Name :- Abdur-Rahman Khan

ID :- 7826

Sec :- A

Subject :- Hydralic Engineering

Submitted to :- Engr Fawad Ahmad

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Final Term Exam

Q1) A Prototype gate value which will control the flow in a pipe system conveying paraffin is to be studied in a model. List the significant on which the pressure drop across the value would depend - Perform dimentional analysis to obtain the relvant non dimentional group. (7826) (1)

A 1/5 scale model is built to determine the pressure drop across the value with water as the working fluid.

a) For a particular opening when .... dynamic similarity.
b) What is the ..... and model?
c) Find the ..... model?

Sol:- The Pressure drop ΔP is expited to depend upon the gate opening h, the overall depth d, the velocity V, density ρ & viscosity μ.

→ list the relevent variable.

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

Dimension.

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

Number of variable = $n = 6$

Number of Indypendant dimension $m = 3$ (M, L & T)

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

→ Choose m (=3) Scaling variable: geomatric (d); kinematic /time-dependent (V); dynamic /mass-dependant (P)

Form dimensionless group by non-dimensionalising the remaining variable : $\Delta P, h$ & μ.

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

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

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

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

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

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

$\rightarrow \quad \Pi_1 = \Delta P V^{-2} \rho^{-1} = \frac{\Delta P}{\rho V^2}$

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

$\Pi_3 = \mu d^a V^b \rho^c$

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

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

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

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

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

$\Rightarrow \quad \Pi_3 = \mu d^{-1} V^{-1} \rho^{-1} = \frac{\mu}{\rho V d}$

Recognition of the Reynold number suggest that we replace Π_3 by $\Pi_3' = (\Pi_3)^{-1} = \frac{\rho V d}{\mu}$

Hence dimensional Analysis yield.

i.e $\Pi_1 = f(\Pi_2, \Pi_3')$

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

a) Dynamic similarity requires that all non-dimensional group to be the same in model and prototype

i-e

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

$$\Pi_2 \left[\frac{h}{d}\right]_n = \left(\frac{h}{d}\right)_m$$ (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

$$\frac{V_p}{V_m} = \frac{(\mu/\rho)_p}{(\mu/\rho)_m} \frac{d_m}{d_p} = \frac{0.002/800}{1.0 \times 10^{-6}} \frac{\times 1}{5} = 0.5$$

Thus; $V_m = \frac{V_p}{0.5} = \frac{3.0}{0.5} = 6 m/s$

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,

$$\pi_1 = \left[\frac{\Delta P}{\rho V^2}\right]_p = \left[\frac{\Delta P}{\rho V^2}\right]_m \Rightarrow \frac{(\Delta P)_p}{(\Delta P)_m} = \frac{\rho_p}{\rho_m}\left[\frac{V_p}{V_m}\right]^2$$

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

Hense $VP_p = 0.2 \times \Delta P_m = 0.2 \times 60 = 12.0 \text{ kPa}$.

Q2) Design a Practical Profile of gravity dam with following data.

1) Maximum depth ..... (Your First two digits of R)
2) Specfic gravity ..... (Can be of you own choice)
3) Allowable Compressive .... (your first three digit of R T/m²)
4) Height of wave ..... (Can be of your own choice)
5) G & Hw of your ..... one another.

Sol:- : T= 782 ;:- $G_1 = 2.4$, $C_u = 0$

1) Limiting $= \frac{\sigma_{all}}{\gamma_w (G - C_u + 1)} = \frac{120 \times 782 \times 1000}{1000(2.4 - 0 + 1)} = 27600 \text{ m}$

let $H_w = 26000m$

Thus $27600 > H_w = 26000$.

So it is low gravity dam.

2) Top width "a" =

Free board $= 1.5\, h_{wave} = \frac{1.5 \times 26000}{}$

$\boxed{F.B = 39000\ m}$

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

$= H_D = 26000 + 39000$

$\boxed{H_D = 65000m}$

$a = 14\%$ of H_D

$= 0.14 \times 65000$

$\boxed{a = 9100}$

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

i) For no Sliding Criteria

$$b' = \frac{H_w}{\mu G} = \frac{26000}{0.7 \times 2.4} = 15476.19$$

$\boxed{b' = 15476m}$

3) For non tension criteria:

$$b' = \frac{Hw}{\sqrt{G}} = \frac{26000}{\sqrt{2.4}} = 16782.92$$

$$b' \approx 16783 m$$

4) Depth of vertical portion on u/s side:

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

$$h' = 2 \times 9100\sqrt{2.4-0}$$

$$h' = 28195.31$$

$$h' = 28195 m$$

5) upstream offset:-

$$\frac{a}{16} = \frac{9100}{16} = 568.75 m$$

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

$$= 3.14(9100)\sqrt{2.4}$$

$$= 44266.65 m$$

7) Total width of the base of the dam:

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

$$= 16783 + \frac{9100}{16}$$

$$\boxed{b \Rightarrow 17351.75\ m}$$

8) $\tan\alpha = \frac{b'}{H} = \frac{16783}{26000} \Rightarrow$

$$\alpha = \tan^{-1}\left(\frac{16783}{26000}\right)$$

$$\boxed{\alpha = 32.84^\circ}$$

9) Depth of vertical portion on D/s

$$\tan\alpha = \frac{a}{d'} = \frac{9100}{d'}$$

$$\left(\frac{16783}{26000}\right) d' = 9100$$

$$d' = \frac{9100 \times 26000}{16783} = \boxed{14097.59\ m}$$

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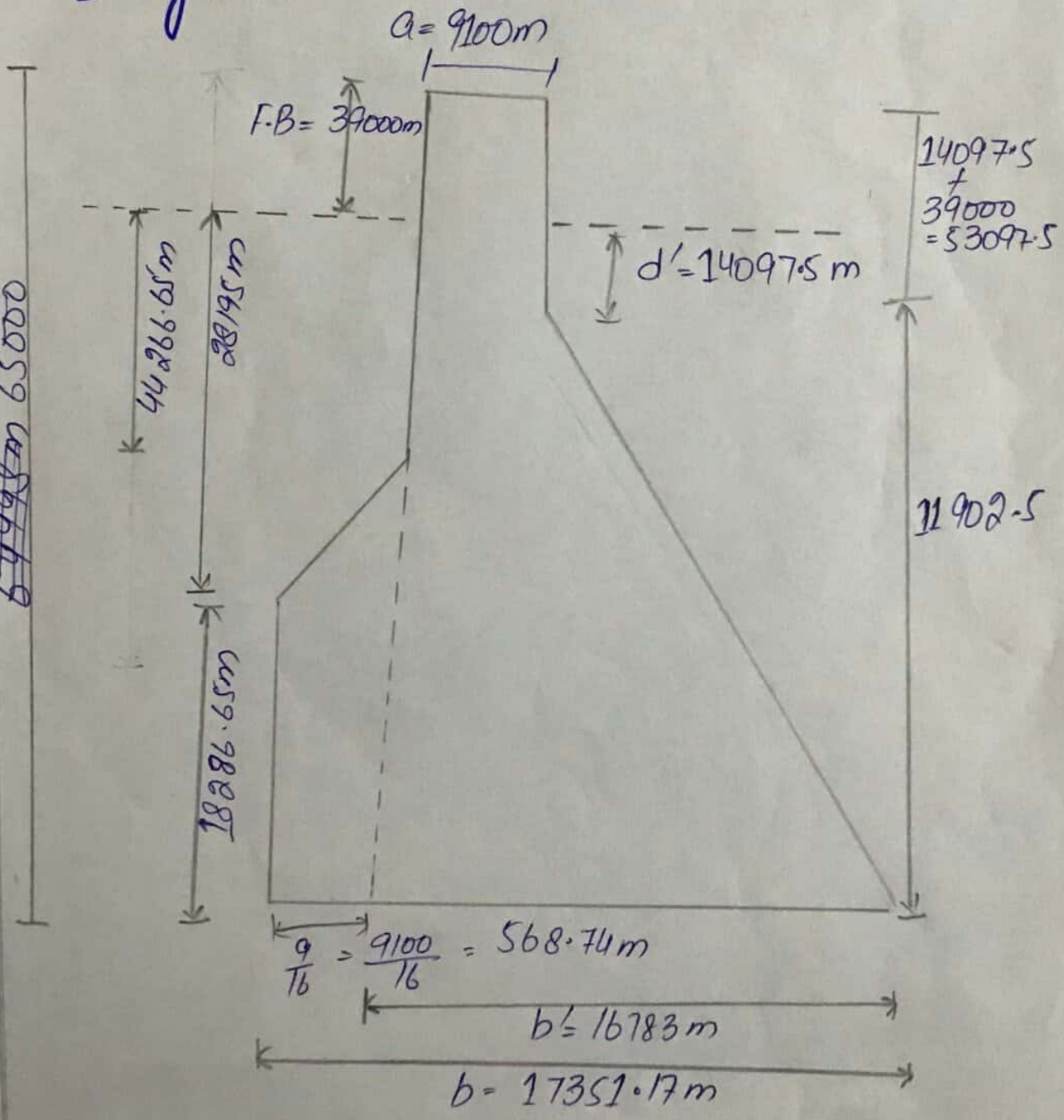
depth of vertical portion

$d = d' + F.B$

$= 14097.59 + 39000$

$d = 53097.59\,m$

Diagrom:-



Q3) Using any hydraulic model & explain the concept of Dimensional analysis & Similitude - Each student should have seperate model analysis.

Ans: Dimension analysis is a ~~is a~~ mathematical technique making use of study of dimension.

→ "Purpose of dimensim analysis:-"

- To obtain scaling laws so that prototype performance can be predicted from model performance.
- To predict in the relationship between parameter.
- To generate non dimensional parameter that help in the design of experiment and in reporting of results.

→ "Fundamental dimensim:-"

There are the basic quantities.
For example
Time, T ; Distance, L ; Mass, M

→ "Secondary Dimensim:-"

Those quantity which posses more then one fundamental dimensim
Velocity, L/T ; Acceleration, L/T²
Density, M/L^3

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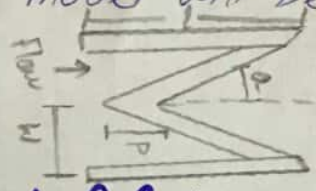
"Similitude:-" It is defined as similarity b/w the model and prototype in every respect which mean model and prototype have similar properties or model and prototype are completely similar.

- It is used in testing ~~energ~~ engineering model.

Example:- Consider a submarine modeled at 1/40th scale - The application operate in sea water at 0.5°C moving at 5m/s. The model will be tested in fresh water at 20°C



Q4) What will be the effect of Sediment particle dia, particle concentration, particle shape, viscosity of water, Turbulence of water flowing in reservoir on fall velocity? Explain in detail

Ans: "Particle diameter:-" The diameter of the particle is directly proportional to the fall velocity because greater the size of particle so it will 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.

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2) "Particle Density:-" Density of the particle is directly proportional to the rate of fall velocity since particle with high density tends to settle down early compared with particle of low density.

3) "Particle Concentration:-" Consentration of particle size will considerably effect its fall velocity as the section having greater Concentration will be settled down at the place thus causing more fall velocity comparing with section of low Concentration.

4) "Particle Shape:-" Particles having regular shapes tends to be effected more then irregular shapes since regular shapes particles have even surfaces which offers very little or no friction while particles with irregular shape offers more friction, as the particle with smaller surface area are more likely to be effected due to their less resistance.

5) "Viscosity of water:-"

From the experimental study we can see that parameter such as temperature and pressure changes the magnitude of viscosity so the section of water having more temperature and pressure will fall objectively more due to increase in the kinectic energy. So fall velocity will be more-

6) "Turbulence of water:-"

Turbulance of water depends upon the different factors such as velocity. It will effect the fall velocity because of its zigzag motion thus the velocity varies at every point which is why it effect the fall velocity. moreover increase in the kinectic energy tends to effect the fall velocity compared with steady fluid.

The END