$

$$= 55.9$$

$$\boxed{= 56m}$$

⑦ total width of base of dam.

$$b = b' + \frac{a}{16} = 48 + \frac{11.05}{16}$$

[illegible] $\boxed{b = 48.69m}$

[illegible]

⑧ $\tan \theta = \frac{b'}{H} = \frac{48}{77} = 0.62$

$$\theta = \tan^{-1}(0.62)$$

$$\boxed{\theta = 31.79^\circ}$$

(9) Depth of vertical portion on D/s (9)

$$\tan\theta = \frac{a}{d'} = \frac{11.05}{d'}$$

$$\tan\theta = \frac{11.05}{d'}$$

$$0.62 = \frac{11.05}{d'}$$

$$d' = \frac{11.05}{0.62}$$

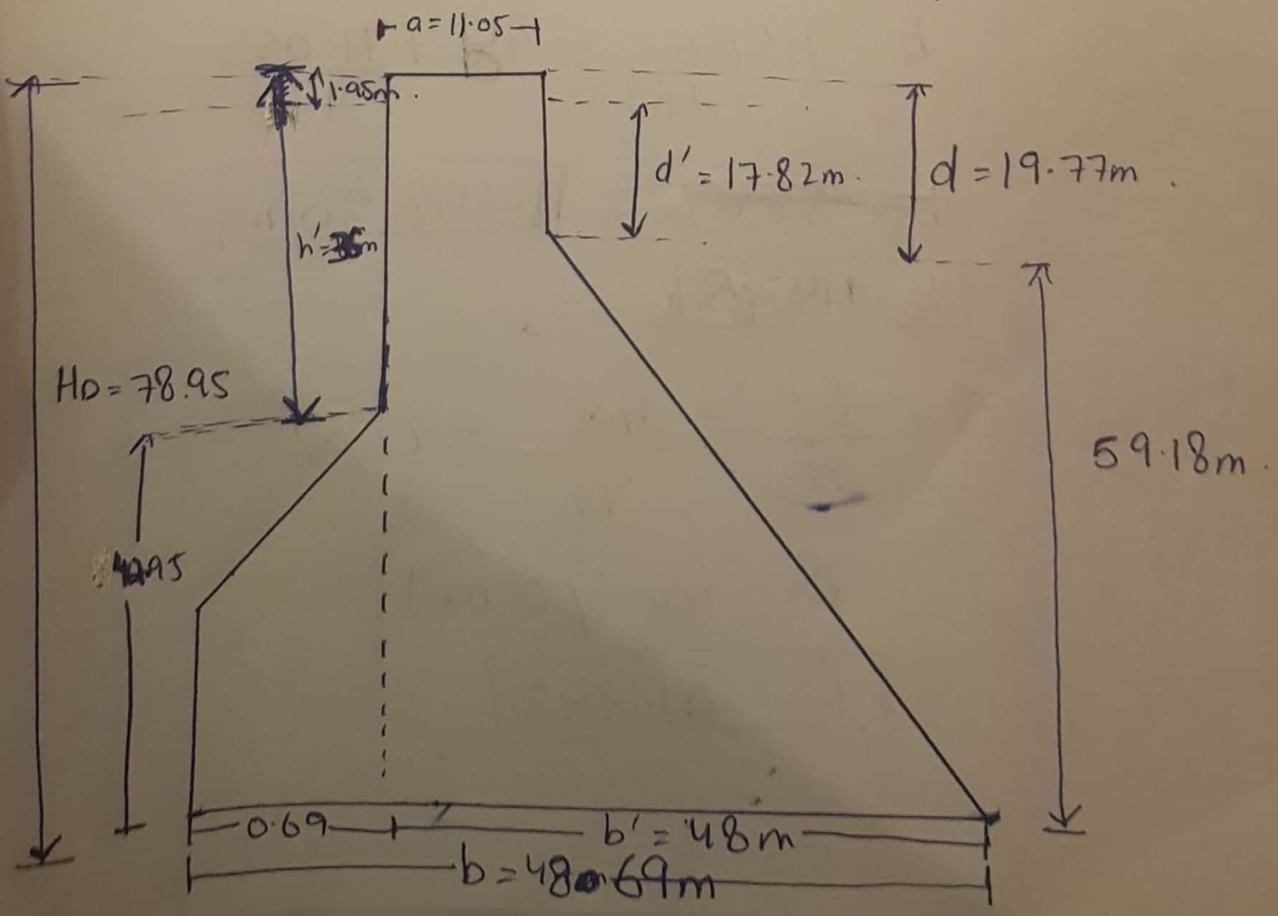
$$\boxed{d' = 17.82\text{m}}$$

Depth of vertical portion.

$$d = d' + FB$$

$$d = 17.82 + 1.95$$

$$\boxed{d = 19.77\text{m}}$$



Question No:- 3

Hydraulic Model :-

I have selected hydraulic bench as the hydraulic model.

Q = mass flow rate (kg/sec)
ρ = density of fluid (kg/m3)
v = velocity of fluid (m/sec)
A = Area (vertical) in which flow goes on (m²)

These are the parameters that we use to calculate the flow rate of water

Now if we want to calculate the volume of water present in the ~~t~~ measuring tank of hydraulic bench we will take in use of the dimensions.

Volume = Length x Breadth x height.

Question #4:-

Effects on Fall velocity:-

ANS:- **Fall Velocity:-** When a grain falls in water it starts to move with a velocity which is constant, at the same time we get the upward fluid drag force equal to the downward submerged weight of grain.

upward fluid drag = downward submerged weight.

1) **Turbulence:-** The particles move in an irregular path which causes a zig-zag ~~flow~~ movement of the particle in water as a result of which variation is caused in the flow.

2) **Viscosity of Water:-**

Since Fluid velocity $\propto \frac{1}{\text{kinematic viscosity}}$

This is a phenomenon occuring in pourous media. So, a decrease in viscosity increases velocity of compound through porous media.

3) **Particle Density:-** Particles that posess high velocity, they settle down early. So, we can say particle density effects the settling ~~of~~ fall velocity

4) Particle Diameter:-

Greater size particles tend to move faster than the smaller sized ones and due to gravitational force on particle of greater size so they will fall quickly due to its weight.

5) Particle Concentration:-

Increase in suspended concentration of sediment, a decrease in the settling velocity of each particle occurs because of modification of flow that had been induced due to the previous particles.

6) Particle Shape:-

Particles are of 2 types in terms of shape

- regular shape
- irregular shape.

The even surfaces of regular shape particles offer even to no friction whereas irregular particles offer friction even more.

The non-spherical particles fall 75% slower than sphere particles