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Sec :- A

Subject :- Hydraulic Engineering

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Solution:-

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

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

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

Choose $m(=3)$ scaling variables

geometric (d); kinematic/time-dependent (V); dynamic/mass (ρ)

From dimensionless groups by non-dimensionals the remaing variables Δp, h and μ.

$$\Pi_1 = \Delta p d V^b \rho^c$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Recognition of the Reynolds number suggest 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; i-e

$\Pi_1 = \left[\frac{\Delta p}{\rho V^2}\right]_p = \left[\frac{\Delta p}{\rho V^2}\right]$

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

$$\Pi_3 = \left[\frac{\rho V d}{\mu}\right]_1 = \left[\frac{\rho V d}{\mu}\right]_{111}$$

From the last, we have velocity ratio

$$\frac{V_p}{V_m} = \frac{(\mu/\rho)\, d_m}{(\mu/\rho)_= d_p} = \frac{0.002/800}{1.0\times10^{-6}} \times \frac{1}{5} = 0.5$$

Hence,

$$V_m = \frac{V_p}{0.5} = \frac{30}{0.5} = 6.0\,ms^{-1}$$

(b) The ratio of the quantities of flow is

$$\frac{Q_p}{Q} = \frac{(\text{velocity} \times \text{area})_p}{(\text{velocity} \times \text{area})_m} = \frac{V_p}{V_m}\left(\frac{d_p}{d_m}\right)^2 = 0.5\times5^2 = 12.5$$

(c) Finally, for the pressure drop

$$\Pi_2 = \left[\frac{\Delta p}{\rho V^2}\right]_p = \left[\frac{\Delta p}{\rho V^2}\right] \Rightarrow \frac{(\Delta p)_p}{(\Delta p)_m} = \frac{\rho_p}{\rho_m}\left[\frac{V_p}{V_m}\right]^2 = \frac{800}{1000}\times 0.5^2$$

$$= 0.2$$

Hence,

$$\Delta P = 0.2\times\Delta p_m = 0.2\times60 = 12.0\,kPa$$

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Given Data

Max depth = 78m

Specific Gravity = 2.4

Gav = 781 t/m²

Height of wave = 1.2m

Solution:-

$$H_{limiting} = \frac{G_{av}}{r_w(G_{\cdot w}+1)}$$

$$= \frac{781 \times 1000}{1000(2.4+1)} = 229.7$$

Top width 'a'

Free board = 1.5 × h wave

= 1.5 × 1.2

= 1.8m

Height of Dam = Hw + F.B

78 + 1.8

HD = 79.8

a = 14% of HD

= 0.14 × 79.8

Base width

$$b' = \frac{H_w}{\mu G} = \frac{78}{0.7 \times 2.4}$$

= 46.42m

= 47m

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For no tension Criteria

$$b' = \frac{H_w}{\sqrt{G}} = \frac{78}{\sqrt{2.4}}$$

$= 50.34$

Depth of vertical Portion on U/s side

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

$= 2 \times 11.17\sqrt{2.4-0}$

$= 34.60$

$= 35m$

upstream off set $= \frac{a}{16} = \frac{11.17}{16}$

$= 0.6$

Depth below the water level in the end of inclined Portion U/s

$= 3.14a\sqrt{G}$

$= 3.14 \times 11.17\sqrt{2.4}$

$= 54.33$

Total width of the Base of the dam

$$b = b' + \frac{a}{16} = 50.34 + \frac{11.17}{16}$$

$= 51.03$

$$\tan\theta = \frac{b'}{h} = \frac{50.34}{78}$$

$\theta = \tan^{-1}(0.64)$

$= 44.80''$

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

$\tan\theta = \frac{a}{d'} = \frac{11.17}{d}$

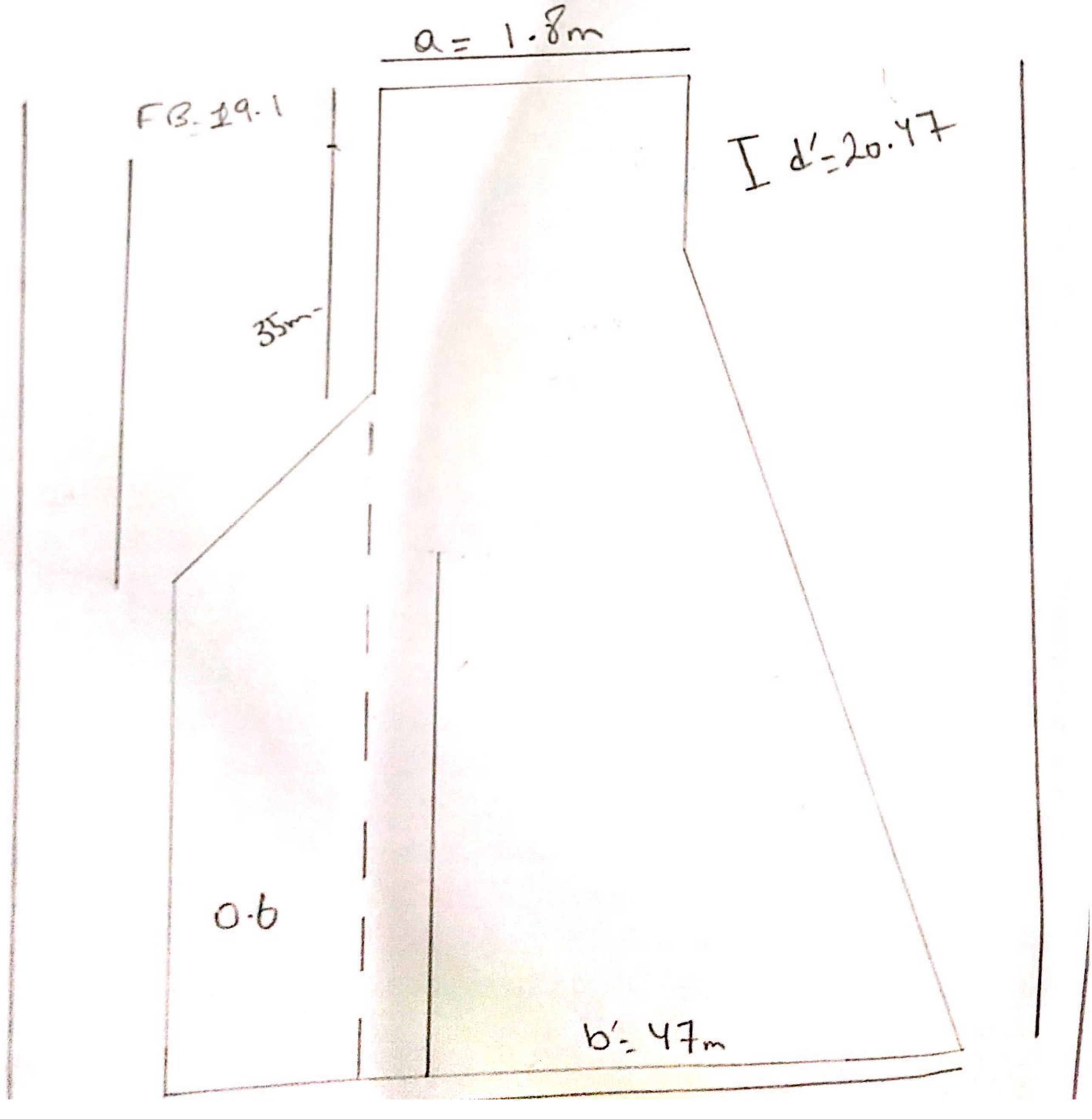
$d' = 17.30m$

Depth of vertical Portion

$d = d' + F.B$

$= 17.30 + 1.3$

$= 19.1$



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Ans

Dimensional Analysis and Hydraulic Similitude Introduction

Dimensional analysis refers to the investigation of connections between various physical amounts by distinguishing their major measurements (For example lenght, mass, time and electric charge.) and units of measure. Tracking these measurements as estimation or correlations are also performed in dimensional analysis.

For example, write the dimensional Formula for the velocity.

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

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

$$= LT^{-1}$$

$$= M^{0}LT^{-1}$$

The distance is d and time is T

The value of $M^{0} = 1$

Similitude is a concept of estimating the behavior of a prototype from model measurements. It is generally used to test engineering models.

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Hydraulic Model:-

Closed-loop Hydraulic Actuator Model For real Time simulation:-

The actuator consists of a proportional 4-way directional valve driving a double-acting hydraulic cylinder. The cylinder driveas a load consisting of a mass, viscous and coulomb friction constant Force, and a spring. The actuator is powered by a variable-displacement, pressure compensated pump, driven by a constant velocity motor. Pipelines between the valve, cylinder, pump and the tank are simulated with the Hydraulic Pipelines blocks.

Abstract variants of the hydraulic cylinder and of the valve and pump unit are also included in the model. The model be configured to use these abstract variants.

The model can also be configured For simulation with a fixed-step solver, as would used in hardware in the loop testing.

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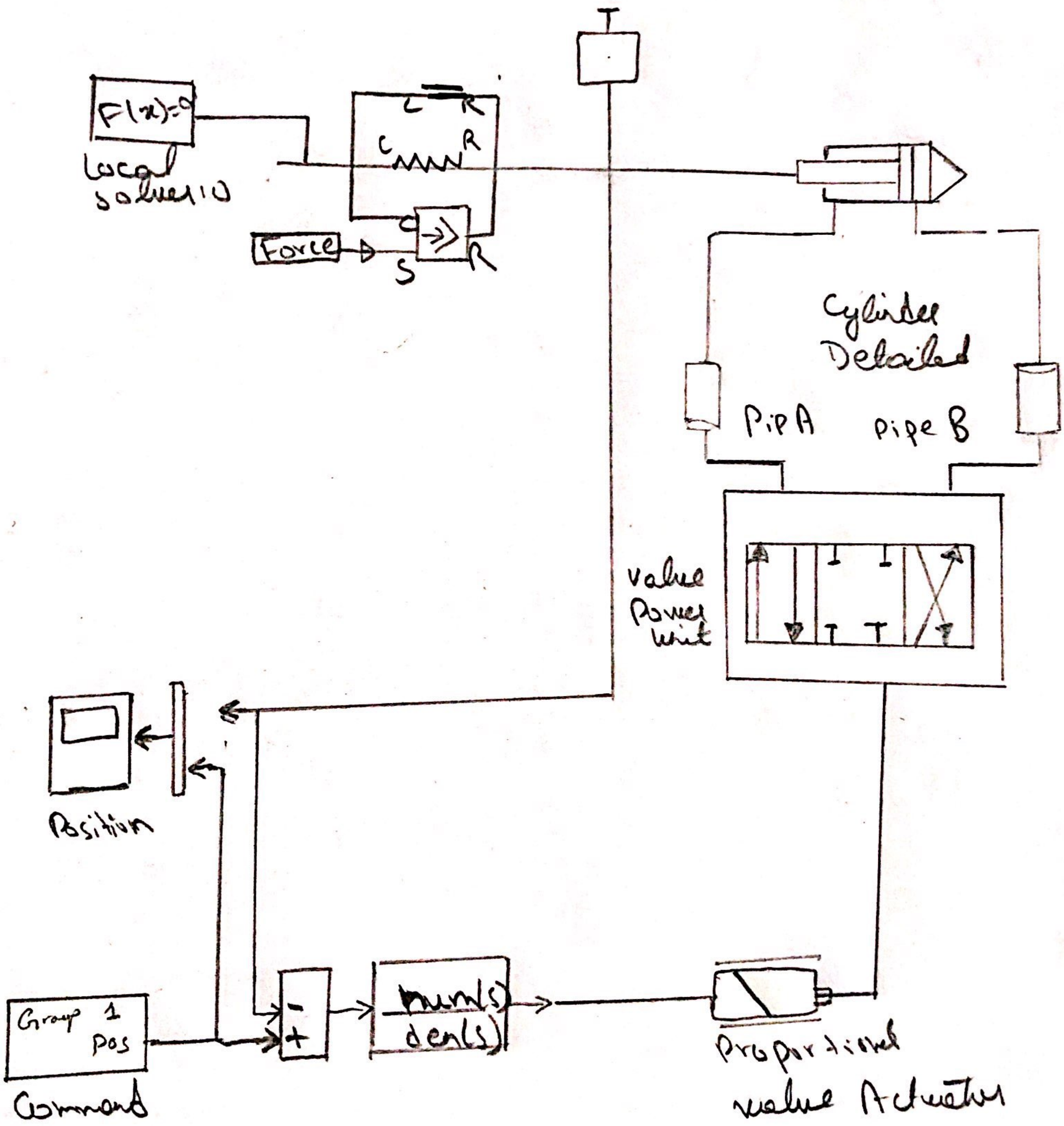
(Model)



F(x)=0
Local solver10
C
R
Force
S
Cylinder Detailed
PipA
pipe B
valve Power unit
Position
Group 1 Pos
Command
num(s)
den(s)
Proportional valve Actuator

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Fall velocity.

When a grain Falls down in still water it obtains a constant velocity when the upward Fluid drag Force on the grain is equal to the downward submerged weight of the grain.

The constant velocity is defined as the Fall velocity of the grain

Fall velocity depends on

- Particle diameter
- Particle density
- Particle concentration
- Particle shape
- Viscosity of water
- Turbulance

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 more Faster as compared to the particles of small size thus there will more gravitational Force on particle of greater size so it will Fall quickly due to its weight

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- Particle Density:-

Density of the particle is directly proportional to the rate of the fall velocity since particle with high density tends to settle down early compared with particles of low density.

- Particle concentration:-

Concentration 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 low concentration

- Particle shape:-

Particles having regular shapes tends to be effected more then irregular shapes since regular shapes particles have even surfaces which offer very little or no friction while particles with irregular shape. offers more frictions as particle with smaller surface area are more likely to be effected due to their less resistance.

- Viscosity of water:

From the experiment 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 kinetic energy so fall velocity will be more.

- Turbulance of water:

Turbulance of water effects the fall velocity of water in reservior because the non-linearity & zigzag path effect the flow of water & cause the variation in the flow.

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