FINAL TERM EXAMINATION

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SECTION "B"

DEPARIMENT BE(CIVIL)

SUBJECT FLUID MECHANICS I

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QUESTION NO 01 (a)

Define total energy head and various forms of energy head with mathematical equation?

TOTAL ENERGY HEAD :~

DEFINITION :~

The sum of all energy heads at a point in a fluid is called as Total Energy head.

FORMS OF ENERGY HEAD :~

Following are the forms of Energy head.

- Kinetic head
- Potential head
- Pressure head.

i) KINETIC HEAD :~

The kinetic energy per unit weight of the fluid is known as Kinetic head.

$$K.H = \frac{K.E}{W}$$

MATHEMATICALLY :~

As we know that from the equation of Kinetic Head.

$$\frac{K.E}{W} = \frac{\frac{1}{2} mv^2}{mg}$$

$$\frac{K.E}{W} = \frac{1}{2} \frac{v^2}{g}$$

This is also known as velocity Head.

UNIT :-

The unit of Kinetic Head is meter. (m).

ii) POTENTIAL HEAD :~

The potential energy per unit weight of the fluid is called as Potential Head.

$$\text{Potential Head} = \frac{P.E}{W}$$

MATHEMATICALLY :~

As from the above equation.

$$\frac{P.E}{W} = \frac{mgh}{mg} = h$$

iii) PRESSURE HEAD :-

The vertical height of free surface above any point in a liquid at rest is pressure head

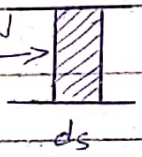
OR

The level of fluid due to pressure exerted by fluid.

MATHEMATICALLY :-

As from the above theory.

$$\frac{\text{Work}}{W} = \frac{F.ds}{W}$$



$$= \frac{P.A\,ds}{W}$$

$$= \frac{PV}{W} \Rightarrow \frac{P}{\gamma} \text{ is pressure}$$

QUESTION NO 01 (b)

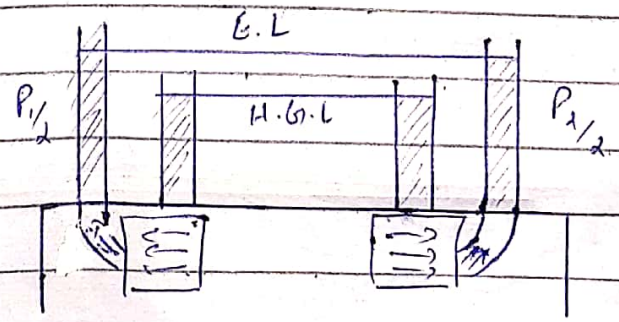
Define Hydraulic line, Energy line and hydraulic radius?

HYDRAULIC GRADE LINE :-

It is line showing the pressure head and potential head at a point in fluid. The term $\frac{P}{\gamma} + z$ is static head or piezometer head because it represent the level to which liquid will rise in piezometer tube. The HGL is line drawn through top of piezometer columns.

The line showing total head of fluid at any point is Energy line.

The line joining level of pitot tube is energy line



ENERGY GRADE LINE :-

A line that represent elevation of energy head of water flowing in a pipe, conduit or channel. The line is drawn above the hydraulic grade line a distance equal to the velocity head $(V^2/2g)$ of the water flowing at each section or point along the pipe or channel. Also see hydraulic grade line.

HYDRAULIC RADIUS :-

The ratio of the cross sectional area of a channel or pipe in which a fluid is flowing to the wetted perimeter of the conduit.

$$\text{Hydraulic radius} = \frac{\text{Cross-sectional area}}{\text{Wetted perimeter}}$$

QUESTION No 2 (a)

Calculate the total energy ---
..... the datum is 5 m?

TO FIND :-

Total energy = H = ?

GIVEN DATA :-

Velocity = V = 2 m/s

pressure = P = 300 Kpa

datum = z = 5 m

$\gamma = \rho g = 1000 \times 9.81 \Rightarrow 9810\ N/m^3$

SOLUTION

As we know that

H = pressure head + Kinetic head + P.H

$$H = \frac{P}{\gamma} + \frac{V^2}{2g} + z$$

putting values in above equation

$$H = \frac{300 \times 10^3}{9810} + \frac{2^2}{2 \times 9.81} + 5$$

$$H = 35.78\ J/N$$

HENCE :

The total energy = H = 35.78 J/N

QUESTION NO 2 (b)

A tapering pipe is having .....
..... head loss is negligible?

TO FIND :-

Datum = z = ?

GIVEN THAT :-

Diameter = d_1 = 300 mm = 0.3 m

Diameter = d_2 = 200 mm = 0.2 m

Pressure = P_1 = 300 KPa = 300×10^3 N/m²

$\Rightarrow P_2$ = 120 KPa = 120×10^3 N/m²

$Q = \frac{40}{1000}$ m³/sec $\Rightarrow$ 0.04 m³/sec

SOLUTION :-

As we know that

$$A_1 = \frac{\pi d_1^2}{4}$$

$$= \frac{3.14 \times (0.3)^2}{4}$$

$$A_1 = 0.07065 \text{ m}^2$$

$$A_2 = \frac{\pi d_2^2}{4}$$

$$A_2 = \frac{3.14 \times (0.2)^2}{4}$$

$$A_2 = 0.0314 \text{ m}^2$$

Now, As we know that

$Q_1 = V_1 A_1$

$V_1 = \frac{Q_1}{A_1}$

$= \frac{0.04}{0.0706}$

$V_1 = 0.5661 \text{ m/s}$

And

$V_2 = \frac{Q}{A_2}$

$= \frac{0.04}{0.0314}$

$V_2 = 1.2738 \text{ m/s}$

Now,

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

where $z_1 = 0$

$\gamma = 9810$

$$\frac{300 \times 10^3}{9810} + \frac{0.566^2}{2(9.81)} + 0 = \frac{120 \times 10^3}{9810} + \frac{1.27^2}{2(9.81)} + z_2$$

$30.59 = 12.314 + z_2$

$30.59 - 12.314 = z_2$

$z_2 = 18.276 \text{ m}$

HENICE

Datum = $z = 18.276 \text{ m}$

QUESTION No 03

A 500 m long 0.2m ---
--- ---where R is reynolds number?

TO FIND :-

Pressure Loss = ΔP = ?

GIVEN DATA :-

Length of Pipe = L = 500 m
diameter = d = 0.2 m
Specific gravity of oil = 0.9
flow rate Q = 0.06 m^3/s
Viscosity = μ = 6×10^{-5} $N.s/m^2$

SOLUTION :-

As we know that

$$\nu = \frac{\mu}{\rho}$$

$$= \frac{6 \times 10^{-5}}{900} \quad \therefore \rho = \text{density of oil}$$

$$\nu = 6.67 \times 10^{-8} \ m^2/s$$

And

$$V = \frac{Q}{A} \qquad \text{where } A = \frac{\pi}{4} d^2$$

$$= \frac{0.06}{0.0314} \qquad = \frac{\pi}{4}(0.2)^2$$

$$\therefore A = 0.031 \ m^2$$

$$\boxed{V = 1.91 \text{ m/s}}$$

Now

$$R = \frac{V \alpha d}{\gamma}$$

$$= \frac{1.91 \times 0.2}{6.67 \times 10^{-8}}$$

$$\boxed{R = 5.72 \times 10^{6}}$$

Now, As we know that

$$f = 0.0032 + \frac{0.221}{(5.72\ 10^{6})^{(0.237)}}$$

$$f = 0.032 + (5.5320 \times 10^{-3})$$

$$\boxed{f = 8.73209 \times 10^{-3}}$$

Now, from Bernoulli's Equation

Head loss,

$$H_f = \frac{fLV^2}{2gD}$$

$$= \frac{(8.73209)(500)(1.91)^2}{2(9.81)(0.2)}$$

$$H_f = 4.0590 \text{ m}$$

As we know that from Pressure head and head loss relation

$$H_f = \frac{\Delta P}{\gamma}$$

$$h_f = \frac{\Delta P}{\rho g}$$

$$\Delta P = h_f \rho g$$

$$\Delta P = 4.0590 \times 9.81$$

$$\Delta P = 35837.45 \text{ Pa}$$

$$\boxed{\Delta P = 35.837 \text{ KPa}}$$

RESULT

Hence Pressure loss $= \Delta P = 35.837$ KPa