13.01.20

INTRODUCTION :-

->Fluid machanic is the breanch of science which deals with behavioure of fluid at reest as usual as in motion.

->Thus, this breanch of science deals with static kinematic and dynamic aspects of fluid.

->The study of fluid at reest is called fluid static.

->The study of fluid in motion press forece arce not considereed is called fluid kinematics.

->If the preess forece in also considereed fore fluid in motion that breanch of science is called fluid dynamics.

Proeperties of fluid :-

Density / mass density :-

->Density ore mass density of fluid is defined as the reatio of the mass of the fluid to the volume.

->Thus, the mass pere unit volume is called density.

->It is denoted by the symbol reow 'p'.

->The unit of mass density in SI unit is 'kg/m³'.

->mathematically is mass density is wreiten as reow p.

$$p = \frac{\text{mass of fluid}}{\text{volume of fluid}}$$

->Density of watere is 1gm/cm³ ore 1000 kg/m³.

specific weight / weight density :-

->specific weight ore weight density of fluid in the reatio between the weight of the fluid ~~in the reatio bet~~ ~~to~~ to its volume.

->Thus weight pere ~~a~~ unit volume of fluid is called weight density.

->It is denoted by the symbol 'w'.

->mathematically $w = \frac{\text{weight of fluid}}{\text{volume of fluid}}$

$$= \frac{\text{mass of fluid} \times \text{acceleration due to gravity}}{\text{volume of fluid}}$$

$$= \frac{\text{mass of fluid} \times g}{\text{volume of fluid}}$$

$$= \frac{\text{mass of fluid}}{\text{volume of fluid}} = \rho$$

Specific volume :-

-> Specific volume of fluid is defined as the volume of the fluid occupied by unit mass or volume per unit mass of fluid is called specific volume.

-> mathematically is express as

$$= \frac{\text{volume of fluid}}{\text{mass of fluid}}$$

$$= \frac{1/\text{mass of fluid}}{\text{volume of fluid}}$$

$$= 1/\rho$$

-> specific volume is the reciprocal of mass density.

-> It is express as m^3/kg.

Specific gravity :-

-> specific gravity is defined as the ratio of weight density of fluid to the weight of standard fluid.

-> for liquid the standard fluid is taken as 'water'. And for gases the standard fluid is taken as 'air'.

-> specific gravity is also called as relative density.

-> It is dimensionless quantity and it is denoted by symbol 'S'.

-> mathematically S for liquid

$$S = \frac{\text{weight density of liquid}}{\text{weight density of water}}$$

similarly for gases

$$S = \frac{\text{weight density of gases}}{\text{weight density of air}}$$

weight density of Liquid = S × weight of water

$= S \times 1000 \times 9.81 \, N/m^3$

$= S \times 1000 \, kg/m^3$

Problem-1

Calculate the specific weight density and specific gravity of 1L liquid which weight 7N.

A:- $1L = \frac{1}{1000} m^3$

weight per volume $7000 N/m^3$.

density $= w/g$

$= \frac{7000}{9.81}$

$= 713.5 \, kg/m^3$

specific gravity $= 713.5 \times 1000$

$= 0.7135 \, kg/m^3$

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Problem-2

Calculate the density specific weight and weight of 1L of petrol of specific gravity 0.7.

A:- $1L = \frac{1}{1000} m^3 = 0.001 \, m^3$

$S = 0.7 \times 1000$

$= 700 \, kg/m^3$

specific weight $= 700 \times 9.81$

$= 6867 \, kg/m^3$

$w = \frac{w}{0.001}$

$6867 = \frac{w}{0.001}$

$w = 6867 \times 0.001$

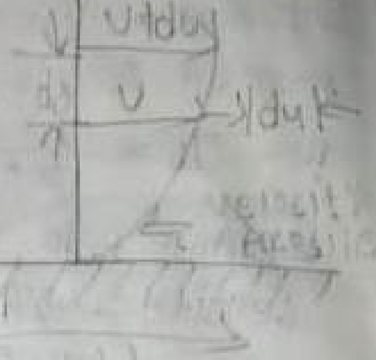
$= 6.867 \, kg/m^3$

Viscocity :-

→ Viscocity is defined as the property of fluid which offers resistance to the movement 1 layer of fluid over other adjecent layer of fluid.

For example :- oil flows in water.

-> When two layers of fluid, a distance dy apart move one over the other at different velocity u+du, the viscocity together with relative velocity causes a shear stress acting between the fluid layer.



-> The top layer causes shear stress on the adjacent lower layer while the lower layer causes a shear stress on the adjacent top layer. This shear stress is proportional to rate of change of velocity with respect to y. It is denoted by symbol 'τ'.

$$\boxed{\tau \propto \frac{du}{dy}} \qquad \boxed{\tau = \mu \frac{dy}{dy}}$$

-> μ is the constant of the properties and it is known as coefficient of dynamic viscocity or only viscocity.

-> $\frac{du}{dy}$ represents the rate of shear strain or velocity gradient.

$$\boxed{\mu = \frac{\tau}{\left(\frac{du}{dy}\right)}}$$

Unit of viscocity :-

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$$\mu = \frac{\tau}{\frac{du}{dy}}$$

$$\mu = \frac{\text{shear stress}}{\frac{\text{change in velocity}}{\text{change in distance}}}$$

$$\mu = \frac{F/A}{\frac{\text{length}}{\text{time}} \times 1/\text{length}}$$

$$= \frac{F/L^2}{1/\text{time}}$$

$$= \frac{\text{Forece} \times \text{time}}{l^2}$$

$$= \boxed{\frac{\text{kgf} \times \text{sec}}{m^2}}$$

(MKS unit of viscocity)

Cgs unit of viscocity

$$\boxed{= \frac{\text{dyne} \times \text{sec}}{cm^2}}$$

SI unit of viscocity

$$= \boxed{\frac{N \times \text{sec}}{m^2}}$$

Numerical conversation of unit of viscosity from mks unit to cgs.

A:- $\frac{1 \text{kgf} \times \text{sec}}{m^2} = \frac{9.81 N/\text{sec}}{m^2}$

But 1 Newton = 1kg $\left(\frac{m \times 1m}{\text{sec}}\right)$

(acceleration)

$$1N = \frac{1000\, g \times 100\, cm}{\text{sec}^2}$$

$$= \frac{1000 \times 100 g\, cm}{\text{sec}^2}$$

$$= \frac{1000 \times 1000 \text{ dyne}}{\text{sec}^2}$$

Therefore

$$\frac{1 \text{kgf} \times \text{sec}}{m^2} = \frac{9.81 \times 100000 \text{ dyne} \times \text{sec}}{cm^2}$$

Newton laws of viscocity:-

It's state that sheare stress of fluid element layere is directly proportion to rate of sheare strain. The constant proportionality is called coefficient of viscocity

$$\boxed{\mu = \frac{\tau}{\frac{du}{dy}}}$$

→ Fluid is obey the above relation are known as Newtonian fluid where as fluid is not obey the above relation are known as Non- Newtonere fluid.

Preoblem-3

velocity distribution over a plate is given by $u = \frac{2}{3}y - y^2$, in which u is velocity in m./sec at a distance y m above the plate. Determine the shear stress at $y=0$, $y=0.15$ take dynamic viscocity of fluid as 8.63 poise.

A:- Given data:- $v = u = \frac{2}{3}y - y^2$

$$\mu = 8.63 \text{ poise} = \frac{8.63}{10} = 0.863 \, NS/m^2$$

$y = 0$

$y = 0.15$

$$\tau = \mu \cdot \frac{du}{dy}$$

at $y=0$

$$\tau = \mu \frac{du}{dy}$$

$$\frac{d}{dy}(2/3y - y^2)$$

$$2/3 - 2y$$

$$= \frac{2}{3} - 2\times 0$$

$$= \frac{2}{3}$$

$$\tau = \mu \frac{du}{dy}$$

$$= 0.863 \frac{\frac{2}{3}}{0}$$

$$= 0.15$$

at $y = 0.15$

$$\tau = \mu \frac{du}{dy}$$

$$= 0.863 \frac{2/3}{0.15}$$

$$= 0.13$$

Problem-4

A plate 0.025mm distance from a fixed plane moves at 60cm/s and requires a force of 2N/per unit area 2N/m² to maintain the speed. Determine the viscosity between the plate.

A:- given data:- $dy = 0.025\ mm = 0.025 \times 10^{-3}$

τ force $= 2N/m^2$

$v = 60cm/sec = 0.6m/sec.$

$$\mu = \frac{\tau}{\frac{du}{dy}}$$

$$\tau = \mu \frac{du}{dy}$$

$$du = 0.6$$

$$\mu = \frac{\tau}{\frac{du}{dy}}$$

$$= \frac{2}{\frac{0.6}{0.025}}$$

$$= 0.08\ m/sec^2$$

Problem-5

Find the kinematic viscosity of an oil having density 981 kg/m³. The shear stress at a point in oil is 0.02452 N/m² and the velocity gradient at point 0.2:

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

A:- given data:- $\rho = 981\ kg/m^3$

$$\frac{du}{dy} = 0.2$$

$$\tau = 0.2452\ N/m^2$$

Problem-4

A plate 0.025mm distance from a fixed plate moves at 60cm/s and requires a force of 2N/per unit area $2N/m^2$ to maintain the speed. Determine the viscocity between the plate.

A:- given data:- $dy = 0.025\ mm = 0.025 \times 10^{-3}$

τ force $= 2N/m^2$

$v = 60cm/sec = 0.6m/sec.$

$$\mu = \frac{\tau}{\frac{du}{dy}}$$

$$\tau = \mu \frac{du}{dy}$$

$$du = 0.6$$

$$\mu = \frac{\tau}{\frac{du}{dy}}$$

$$= \frac{2}{\frac{0.6}{0.025}}$$

$$= 0.08\ m/sec^2$$

Problem-5

Find the kinametic viscocity of an oil having density 981 kg/m³. The sheare stress at a point in oil is $0.02452\ N/m^2$ and the velocity gradi- at point 0.2.

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

A:- given data:- $\rho = 981\ kg/m^3$

$$\frac{du}{dy} = 0.2$$

$$\tau = 0.2452\ N/m^2$$

$$\nu = \frac{\mu}{\rho} = \frac{1.226}{981} = 1.24 \times 10^{-3} m^2/s$$

$$\mu = \frac{\tau}{\frac{du}{dy}} = \frac{0.2452}{0.2} = 1.226 N/m^2$$

<u>problem-6</u>

The dynamic viscosity of oil used fore lubreigation between a shaft and sleeve is 6 Poise. The shaft is diametere 0.4m and rotate at 190 rpm. calculate the powere losed in bearing fore a sleeve length of 90 mm.
The thickness of oil freum 1.5 m.

A:- Given data:-

$\mu = 6$ Poise $= \frac{6}{10} = 0.6$ N sec/m2

$D = 0.4m$

$N = 190$ rpm.

$l = 90mm = 90 \times 10^{-3} m.$

$t = 1.5mm = 1.5 \times 10^{-3} m.$

$$\tau = \mu \cdot \frac{du}{dy}$$

$$du = u - 0$$

$$u = \frac{\pi D N}{60}$$

$$= \frac{\pi\, 0.4 \times 190}{60}$$

$$= 3.97 M/s.$$

$$dy = 1.5 \times 10^{-3}$$

$$\tau = \mu \frac{du}{dy}$$

$$= 0.6 \frac{3.97}{1.5 \times 10^{-3}}$$

$$= 1588$$

$$F = \tau \times A$$

$$= 1588 \times 0.11$$

$$= 174.68$$

$$A = \pi D L$$

$$= \pi \times 0.4 \times 90 \times 10^{-3}$$

$$= 0.11$$

$$T = F \times \frac{D}{2}$$

$$= 174.68 \times \frac{0.4}{2}$$

$$= 34.93$$

$$P = \frac{2\pi N T}{60}$$

$$= \frac{2 \times \pi \times 190 \times 34.93}{60}$$

$$= 694.99$$

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PROBLEM-7

A newteonian fluid is field with clearenass between a shaft & concetreic ~~step~~ sleeve the sleeve attendence a speed of 50 C.M./sec when a forece of 40N is applied to sleeve parallel to the shaft determine the speed if a forece of 200N is applied.

A:- Given data:- $F = 40N$

$U = 50 CM/sec$

$$\tau = \frac{F}{A}$$

$$\tau = \mu \frac{du}{dy} \qquad du = U - 0$$

$$dy = y$$

$$\frac{F}{A} = \mu \left(\frac{U}{y}\right)$$

$$F = \frac{AU}{y}$$

$F \alpha U$

$$\frac{F_1}{V_1} = \frac{F_2}{V_2}$$

$$\frac{40}{60} = \frac{200}{V_2}$$

$$V_2 = \frac{200 \times 50}{40} = 250 \text{ CM/SEC}$$

Preoblem-8

2 larege plain surefsace aree 2.4 C.M. aparet the space between the syresace is filled with glicer grein the forece is reqyireed to dreast avery thin plate of syresace areaa 0.5 sqm between the two larege plain syresace at a speed of 0.6 M/SEC. If i) A thin plate is in the middle of aplain syresace ii) The thin plate is at a distance of 0.8 C.M. freom one of plaving suresace. the dynamic viscocity of gliccerein $= 8.1 \times 10^{-1} \frac{N sec}{m^2}$.

A:- given data:- $dy = 2.4$ C.M.

$A = 0.5$ Sqm.

$du = 0.6$ M/sec

$\mu = 8.1 \times 10^{-1} \frac{NSEC}{m^2}$

i) F_1 = sheare forece on the upper side of thin plate

F_2 = sheare forece on the lowere side of thin plate

F = Total forece reequireed to dreast the plate.

$F = F_1 + F_2$

$$\tau_1 = \frac{F_1}{A_1}$$

$\tau_1 = \mu\left(\frac{du}{dy}\right)_1$

$du = 0.6 \, m/sec$

$dy = 0.012 \, m$

$\tau_1 = 8.1 \times 10^{-1}\left(\frac{0.6}{0.012}\right)_1$

$= 40.5 \, N/m^2$

$F_1 = \tau_1 \times A_1$

$= 40.5 \times 0.5$

$= 20.25$

$F_2 = \tau_2 \times A_2 = 20.25$

Total stress $= F_1 + F_2$

$= 20.25 + 20.25$

$= 40.5 \, N$

ii) F_1 = shear force on the upper side of thin plate.

F_2 = shear force on the lower side of thin plate.

F = Total force required to drag the plate.

$F = F_1 + F_2$

$\tau_1 = \frac{F_1}{A_1}$

$\tau_1 = \mu\left(\frac{du}{dy}\right)_1$

$du = \cancel{0.6 \, m/sec}$ 0.6 m/sec

$dy = \cancel{0.8 \, cm}$ $8 \times 10^{-3} \, m$

$\cancel{\tau_1 = 8.1 \times 10^{-1} \left(\frac{60}{0.8}\right)_1}$

$\tau_1 = 8.1 \times 10^{-1}\left(\frac{0.6}{8 \times 10^{-3}}\right)_1$

$= 60.75 \, N/m^2$

$F_1 = \tau_1 \times A_1$

$= 60.75 \times 0.5$

$= 30.375$

$\tau_1 = \mu\left(\frac{du}{dy}\right)_1$

$du = 0.6 m/sec$

$dy = 0.012 m$

$\tau_1 = 8.1 \times 10^{-1}\left(\frac{0.6}{0.012}\right)_1$

$= 40.5 N/m^2$

$F_1 = \tau_1 \times A_1$

$= 40.5 \times 0.5$

$= 20.25$

$F_2 = \tau_2 \times A_2 = 20.25$

Total stress $= F_1 + F_2$

$= 20.25 + 20.25$

$= 40.5 N$

ii) F_1 = shear force on the upper side of thin plate.

F_2 = shear force on the lower side of thin plate.

F = Total force required to drag the plate.

$F = F_1 + F_2$

$\tau_1 = \frac{F_1}{A_1}$

$\tau_1 = \mu\left(\frac{du}{dy}\right)_1$

$du = \cancel{0.6 m/sec}$ 0.6m/sec

$dy = \cancel{0.8 cm}$ $8 \times 10^{-3} m$

$\cancel{\tau_1 = 8.1 \times 10^{-1}\left(\frac{60}{0.8}\right)_1}$

$\tau_1 = 8.1 \times 10^{-1}\left(\frac{0.6}{8 \times 10^{-3}}\right)_1$

$= 60.75 N/m^2$

$F_1 = \tau_1 \times A_1$

$= 60.75 \times 0.5$

$= 30.375$

$du = 0.6 M/sec$

$dy = 1.6 CM = \frac{1.6}{100} = 0.016 M$

$\tau_2 = \mu \left(\frac{du}{dy}\right)_1$

$= 8.1 \times 10^{-1} \left(\frac{0.6}{0.016}\right)_1$

$= 30.375$

$F_2 = \tau_2 \times A_2$

$= 30.375 \times 0.5$

$= 15.1875$

Total Stress $= \overset{F_1 + F_2}{30.375 + 15.1875}$

$= 45.5625$ N

Surface tension :-

Surface tension is defined as the tensile force acting on the surface of liquid in contact with gas or 2 immiscible liquid such that the contact surface behaves live membrein under tension.

→ The magnitude of this force per unit length of free surface is known as surface tension. It is denoted by σ.

$$\boxed{\sigma = \frac{F}{L}}$$

mcase unit will be kgf/m. and SI unit N/m.

The fenomenon of surface tension is explained considere 3 maliqules A, B, C mass of liquid.

i) The maliquel A is attreacted in all direction equale by the sorreounding maliquels of liquid.

$\tau_1 = \mu\left(\frac{du}{dy}\right)_1$

$du = 0.6\ m/sec$

$dy = 0.012\ m$

$\tau_1 = 8.1\times10^{-1}\left(\frac{0.6}{0.012}\right)_1$

$= 40.5\ N/m^2$

$F_1 = \tau_1 \times A_1$

$= 40.5\times0.5$

$= 20.25$

$F_2 = \tau_2 \times A_2 = 20.25$

Total stress $= F_1 + F_2$

$= 20.25 + 20.25$

$= 40.5\ N$

ii) F_1 = shear force on the upper side of thin plate.

F_2 = shear force on the lower side of thin plate.

F = Total force required to drag the plate.

$F = F_1 + F_2$

$\tau_1 = \frac{F_1}{A_1}$

$\tau_1 = \mu\left(\frac{du}{dy}\right)_1$

$du = \cancel{0.6\ m/sec}\ \cancel{60\ cm}\ 0.6\ m/sec$

$dy = \cancel{0.8\ cm.}\ 8\times10^{-3}\ m$

~~$\tau_1 = 8.1\times10^{-1}$ $\left(\frac{60}{0.8}\right)_1$~~

$\tau_1 = 8.1\times10^{-1}\left(\frac{0.6}{8\times10^{-3}}\right)_1$

$= 60.75\ N/m^2$

$F_1 = \tau_1 \times A_1$

$= 60.75\times0.5$

$= 30.375$

The net resultant force acting on maliqule A is 0.
ii) But the maliqule B which is situated near the free surface is acted upon the upword & downword force which are unbalanced. Thus, net resultant force acting on B is on downword direction.
iii) The maliqule C situated free surface of liquid does experience a resultant downword force all the maliquel free surface experies a downword force.
iv) Thus the free surface of a liquid act like very thin fall under tension on the surface of liquid act as though it is elastic membrain under tension.

<u>Surface tension liquid on dreaw plate :-</u>

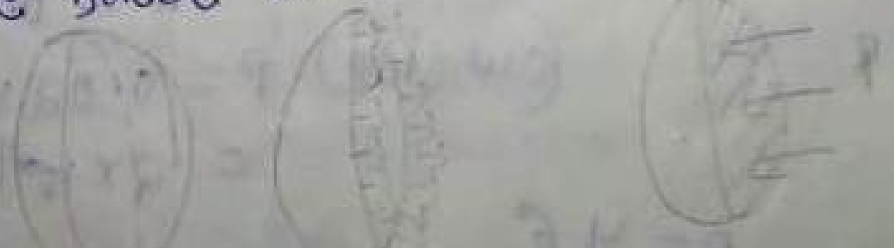
Consider a spherical drawplate of radious r on the entersurface of the dreawplate the tensile force due to surface tension will be acting.

σ = surface tension of liquid
P = Pressure insided the liquid dreaw plate.
d = dia of dreaw plate

Let the dreawplate is cut into 2 halfs the force acting on $1\frac{1}{2} = \sigma \times$ surcumfareance.

$\boxed{\sigma \times \pi d}$

pressure force on the area = $\boxed{P \times \frac{\pi}{4} d^2}$



$$\sigma = \frac{F}{L}$$

$$F = \sigma \times \pi d$$

$$P \times \pi/4 \, d^2 = \sigma \times \pi d$$

$$= \frac{4\sigma}{d}$$

Surface tension on hollow bubbels:-

A hollow bubbel or soap bubbel in air has 2 surface in contact with air 1 inside or other outside. Thus 2 surface are subjected to surface tension is such case we have

$$\boxed{P \times \frac{\pi}{4} \times d^2 = 2(\sigma \times \pi d)}$$

$$P = \frac{2(\sigma \times \pi d)}{\frac{\pi}{4} d^2}$$

$$= \frac{8\sigma}{\pi d}$$

problem-9

The surface tension of water in contact with a air at 20°C is 0.0725 N/m. The pressure inside a dreawplate of water is to be 0.02 N/cm² greater than outside pressure calculate the diameter of calculate of dreaw plate water

A:- ~~surfac~~ given data:- surface tension

$\sigma = 0.0725$ N/m.

(outside) $P = 0.02$ N/cm².

$= 2 \times 10^{-4}$ N/m².

$$P = \frac{4\sigma}{d}$$

$$0.1032 = \frac{8 \times 0.0725}{\pi \times 0.04}$$

$$P = \frac{4\sigma}{d}$$

$$0.1032 = \frac{4 \times 0.0725}{0.04}$$

$$= 7.25\ N/m^2$$

$$P = \frac{8\sigma}{\pi d}$$

$$0.1032 = \frac{8 \times 0.0725}{\pi \times 0.04}$$

$$= 4.61\ N/m.$$

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Capilarcity :-

→ capilarcity is defined as a fenomenere of reise ore fall of liquid surface in a small tube reelative to the adjecnt layore of liquid surface in a small tube reelative to the adjecent general level of liquid when the tube is hailed varticaly in the liquid.

→ The reise of liquid surface is known as capilarey reise when a fall of liquid surface is known as capilarey depreeation.

→ It is cm ore mm of liquid.

→ It's value depends upon the specific weight ~~diamete~~ liquid diameter of tube & surface tension of liquid.

Expression fore capilare reise :-

consider a glass tube of small diametere 'd' opened at both ends and inserted in a liquid say water the liquid will reise in the tube above the liquid sureface.

H = Hieght of the liquid on tube undere a state of equilibreium.

The weight of liquid of height 'h' is balance by forece at the sureface of liquid on the tube due to sureface tension.

σ = sureface tension of liquid

ϕ = Angel of contact between ϕ glass tube.

The weight of liquid of height 'h' in the tube = area of the tube × h (ρ × g)

$$= \boxed{\frac{\pi}{4} d^2 \times h \times \rho \times g}$$

where, γ = Density of liquid = σ × surecum fareance × cosθ

= $\sigma \times \pi d \times \cos\theta$

fore equilibreium $\frac{\pi}{4} d^2 h \rho g = \sigma \pi d \cos\theta$

$$h = \frac{\sigma \pi d \cos\theta}{\frac{\pi}{4} d^2 \rho g}$$

$$= \frac{4\sigma}{\rho g d}$$

Expression fore capilary fall :-

If the glass tube is deeped in merequrei the level of the mereqprei in the tube will be lower than general level up the outside liquide aree show in the fig.

let H = Height of depreeotion in the tybe then in equilibreium 2 foreces are acting on the marequrci inside the tube

1st one is due to surefaece tension acting in doconwored direcction = ~~πd~~ $\boxed{6\pi d \cos\theta}$

2nd forece is due to hydreostatic forece acting upwored & = entensity of preessure at a depth = $\boxed{H \times \text{area}}$

$$h = \frac{4 6}{\rho g d}$$

$$h = \frac{4 6 \cos\theta \; 6\pi d \cos\theta}{\rho g d} = \frac{p \times \frac{\pi}{d^2}}{\rho g h \times \frac{\pi}{4} d^2}$$

value of ~~[illegible]~~ ϕ fore morequrci & glass tube is 128°

preoblem-12

calculate the capilarei reise in a glass tybe of 2.55mm diametere when inmerege vereticaly in watere & marequrei takes surefaece tension $6 =$ 0.0725 N/m. fore watere & $6 = 0.52$ N/m fore marequrei in contaect with aire the speific greavity of marequirey is given as 13.6 an ange of contact = 130°.

A:- Given data :- $\sigma_1 = 0.0725$ N/m.

$\sigma_2 = 0.52$ N/m

$$G = \frac{\text{Density of liquid}}{\text{Density of water}}$$

$$= \frac{13.6}{1000}$$

$$= 0.0136$$

capilary rise for water ($\theta = 0$)

$$\frac{4\sigma}{\rho g d}$$

$$= \frac{4 \times 0.0725}{1000 \times 9.81 \times 2.5 \times 10^{-3}}$$

$= 0.0118$ m. $= 1.18$ c.m. (for morcurei)

Angel of contact between morcurei & glass tube

$$h = \frac{4\sigma \cos\theta}{\rho g d}$$

$$\cos\theta = \frac{4 \times 0.52 \times \cos 130}{1000 \times 9.81 \times 2.5 \times 10^{-3}}$$

$= 0.081$

Preoblem-13

Calculate the capilary effect im MLMS in a glass tube of 4mm diametere when emereged in watere & marcuurei at 20°C. in contact with aire aree 0.073575 N/m & 0.51 N/m. The angel of contact fore watere is 0 & that fore morcuurei is 130° take density of watere at 20°C. ... kg/m3

A:- given data = $d = 4mm = 0.004 m.$

$\sigma_1 = 0.073575 N/m$

$\sigma_2 = 0.51 N/m$

for water.

$$h = \frac{4\sigma}{\rho g d}$$

$$= \frac{4 \times 0.073575}{1000 \times 9.81 \times 0.004}$$

$$= 0.075 m.$$

for mercury

$$h = \frac{4\sigma \cos\theta}{\rho g d}$$

$$= \frac{4 \times 0.51 \times \cos 130}{\cancel{1000}\ 13600 \times 9.81 \times 0.004}$$

$$= -2.457 \times 10^{-3}$$

problem - 14

capillary rise is glass tube is not to capillary rise . is glass tube is not to exceed 0.2mm of water determind i's minimum size given that surface 2m. water in contact with air = 0.0725 N/m

A: given data:- $d = 0.2mm = 2 \times 10^{-3} m.$

$\sigma = 0.0725$

for water

$$h = \frac{4\sigma}{\rho g d}$$

$$= \frac{4 \times 0.0725}{1000 \times 9.81 \times 2 \times 10^{-3}}$$

$$= 0.014 m.$$

problem-15

Find out the minium size of glass tube that can be used in measured water in the capillary rise in tube is restricted in 2mm considered contact as 0.07 surface tension of water 3575.

Given data :- $H = 2mm = 2\times10^{-3}$ m.

$\sigma = 0.073575$

$$h = \frac{4\sigma}{\rho g d}$$

$$2 = \frac{4\times0.073575}{1000\times9.81\times d}$$

$$d = \frac{4\times0.073575}{1000\times9.81\times2\times10^{-3}}$$

$= 0.015$ m.

problem-16

An oil of viscocity 5 poise is used for lubrication between a shaft & sleeve the diameter of the shaft is 0.5m. & it rotates at 200 rpm. calculate the power lost in oil for a sleve length of 100 mm the thickness of oil farm is 1mm.

A:- Given data :- $\mu = 5$ poise $= \frac{5}{10} = 0.5 \frac{N/sec}{m^2}$

$D = 0.5$ m.

$N = 200$ rpm.

$L = 100$ mm. $= 0.1$ m.

$dy = 1m = 1\times10^{-3}$

$$V = \frac{\pi D N}{60}$$

$$v = \frac{\pi \times 0.5 \times 200}{60}$$

$$= 5.23$$

$$\tau = \mu \frac{du}{dy}$$

$$= \frac{0.5 \times 5.23}{1 \times 10^{-3}}$$

$$= 2615$$

Sheare streess $\tau = F \times A$

$$= F \times \pi D L$$

$$= 2617.5 \times \pi \times 0.5 \times 0.1$$

$$= 411.15$$

Top on the shaft

$$T = F \times \frac{D}{2}$$

$$= 410.95 \times \frac{0.5}{2}$$

$$= 102.73$$

Powere lossed $= P = T \times \omega$

$$= 102.73 \times \frac{2\pi N}{16}$$

$$= \frac{102.73 \times 2 \times \pi \times 200}{16}$$

$$= 8068.395$$

03.02.20

Intensity of preessuree & atmosphoreic preessure and it's measureement :-

Fluid preessuree at a point :-

Considere a small areea the A in large mass

of fluid if fluid is stationary then the force
exerted by the surrounding fluid on the
area dA in normal tension. Then the ratio
$\frac{df}{dA}$ is known as intensity of pressure or
simply pressure an the ratio is represented
by as P.

The mathematically the pressure at point
P in a fluid at is $P = \frac{dF}{dA}$
If the force is uniformly distributed
over an area A then the pressure at
point P then the fluid as rest $P = \frac{F}{A}$

Intensity of pressure :-

-> It is defined as the force (weight) of a liquid
to the area in contact to the fluid.

-> fluid should be static.

$$\boxed{P = \frac{F}{A} = \frac{W}{A}}$$

-> It's unit is N/m^2 or KN/m^2.

Atmospheric pressure :-

-> It is the pressure exerted by weight
of the atmosphere which at a level which
an mean value of, ~~325 Pa~~ 101,325 Pascales
-> It is also known as baromatric pressure.
-> The standard pressure is a unit of press
ure defined as 101,325 PA which is equiva
lent to 760 H_2mg.

of fluid if fluid is stationary then the force exerted by the surrounding find on the area dA in normal tension. Then the ratio $\frac{dF}{dA}$ is known as intensity of pressure or simply pressure an the ratio is represented by as P.

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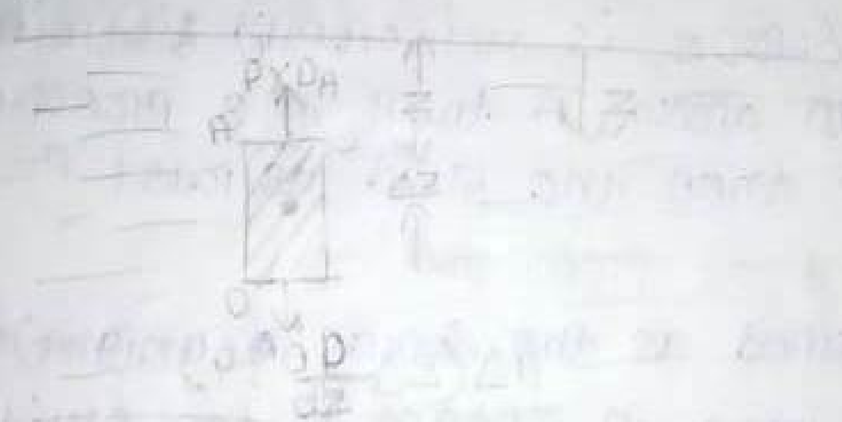
-> The standard pressure is a unit of pressure defined as 101,325 PA which is equivalent to 760 H2mg.

Preessuree Head :-

Freessuree variation in fluid & reest :-

The preessuree at any point in a fluid at rest is offtend by hydrostatic law which state that - The increase in reate of preessuree in verticaly downwared direction must be equalt to specific greeat of fluid at reest This provied considere a small fluid element in fig.



The preessuree at any point in a fluid at rest is offtained by the Hydrostatic law which state that the reate.

ΔA = crossectional area of element.

ΔZ = Height of fluid element.

P = preessuree on the face AB.

Z = distance of fluid element freom free surface.

weight of the fluid element = Density × g × ...

= ΔA

= $\Delta A \times \Delta Z$

Preessuree forece on the surface BC & AD are equal & oppositie fore. equilibrium fluid we have $\boxed{P\Delta A - \left(p + \frac{dp}{dz}\Delta z\right)\Delta A + \rho g \times \Delta A \times \Delta z = 0}$

$$P\Delta A - \left(P + \frac{dP}{dz}\Delta z\right)\Delta A + \rho g\left(\Delta A \times \Delta z\right) = 0$$

$$P\Delta A - P\Delta A - \frac{dP}{dz}\Delta z \Delta A + \rho g \, \Delta A \Delta z = 0$$

$$\Rightarrow \; -\frac{dP}{dz}\Delta z \, \Delta A + \rho g \, \Delta_A \Delta z = 0$$

$$\Rightarrow \frac{dP}{dz}\Delta z \Delta A = \rho \times g \times \Delta A \Delta z$$ [cancelling $\Delta A \Delta z$ on both side]

$$\Rightarrow \frac{dP}{dz} = \rho \times g$$

$$\Rightarrow \frac{dP}{dz} = \rho \times g = \omega$$

where ω = weight density of fluid.

Eq^n state that rate of increase of pressure in a veretical direction is equal to weight density of the fluid at that point. This Hydreostatic law.

By integrating the above eq^n fore liquid, we get.

$$\int dP = \int \rho g \, dz$$

$$P = \rho g z$$

where P is the pressure above atmospheric preessure and z is the height of the point from free surface.

From eq^n, we get.

$$\boxed{z = \frac{P}{\rho \times g}}$$

Pascal's law :

Due to pascal's law the intensity of pressure will be equally transmited in all direction.

Problem-18

A open tank contains water upto a depth of 2m. above it an oil of specific gravity 0.9 for a depth of 1m. find the pressure intensity surface of a liquid. and find the bottom of tank.

A:- B = 2m. Given data :- $z_1 = 2m$.
d = 1m.

$z_2 = 1m$.

$S = 0.9$

$\rho_1 = 1000\ kg/m$

$$S = \frac{\text{density of liquid}}{\text{density of water}}$$

$$0.9 = \frac{\text{density of liquid}}{1000}$$

Intensity at a

density of liquid = 1000 × 0.9

$\rho_2 = 900\ kg/m$

$P = \rho g z$

$= 900 \times 9.81 \times 1$

$= 8829\ N/m^2$

Intensity at b

$P = \rho g z$

$= 1000 \times 9.81 \times 2$

$= \cancel{17658}\ \cancel{N/m^2}\ 19620\ N/m^2$

Pascal's law :-

Due to Pascal's law the intensity of pressure will be equaly transmited in all direction.

Problem-18

A open tank contains water upto a depth of 2m. above it an oil of specific gravity 0.9 fore a depth of 1m. find the pressure intensity surface of a liquid. and find the bottom of tank.

A:- ~~B~~ = 2m. Given data :- $z_1 = 2m.$
~~B~~ = 1m. $z_2 = 1m.$

$S = 0.9$

$\rho_1 = 1000 \; kg/m$

$$S = \frac{\text{density of liquid}}{\text{density of water}}$$

$$0.9 = \frac{\text{density of liquid}}{1000}$$

Intensity at a

density of liquid = 1000×0.9

$\rho_2 = 900 \; kg/m$

$$P = \rho g z$$

$$= 900 \times 9.81 \times 1$$

$$= 8829 \; N/m^2$$

Intensity at b

$$P = \rho g z$$

$$= 1000 \times 9.81 \times 2$$

$$= 19620 \; N/m^2$$

& the total pressure on the holl area is calculat-
ed by intigrating the force on small strip.
pressure intensity on each trip $p = \rho g h / \rho g z$
area of the strip $dA = b \times dh$
The pressure force on the strip $df = p \times area$
$= \rho g h \times b \times dh$

Total ~~pressure~~ force on the holl surface $= F = \int df$
$= \int \rho g h \times b \times dh$

$\int bh\,dh = \rho g \int h \cdot b\,dh = \int bh\,dh$
= moment of surface area
about the free surface area of liquid =
area of surface $\times$ distance of cg
from the surface

$= A\bar{h}$

$F = A\bar{h}\rho g$

for water the value of $\rho = 1000\ kg/m^3$
$g = 9.81\ m/s^2$

centre of pressure :-

centre of pressure is calculated by using principal of moment which states that. The moment of the resultant force about an axis = some of the moment of the components about the same axis. Resultant force f is acting at p distance h star's from free surface of the liquid as shown in the fig.
hence, moment of force f about free surface of the liquid $= f \times h$ star
moment of force dF acting on a strip about free surface of liquid $= df \times h$ ($df = \rho g h \times b \times dh$)

since some of moment of all such forces about free surface of liquid $= \int \rho g h \times b \times dh \times h$

$$= \rho g \int b h \times dh \times h$$

$$= \int \rho g h \times b \times dh = \rho g \int b \times dh \times b dh$$

$$= \rho g \int b h^2 dh = \rho g \int h^2 dA$$

$$\int h^2 dA = \int b h^2 dh$$

Moment of inertia $= I_0$

$$= \rho g I_0$$

$$F \times h^* = \rho g I_0 \quad \text{—— (3.2)}$$

$$F = \rho g A \bar{h}$$

$$\rho g A \bar{h} \times h^* = \rho g I_0 \quad \text{—— (3.3)}$$

$$h^* = \frac{\rho g I_0}{\rho g A \bar{h}} = \frac{I_0}{A \bar{h}}$$

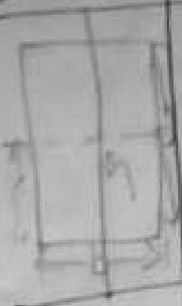
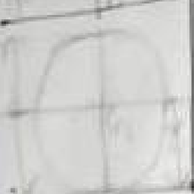
$$I_0 = I_G + A \bar{h}^2$$

$$h^* = \frac{I_G + A\bar{h}^2}{A\bar{h}} = \frac{I_G}{A\bar{h}} + \bar{h}$$

But the theorem for parallel axis we have $\boxed{I_0 = I_G + A\bar{h}^2}$

I_G = moment of inertia about to the axis passing through the CG parallel to the free surface.

substituting I_0 $\boxed{h^* = \frac{I_G + A\bar{h}^2}{A\bar{h}}}$

TYPES	C.G. from the base	area	moment of inertia about an axis passing through CG and parallel to base(I_G)	10.02.20 Moment of inertia about base (I_0)
	$x = \frac{d}{2}$	bd	$\frac{bd^3}{12}$	$\frac{bd^3}{3}$
	$x = \frac{h}{3}$	$\frac{bh}{2}$	$\frac{bh^3}{36}$	$\frac{bh^3}{12}$
	$x = \frac{d}{2}$	$\frac{\pi d^2}{4}$	$\frac{\pi d^4}{64}$	—

Problem-19

Determine the total pressure on an area of circulare plate of diametere 1.5 M. which is placed vereticaly in such a way that centere of plate is 3M. below of water free surface find the position of centere of pressure.

given data:- $d = 1.5M.$
$\bar{h} = 3M.$

$$Area = \frac{\pi}{4} d^2$$
$$= 1.76$$

Total pressure is given by the eq^n.

$$F = \rho g A \bar{h}$$
$$= 1000 \times 9.81 \times 1.76 \times 3 = 51796.8\ m.$$

Total pressure = 51796.8

center of pressure

$$h^* = \frac{I_G}{A\bar{h}} + \bar{h}$$

$$I_G = \frac{\pi d^4}{64}$$

$$= \frac{\pi \times 1.5^4}{64}$$

$$= 0.24 \text{ M.}$$

$$h^* = \frac{I_G}{A\bar{h}} + \bar{h}$$

$$= \frac{0.24}{1.76 \times 3} + 3$$

$$= 3.04 \text{ M.}$$

Proble-20

A rectangular plane surface is 2M. wide & 3M. d it lies veretical plain in water determine the total pressure & position of center of pressure on the plane surface when the plane is upperedge is horizontal

A (coinsident of water surface)

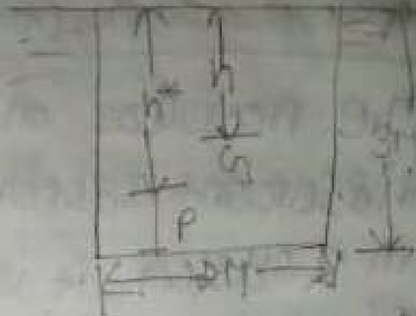
B (2.5M. below the water surface)

A:- Given data :- b = 2M.

d = 3M.

A) upperedge coinside with water surface

Total pressure



$F = \rho g A \bar{h}$

$= 1000 \times 9.81 \times 6 \times \frac{3}{2}$

$= 88290\ N.$

$A = bd$

$= 2 \times 3$

$= 6$

Centre of pressure

$h^* = \frac{I_G}{A\bar{h}} + \bar{h}$

$I_G = \frac{bd^3}{12}$

$= \frac{2 \times 3^3}{12}$

$= 4.5\ M.$

$h^* = \frac{I_G}{A\bar{h}} + \bar{h}$

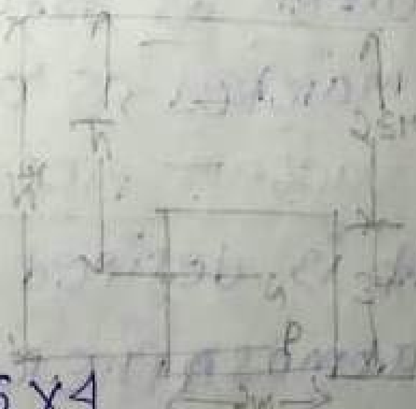
$= \frac{4.5}{6 \times 1.5} + 1.5$

$= 2\ M.$

B) Given data:- $\bar{h} = 2.5 + 1.5 = 4$

$b = 2M.$

$d = 3M.$



Total pressure

$F = \rho g A \bar{h}$

$= 1000 \times 9.81 \times 6 \times 4$

$= 235440\ N.$

Centre of pressure

$h^* = \frac{I_G}{A\bar{h}} + \bar{h}$

$= \frac{4.5}{6 \times 4} + 4 = 4.1875\ M.$

Absolute, Gauge, Atmospheric vaccum pressure: 12·02·20

The pressure on a fluid is measured in 2 different system.
In 1 system it is measured above the absolute '0' or concrete vaccum. It is called absolute pressure.

Absolute pressure :-

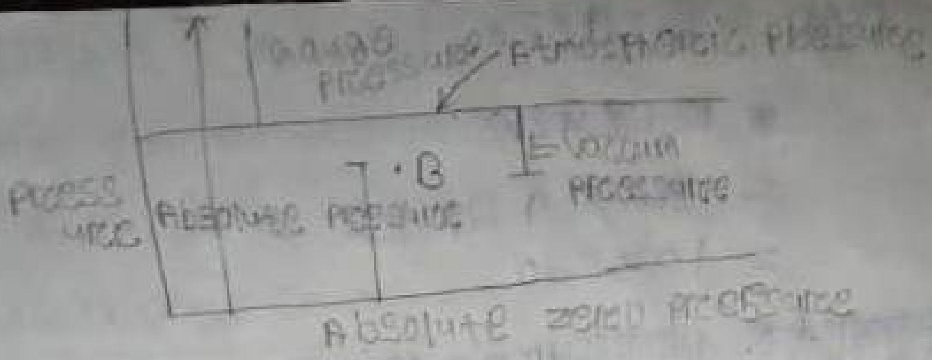
It is defined as the pressure which is measured with reference to absolute vaccum pressure.

Gauge pressure :-

It is defined as the pressure which is measured with the help of pressure measuring instrument atmospheric pressure taken as datum. Atmospheric pressure is marked as '0'.

Vaccum pressure :-

It is defined as the pressure below the atmospheric pressure relation betw absolute, gauge & vaccum pressure are shown in fig.



The reelationship between absolute, gauge & vaccume pressure is given by mathematically

Absolute pressure = Atomospheric pressure + Gauge pressure

$$P_{ab} = P_{atm} + P_{gauge}$$

Similarly, vaccum pressure = Atmospheric pressure − Absolute pressure

$$P_{vacum} = P_{Atm} - P_{absolute}$$

Problem- 21

what are the gauge pressure & absolute pressure at a point 3M. below the free surface of a liquid having density of 1.53×10^3 kg/M^3. Atmospheric pressure is equvalent to 760 MM of marcqure. The specific gravity of marcqure is 13.6 & density of water = 1000.

A:- Given data :- $Z_1 = 3M.$

$\gamma_1 = 1.53 \times 10^3$ kg/m^3

$Z_0 = 750$ MM $= 7.5$ M.

Density of marcqure = specific gravity × density of water

$= 13.6 \times 1000$

$= 13600$

$P_{ATM} = \rho_0 \times g \times Z_0$

~~13.6 × 9.81 × 0.75~~

$= 13600 \times 9.81 \times 7.5$

$= 1000620$

~~Absolute~~ gauge pressure $= \rho_1 g Z_1$

$= 1.53 \times 10^3 \times 9.81 \times 3$

$P_{gauge} = 45027.9$

Absolute pressure $= P_{ATM} + P_{gauge}$

$= 1000620 + 45027.9$

$= 1045647.9$

Basic equation of flow & application & rate of discharge :-

Introduction :-

kinametic flow :-

Kinametic is defined as the branch of science which deals with motion of particle without considering the force in motion. velocity at any point any flow field at any time is studied in this branch of fluid mechanics.

Types of fluid flow :-

The fluid flow is classified as :-

i) Stayed & unstayed flow

ii) Uniform & Non uniform flow

iii) Laminar & Turbulant flow.

iv) compressible & incompressible flow
v) rotational & irrotational flow
vi) 1, 2 & 3 dimensional flow.

i) stayed & unstayed flow :-

stayed flow is defined as that the type of flow in which fluid characterectics like velocity, pressure & density at a point don't change with time.

Mathematically = $\left(\frac{dv}{dt}\right)_{x_0 y_0 z_0} = 0$, $\left(\frac{dp}{dt}\right)_{x_0 y_0 z_0} = 0$

$$\left(\frac{d\rho}{dt}\right)_{x_0 y_0 z_0} = 0$$

where x_0, y_0, z_0 = fixed point in the field.

unstayed flow is a type of flow in which velocity pressure or density at a point doesn't change with respect to time.

Mathematicaly = $\left(\frac{dv}{dt}\right)_{x_0 y_0 z_0} \neq 0$, $\left(\frac{dp}{dt}\right)_{x_0 y_0 z_0} \neq 0$

$$\left(\frac{d\rho}{dt}\right)_{x_0 y_0 z_0} \neq 0$$

ii) Uniform & Non uniform flow :-

uniform flow is defined as the type of flow in which the velocity at any given time doesn't change with respect to space.

$\boxed{\text{mathematically, } \left(\frac{dv}{ds}\right)_t = 0}$

dv = change in velocity

ds = length of flow in dirrection 's'.

Non uniforem flow is the type of flow in which velocity at given time changes with respect to space.

$\boxed{\text{mathematically, } \left(\frac{dv}{ds}\right)_t \neq 0}$

(iii) Laminare & Tarebulant flow :-

Laminare flow is defined as the type of flow in which fluid particles move along well defined path or strim line & strim line's are ~~strees~~ streeat & parrallel. Thus the particaly's moves in lamina or layere's glied smoothly over the adjecant layer. This type of flow is called strim line flow or viscuss flow.

Tarebulant flow is the type of flow in which fluid particles move in a zigzag way due to this movement of fluid particle's in zigzag way the eddis foremation take's place.

~~Reynold number~~ :-

~~iv) compare~~ Reynold Number :-

For a pipe flow the type of flow is determined by non-dimensional number $\left(\frac{VD}{\gamma}\right)$ called reynold's number.

where, D = Diameter of pipe.

V = mean velocity of pipe.

γ = kinematic viscocity.

If reynold's number less than 2000 the flow is called laminar if it is more than 4000 the flow in tarbulant. If the reynold number lies between 2000 & 4000 the flow may be laminar or tarbulant.

iv) compressible & incompressible flow :-

compressible flow is that type of flow in which density of flow changes, from point to point in other word density ρ is constant.

Thus mathematically for compressible flow
$\rho \neq$ constant

Incompressible flow the density is constant for the flow of fluid.

mathematically, ρ = constant

v) Rotational & Irrotational flow :-

Rotational flow is the type of flow in which the fluid particle while flowing alone streimline also rotate in their own axis.

Irrotational flow is the type of flow in which the fluid particle while flowing along streamline also don't rotate in their own axis.

1, 2 & 3 dimensional flow :-

1 dimensional flow in which flow parameters such as velocity is a function of time & one space coordinate only. For steady 1 dimensional flow the velocity is in function of 1 state coordinate.

$$\boxed{\text{mathematically, } u = f(x),\ v = 0\ \&\ w = 0}$$

where, u, v & w = are velocity components in x, y, z direction.

2 dimensional flow it is the type of flow in which velocity is a function of time & 2 rectangular shapes coordinate shapes x, y for steady 2 dimensional flow. The velocity is a function of 2 space coordinate only =

mathematically, $u = f_1(x, y)$, $v = f_2(x, y)$ & $w = 0$

3 dimensional is type of flow in which velocity is a function of time & 3 mutual

perpendicular direction but for steady flow, fluid paramiter's are the function of space cordinate x, y, z.

mathematically, $u = (f_1)x,y,z$ $v = (f_2)x,y,z$, $w = (0)x,y,z$

17.02.20

Rate of flow or Discharge (Q) :-

It is defined as the quantity of fluid flowing per sec. through a secⁿ of pipe or a chanel. For an incompressible fluid or liquid the rate of flow or discharge is expect as volume of fluid across the secⁿ/sec. For compressible fluid the rate of flow is usualy expressed as the weight of fluid flowing across the secⁿ.

→ For liquid's unit QR are m^3/sec or L/sec.

→ For gas the unit's of Q is kgf/sec or N/sec.

continuity equation :-

The equation based on principal of conservation of mass is called continuity eqⁿ. Thus, for a fluid flowing through the pipe at all the corresection, The quantity for fluid or secⁿ is constant.

Let, v_1 = Average velocity & corresection 1-1.

ρ_1 = Density at the secⁿ. 1-1.

A_1 = Area of the pipe at secⁿ 1-1.

ρ_2, v_2, A_2 = Are the follow secⁿ 2-2.

The reate of flow at secⁿ 1-1 = $\rho_1 A_1 v_1$

Then the reate of flow at secⁿ 2-2 = $\rho_2 A_2 v_2$

According to conserevation of mass the reate of flow at secⁿ 1-1 = The reate of secⁿ 2-2 $\boxed{\rho_1 A_1 v_1 = \rho_2 A_2 v_2}$

This is applicable to the compressible as well as in compreessible fluid is called continiuty eqⁿ.

. If fluid is find compressible $\rho_1 = \rho_2$ &

Continuity eqⁿ = $A_1 v_1 = A_2 v_2$

problem-22

The diametere of a pipe at a secⁿ 1 & 2 are 10 C.M. & 15 C.M. Find the distance throug the pipe is the velocity of watere flow at the pipe at the secⁿ 1 is 5M./sec. Then determine the velocity at the secⁿ 2.

A:- Given data :- $D_1 = 10$ C.M. $= 0.1$ M.

$v_1 = 5$ M./sec

$D_2 = 15$ C.M $= 0.15$ M.

$A_1 = \frac{\pi}{4} D_1^2$

$= \frac{\pi}{4} \times 0.1^2 = 7.85 \times 10^{-3}$

$A_2 = \frac{\pi}{4} D_2^2$

$= \frac{\pi}{4} (0.15)^2$

$= 0.017$

Discharce through pipe is $Q = A_1 V_1$

$= 7.85 \times 10^{-3} \times 5$

$= 0.03925$

$A_1 V_1 = A_2 V_2$

$0.03925 = 0.017 \times V_2$

$V_2 = \frac{0.03925}{0.017}$

$= 2.308$

problem-23

A 30c.m. diameter pipe conveying water, branches x 2 pipes of diametere 20c.m. & 15c.m. respectivilling is the avareage velocity in the 30c.M. diameter pipe is 2.5 m/sec find the discharege in the pipe also deteremine the velocity in 15c.m. pipe & average velocity in 20 c.m. pipe is 2m/sec

A: Given data:- $V_1 = 2.5 M/S$

$D_1 = 30\ c.M. = 0.3 M.$

$V_2 = 2 M/S$

$D_2 = 20 c.M. = 0.2 M.$

$D_3 = 15 c.M. = 0.15 M.$

$V_3 = ?$

$A_1 = \frac{\pi}{4} D_1^2$

$= \frac{\pi}{4} (0.3)^2 = 0.070$

$A_2 = \frac{\pi}{4} D_2^2$

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

$= 0.031$

$A_3 = \frac{\pi}{4} D_3^2$

$= \frac{\pi}{4} (0.15)^2$

$= 0.017$

Discharge in pipe 1 or $Q_1 = Q_2 + Q_3$

$Q_1 = A_1 V_1$

$= 0.070 \times 2.5$

$= 0.175$

$Q_2 = A_2 V_2$

$= 0.031 \times 2$

$= 0.062$

$Q_1 = Q_2 + Q_3$

$0.175 = 0.062 + Q_3$

$Q_3 = 0.175 - 0.062$

$= 0.113$

$Q_3 = A_3 V_3$

$0.113 = 0.017 \times V_3$

$V_3 = \frac{0.113}{0.017} = 6.647$

Bernoulli's Equation for Real Fluid :- 19.08.20

The bernoulli's eqn was derived on the assumption of that the fluid is (Non-viscuss) there force friction less but all the real fluid's are viscus and hence offer registance to flow.

Thus, there are always some losses in fluid flows and hence the application of bernoulli's eqn the losses have to be taken into consideration.

Thus, the bernoulli's eqn for real fluid's between point 1 & 2 is given as

$$\boxed{\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + h_L}$$

where, h_L = losse of energy between 1 & 2.

$\frac{P_1}{\rho g}$ = Pressure gradient for 1 fluid.

$\frac{V_1^2}{2g}$ = velocity gradient.

Z_1 = Distance

Problem-24 :-

A pipe of diametore 400MM carries water at velocity of 25 M/sec. The pressure at the point A & B are given by 29.43 N/CM^2 & 22.563 N/CM^2. Respectively while the dattom head at A & B are 28M. & 30M. Find the loss of head between A&B.

A:- Given data:- $V = 25\ M/SEC$

$D_A = 400\ MM = 4\ M.$

$P_A = 29.43\ N/cm^2$

$= 0.2943\ M. = 29.43 \times 10^4\ N/m^2$

$Z_A = 28\ M.$

$D_B = 400\ MM = 4\ M.$

$P_B = 22.563\ N/cm^2$

$= 2286 \times 10^4\ N/m^2$

$Z_B = 30\ M.$

i) $E_A = \frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1$

$= \frac{29.43 \times 10^4}{1000 \times 9.81} + \frac{(25)^2}{2 \times 9.81} + 28$

$= 89.855$

ii) $E_B = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$

$= \frac{22.563 \times 10^4}{1000 \times 9.81} + \frac{(25)^2}{2 \times 9.81} + 30$

$= 84.855$

Energy loss $E_L = E_A - E_B$

$= 89.855 - 84.855$

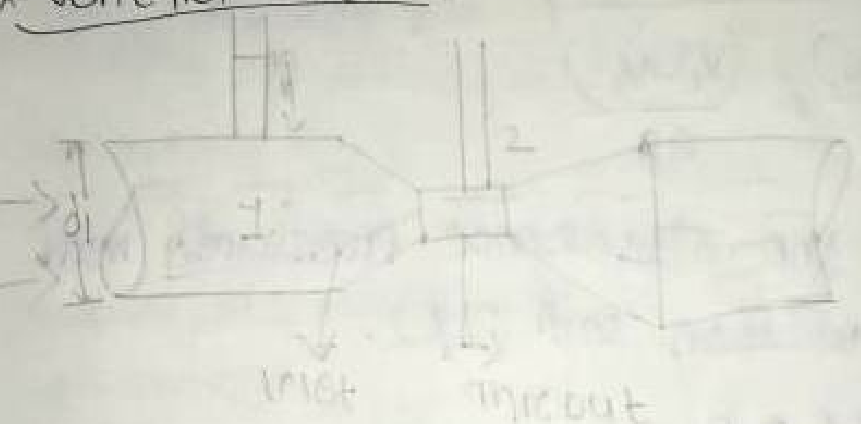
$= 5$

practical application of bernoulli's eqn -

Bernoulli's eqn is applied in all problems of incompressible fluid flow where energy consideration are involved but we shall consider it's application to the following measuring device.

* venturi meter.
* orifice meter.
* Pitot tube.

* venturi meter :-



It is a device used for measuring rate of flow of fluid flowing through the pipe. It consist of 3 parts :

-> A short converging part.
-> Throat
-> diverging part.

It is based on principl of venturi meter.
expression for rate of flow through venturi meter.

d_1 = diameter at inlet or at section 1.
P_1 = Pressure at secn 1.
v_1 = velocity of fluid at secn 1.
a = area of secn 1. $\frac{\pi}{4} d_1^2$

a_2, P_2, V_2 & P_2 are corresponding values at secⁿ 2.

Appling bernulli's eqⁿ at secⁿ 1 & 2 we get

$$\boxed{\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+Z_1=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Z_2}$$

Here $Z_1=Z_2$

$$\boxed{\frac{P_1}{\rho g}+\frac{V_1^2}{2g}=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}}$$

$$\frac{(P_1-P_2)}{\rho g}=\frac{(V_1^2-V_2^2)}{2g}$$

But $\frac{P_1-P_2}{\rho g}$ in the difference pressure head ~~between~~ secⁿ 1 & 2.

It is equalte h.

The substituting the value of $\frac{P_1-P_2}{\rho g}$ in above eqⁿ we get $h=\frac{V_1^2-V_2^2}{2g}$

Now applying continuity eqⁿ at secⁿ 1 & 2 $a_1 V_1 = a_2 V_2$

$$V_1=\frac{a_2 V_2}{a_1}$$

$$h=\frac{V_2^2}{2g}-\frac{V_1^2}{2g}$$

$$h=\frac{V_2^2}{2g}-\frac{\left(\frac{a_2 V_2}{a_1}\right)^2}{2g}$$

$$h=\left\{\frac{V_2^2}{2g}\right\}\times\left[1-\frac{a_2^2}{a_1^2}\right]$$

d_2, P_2, V_2 & P_2 are corresponding values at secⁿ 2.

Appling bernulli's eqⁿ at secⁿ 1 & 2 we get

$$\boxed{\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2}$$

Here $Z_1 = Z_2$

$$\boxed{\frac{P_1}{\rho g} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \frac{V_2^2}{2g}}$$

$$\frac{(P_1 - P_2)}{\rho g} = \frac{(V_1^2 - V_2^2)}{2g}$$

But $\frac{P_1 - P_2}{\rho g}$ in the differencce pressure head ~~between~~ secⁿ 1 & 2.

It is equalte h.

The substituting the value of $\frac{P_1 - P_2}{\rho g}$ in above eqⁿ we get $h = \frac{V_1^2 - V_2^2}{2g}$

Now applying continuity eqⁿ at secⁿ 1 & 2 $a_1 v_1 = a_2 v_2$

$$v_1 = \frac{a_2 v_2}{a_1}$$

$$h = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

$$h = \frac{V_2^2}{2g} - \frac{\left(\frac{a_2 V_2}{a_1}\right)^2}{2g}$$

$$h = \left\{\frac{V_2^2}{2g}\right\} \left[1 - \frac{a_2^2}{a_1^2}\right]$$

~~case-2~~ $h = x\left[\frac{S_h}{S_o} - 1\right]$

Case-2

In differensial manometer contains a liquid which is lighter than the liquid flowing through the pipe the value of h is given by

$$h = x\left[1 - \frac{S_L}{S_o}\right]$$

S_L = speisic gravity of liquid on U-tube.

S_o = speisic gravity of liquid flowing through the pipe.

x = difference between liquid lighter U-tube.

Problem -25

A horizental venturimeter with inlate & throught diameter 30 C.M. & 15 C.M. respectively is used to measure the flow of water the reading of differensial manometer connected in late & throught is 20 C.M. of merequrei. Determine the rate of flow $C_d = 0.98$.

A:- Given data:- $d_1 = 30$ C.M.

$$a_1 = \frac{\pi}{4}(d_1)^2 = 706.85 \text{ C.M.}$$

$d_2 = 15$ C.M.

$$a_2 = \frac{\pi}{4}(d_2)^2 = 176.71 \text{ C.M.}$$

$Cd = 0.98$, $Sh = 13.6$, $So = 1$.

Reading of differensial manometere $y = 20cm$ of morcquri.

$$h = y\left[\frac{Sh}{So} - 1\right]$$

$$= 20\left[\frac{13.6}{1} - 1\right]$$

$$= 252$$

$$Q = Cd \times \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$$

$$= 0.98 \times \frac{706.85 \times 176.71}{\sqrt{(706.85)^2 - (176.71)^2}} \times \sqrt{2 \times 9.81 \times 252}$$

$$= 12576.243$$

27.02.2020

Flow over Notches & weires:-

Notche:-

In notches is a device used for measureing the reate of flow of a liquid through a small channel or a tank. It may be defined as an opening in the side of a tank or a small channel in such a way that. The liquid surface in the tank or channel is below the top edge of the opening.

Weire:-

A weire is a concreete or machinarey structure placed in an open channel overe which the flow occures. It genereally in the form of vertical wall, with sharepe edge at the top reunning although way acreoss open channel. The notche is a small size while the weire is a biggere size.

classification of Notches or weir

The notches is classified as shape of opening :-

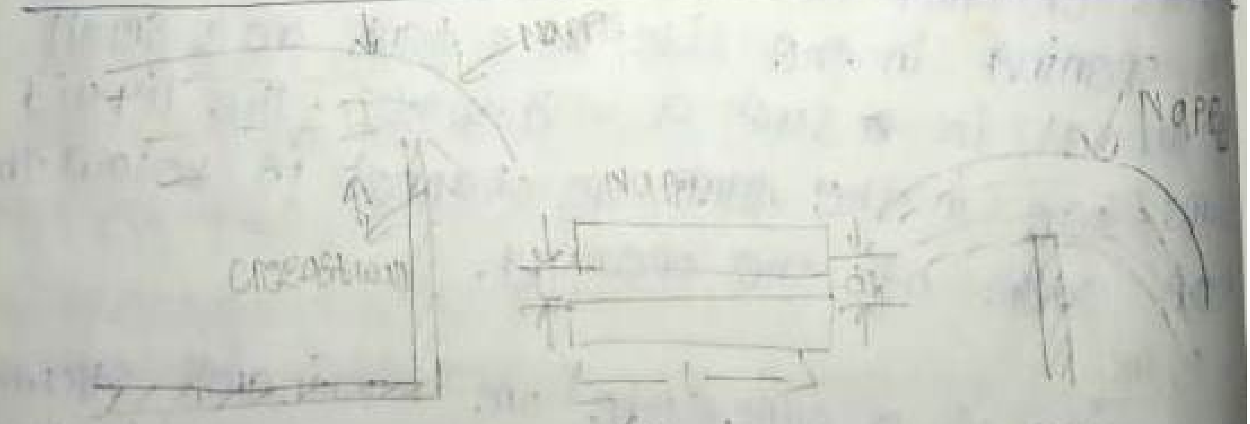
* Rectangulare Notche.
* Triangulare Notche.
* Trapijudial Notche.
* Stepped Notche.

The weir are classified according to the shape of opening, the shape of creased & nature of discharege.

according to the shape of opening:-

* Rectangulare wiree.
* triangulare wiree.
* Trapijudial wiree.

discharege through Rectangulare Notche or weir



(section at creast)

consider a rectangulare notche or wiree provided in channel carreing water

H = Head of watere over the creast.

L = length of notch or wiree.

For finding discharege of watere flowing over the wire or notche consider an elementary horizontal strip of water thickness dh & length L, h from the free surface of water shown in the fig.

The area of the strip = $L \times dh$

The theoritical velocity of water flowing through the strip = $\sqrt{2gh}$

The discharge dQ through the strip is:- Cd × area of the strip × Theoretical velocity

$$\boxed{dQ = Cd \times L dh \times \sqrt{2gh}}$$

The total discharge Q for whole notche & wire is determined by intigrating eqn between the limit zero to H.

$$Q = \int_0^H Cd \cdot L \cdot \sqrt{2gh}\, dh$$

$$= Cd \cdot L \times \sqrt{2g} \int_0^H h^{1/2}\, dh$$

$$= Cd\, L \times \sqrt{2g} \left[\frac{h^{\frac{1}{2}+1}}{\frac{1}{2}+1} \right]_0^H$$

$$= Cd\, L \sqrt{2g} \left[\frac{h^{\frac{3}{2}}}{\frac{3}{2}} \right]_0^H$$

$$\boxed{= \frac{2}{3} Cd\, L \times \sqrt{2g} \left[H \right]^{\frac{3}{2}}}$$

Problem - 26

Find the discharge of water flowing over a rectangular notche 2M. L. when the constant head over the notche is 300MM Take Cd 0.6.

A:- given data:- $L = 2M.$

$H = 300MM = 0.3M.$

$C_d = 0.6$

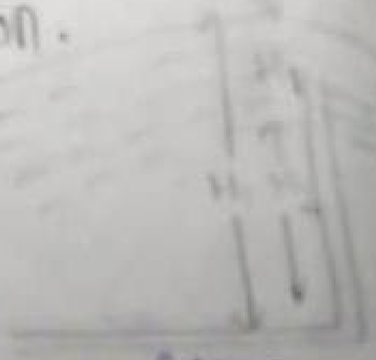
$$\frac{2}{3} C_d L \times \sqrt{2g} [H]^{\frac{3}{2}}$$

$$= \frac{2}{3} \times 0.6 \times 2 \times \sqrt{2 \times 9.81} \left[\frac{0.3}{300}\right]^{\frac{3}{2}}$$

$$= 0.582$$

Problem - 27

Determine the h of a rectangular wire of L = 6M. to built across a rectangular channel. The maximum depth of water on the off stream side of the wire = 1.8M, discharge is 2000 L/sec takes $C_d = 0.6$ neglect end construction.



A:- Given data:- $L = 6M.$

$C_d = 0.6$

$H_1 = 1.8M.$

$Q = 2000\ L/sec = 2m^3/sec$

H = height of the water above crest.

$$Q = \frac{2}{3} C_d L \times \sqrt{2g} [H]^{\frac{3}{2}}$$

$$Q = \frac{2}{3} \times 0.6 \times 6 \times \sqrt{2 \times 9.81}\,[H]^{\frac{3}{2}}$$

$$= 10.63\,[H]^{\frac{3}{2}}$$

$$\left[\frac{2}{10.63}\right] = [H]^{\frac{3}{2}}$$

$$\left[\frac{2}{10.63}\right]^{\frac{2}{3}} = H$$

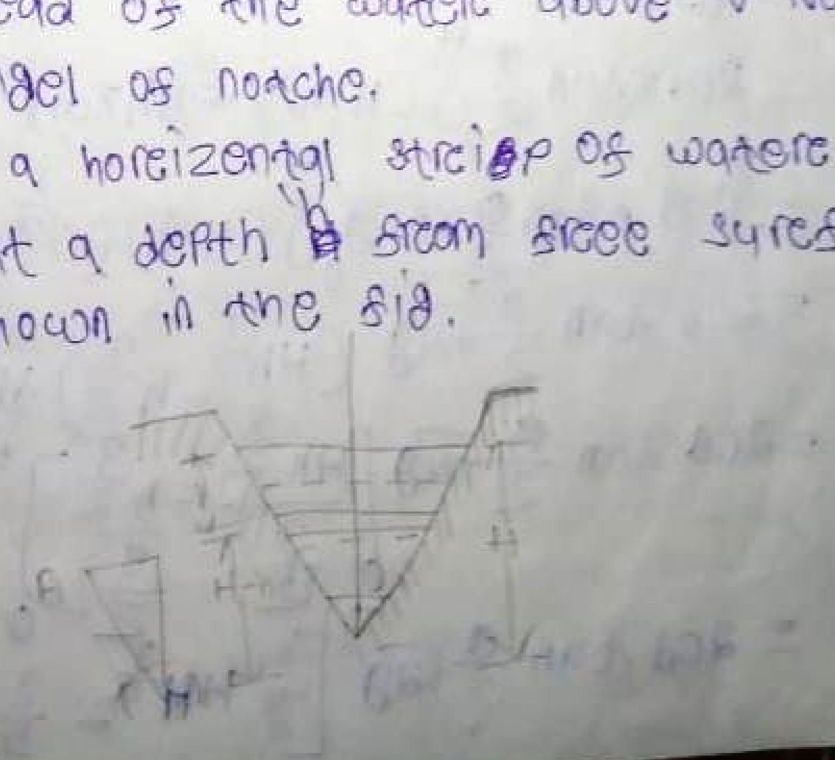
$H = 0.328$

$H_2 = H_1 - H$
$= 1.8 - 0.328$
$= 1.472$

26.02.20

Discharge over a triangular notche or weir:

The expression for the discharge over a triangular notche or weir is same. It is derived as
let H = Head of the water above V Notche.
θ = Angel of notche.
Consider a horizontal strip of water of thickness dh at a depth h from free surface of water shown in the fig.



$$\tan\frac{\theta}{2} = \frac{AC}{BC}$$

$$= \frac{AC}{H-h}$$

$$AC = (H-h)\tan\frac{\theta}{2}$$

width of strip AB

$$= 2AC$$

$$= 2(H-h)\tan\frac{\theta}{2}$$

Area of the strip

$$= 2(H-h)\tan\frac{\theta}{2} \times dh$$

Theoretical velocity of water through strip

$$= \sqrt{2gh}$$

$$dQ = Cd \times \text{Area of the strip} \times \text{velocity}$$

$$= Cd \times 2(H-h)\tan\frac{\theta}{2} \times dh \times \sqrt{2gh}$$

$$= 2Cd \times (H-h)\tan\frac{\theta}{2} \times \sqrt{2gh} \times dh$$

$$Q = \int_0^H 2Cd \times (H-h)\tan\frac{\theta}{2} \times \sqrt{2gh} \times dh$$

$$2Cd \times \tan\frac{\theta}{2} \int_0^H (H-h) \times \sqrt{2gh} \times dh$$

$$= 2Cd \cdot \tan\frac{\theta}{2} \times \sqrt{2g} \int_0^H (H-h)(h)^{\frac{1}{2}} dh$$

$$= 2Cd \tan\frac{\theta}{2}\sqrt{2g}\left(Hh^{\frac{1}{2}} - h^{\frac{3}{2}}\right) dh$$

$$= 2Cd \tan\frac{\theta}{2}\sqrt{2g}\left[\frac{Hh^{\frac{3}{2}}}{\frac{3}{2}} - \frac{h^{\frac{3}{2}}}{\frac{5}{2}}\right]_0^H$$

$$= 2Cd \tan\frac{\theta}{2}\sqrt{2g}\left[\frac{2}{3}HH^{\frac{3}{2}} - \frac{2}{5}H^{\frac{5}{2}}\right]$$

$= 2C_d \tan\frac{\theta}{2}\sqrt{2g} \times \frac{2}{3} H^{\frac{5}{2}} - \frac{2}{5} H^{\frac{5}{2}}$

$= 2C_d \tan\frac{\theta}{2}\sqrt{2g} \times \frac{4}{15} (H^{\frac{5}{2}} - H^{\frac{5}{2}})$

$= \frac{8}{15} C_d \times \tan\frac{\theta}{2} \times \sqrt{2g}\, H^{\frac{5}{2}}$

$C_d = 0.6$

$\theta = 90$

$Q = \frac{8}{15} \times 0.6 \times 1 \times \sqrt{2g} \times H^{\frac{5}{2}}$

$= 1.417\, H^{\frac{5}{2}}$

preoblem-28

find a dischareqe overe treangulare notche of angel 60° when head overe the v notche is 0.3M. assume Cd = 0.6.

A:- given data = $C_d = 0.6$

$H = 0.3M.$

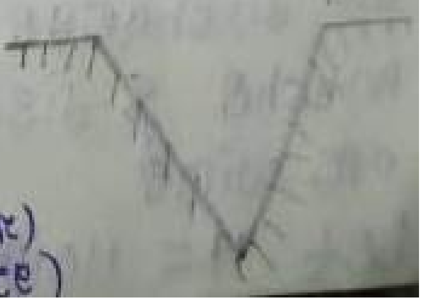
$\theta = 60°$

$Q = \frac{8}{15} \times 0.6 \times 0.57 \times \sqrt{2 \times 9.81} \times 0.3^{\frac{5}{2}}$

$= 0.039 \simeq 0.01$

preoblem-29

watere flows overe a reactangulare wiree 1M. wide at a depth of 150MM. & afterewareds passes through treiangulare rightangel wiree taking cd fore reectangulare & treiangulare wiree as 0.62 & 0.59 reespectivelly. find the depth overe the treiangulare wiree.



A:- given data:- $L = 1M.$

$H = 150\,MM. = 0.15M.$

$C_d = 0.62$ (reectangulare wiree)

$Cd = 0.59$

$H =$ suppose H_1

$$Q = \frac{2}{3} Cd \, L \times \sqrt{2g} \, [H]^{\frac{3}{2}}$$

$$= \frac{2}{3} \times 0.62 \times 1 \times \sqrt{2 \times 9.81} \times 0.15^{\frac{3}{2}}$$

$$= 0.106$$

$$Q = \frac{8}{15} \, Cd \times \tan\frac{\theta}{2} \times \sqrt{2g} \times H^{\frac{5}{2}}$$

$$0.106 = \frac{8}{15} \times 0.59 \times 1 \times \sqrt{2 \times 9.81} \times H_1^{\frac{5}{2}}$$

$$0.106 = 1.393 \, H_1^{\frac{5}{2}}$$

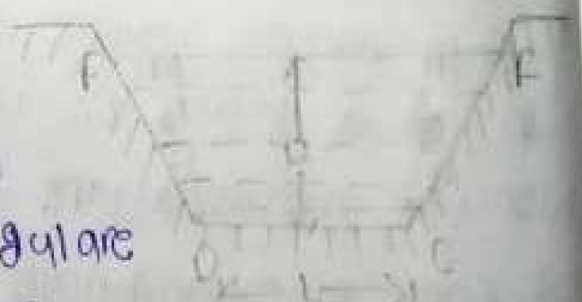
$$\frac{0.106}{1.393} = H_1^{\frac{5}{2}}$$

$$0.076 = H_1^{\frac{5}{2}}$$

$$H_1 = 0.076^{\frac{2}{5}}$$

$$= \cancel{0.0304} \; 0.356$$

Discharege over a treiapijodial Notche or wire:-



A treapijodial notche or wire is a combination of reectangulare & treiangulare notche or wire thus the total discharege will be ~~a~~ equal to some of discharege threough reectangulare wire or notche & discharege threough treangulare notche ore wire

Let $H =$ Height over the notche.

l = Length of the creeast of the notche.

Cd_1 = coefficient of discharege fore rectangulare poretion ABCD

Cd_2 = coefficient of discharege fore trianga-ulare poretion FAD & BCE.

Discharege through rectangulare poretion ABCD is given by $Q_1 = \frac{2}{3} Cd_1 L \times \sqrt{2g}\,[H]^{\frac{3}{2}}$

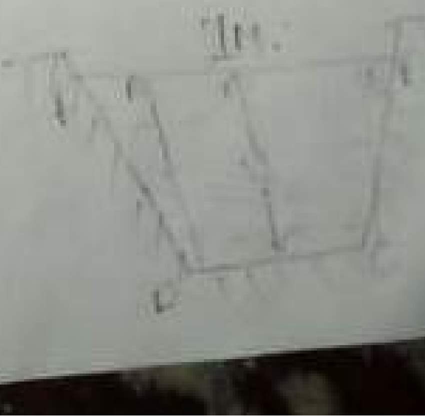
Discharege through true triangulare not-ches FDA & BCE = discharege through single triangulare notche of angel θ & it is given by $Q_2 = \frac{8}{15} \times Cd_2 \times \tan\frac{\theta}{2} \sqrt{2g}\, H^{\frac{5}{2}}$

Discharege through trapijodial notche ore wiree FDCEF $= Q_1 + Q_2$

$= \frac{2}{3} Cd_1 L \times \sqrt{2g}\,[H]^{\frac{3}{2}} + \frac{8}{15} \times Cd_2 \tan\frac{\theta}{2} \sqrt{2g}\, H^{\frac{5}{2}}$

Preoblem

Find the discharege through a trapijodial notche which is 1M. wide at the top & 0.4M. at the bottom & its 30 C.M. in height. The head of watere on the notche is 20C.M. Assume Cd fore rectangulare poretion = 0.62 while fore triangulare poretion = 0.6.



A:- Given data:- EF = 1M.

$L = 0.4M.$

$H = 0.2M.$

$Cd_1 = 0.62$

$Cd_2 = 0.6$

$$\tan = \frac{P}{b} = \frac{FA}{AD} = \frac{0.6}{0.3}$$

$$= 2$$

$\cancel{\tan = 45°}$ $\tan\frac{\theta}{2} = 1$

$\cancel{\theta/2}$

$$Q_1 = \frac{2}{3} Cd_1 L\sqrt{2g}\,[H]^{\frac{3}{2}}$$

$$= \frac{2}{3} \times 0.62 \times 0.4 \times \sqrt{2 \times 9.81} \times 0.2^{\frac{3}{2}}$$

$$= 0.065$$

$$Q_2 = \frac{8}{15} Cd_2 \times \tan\frac{\theta}{2} \times \sqrt{2g} \times H^{\frac{5}{2}}$$

$$= \frac{8}{15} \times 0.6 \times 1 \times \sqrt{2 \times 9.81} \times 0.2^{\frac{5}{2}}$$

$$= 0.025$$

$$0.065 + 0.025$$

$$= 0.09$$

GCA (Gross comanded area)

→ The imaginary area for which we are designing the channel is called Gross-comanded area.

CCA (culturable comandedarea)

→ The area where we cultivate the crop is called culturable, comanded area.

a) culturable comanded area

b) unculturable " "

unculturable area

The area where agriculture cannot be done is called unculturable area.

crop period

The period from sowing of crop to harvesting is called crop period

~~crop~~ Intensity of Irrigation

→ Intensity of irrigation is defined as ratio between cultivation-area to particular crop of culturable area.

$$I.I = \frac{Area}{CCA} \times 1000 (\%)$$

Hydrological cycle

* Hydrologic cycle is the sequence of cyclic events which corelates the movement of H_2O from the atmosphere to the earth surface and then to lage water bodies through sub surface and surface finally going back to the atmosphere

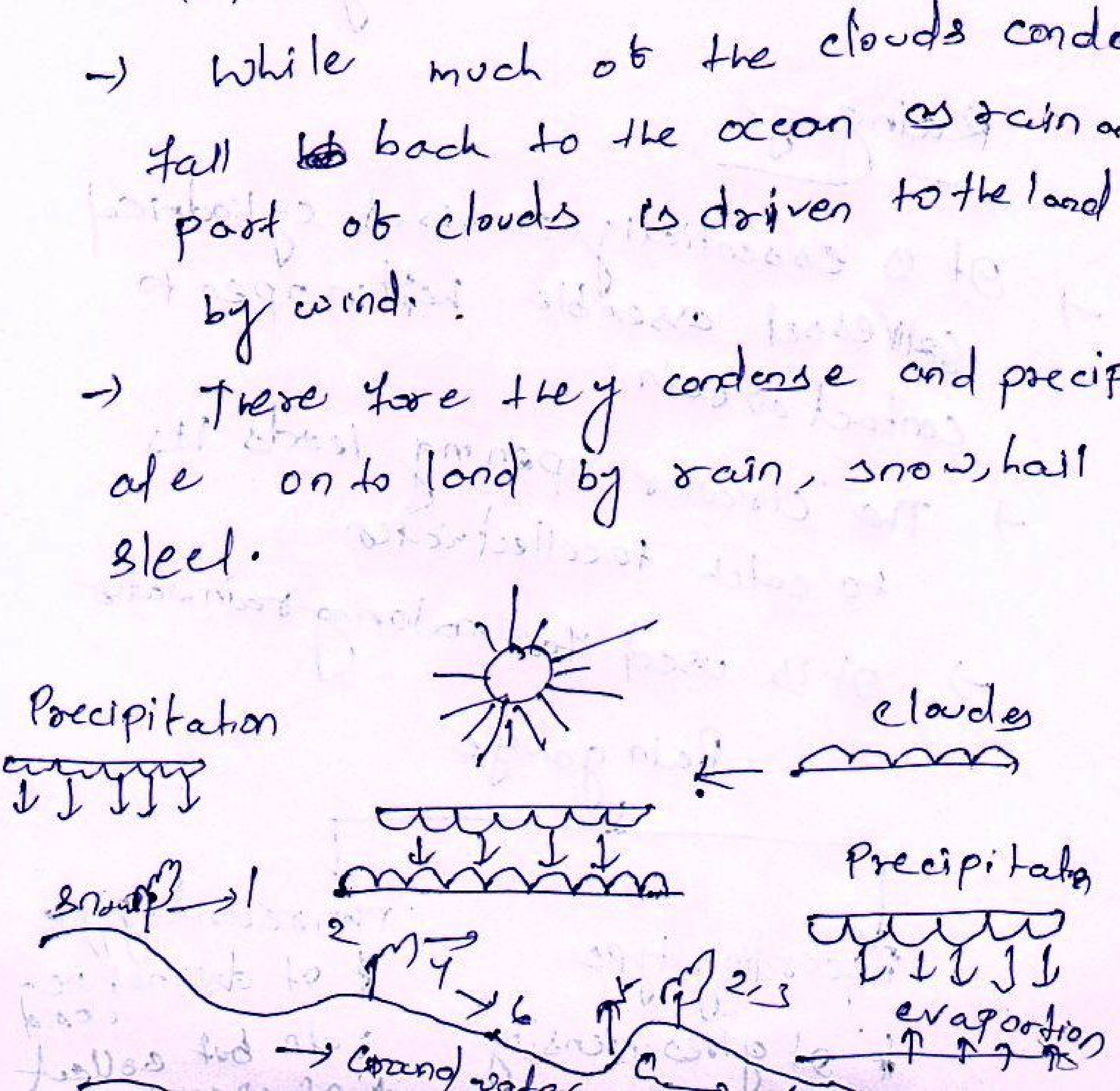
procedure

→ water in the oceans evaporate due to heat energy provided by solar radiation

→ Then water vapor moves upwards and forms clouds

→ While much of the clouds condense fall back to the ocean as rain and part of clouds is driven to the land by wind.

→ There fore they condense and precipitate onto land by rain, snow, hail sleet.



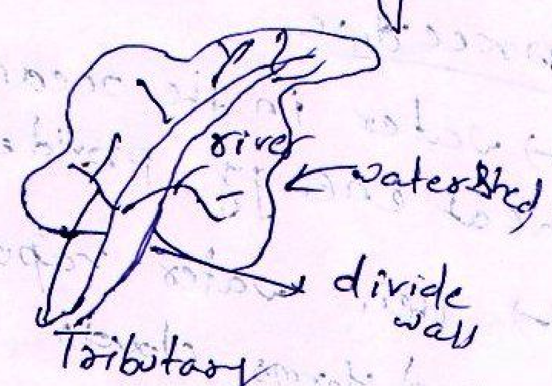
catchment area

→ The area of land draining water into stream or water course at given location is called catchment area

→ It is called drainage basin.

→ In USA it is called watershed

→ It is area is measured by plaintometer



Raingauge

→ It is essentially consis of cylindrical vessel assemble kept in open to contact of rain.

→ The circular opening leads its to catch to collect water.

→ It is used for measuring rain water

Rain gauge

- Recording type
  * It gives intensity of rain fall
- Non recording type
  * It does not record rain but collect
  * It gives depth of rainfall

Hyetograph

A Hyteograph is a graphical representation of the distribution of rainfall

Irrigation

Name:- Shatabdi Dey
Branch- civil engg
designation- Assistant profess

Introduction

Defination of irrigation :

→ The process of artifical application of water to the soil for the growth of agricultural crop is termed as irrigation

→ It is practically a science of planning and designing a water supply for agricultural land to protect the crops from bad effect of drought or low rainfall.

→ It includes the construction of weirs, dams, barrag for the regular supply of water to the cultivable lands

Necessity of irrigation :

→ insufficient Rainfall :- when the seasonal rainfalls minimum ie insufficient for crops then irrigation is necessary.

→ uneven distribution of rainfall:- when the rainfall is not distributed evenly through out the crop period, then irrigation is necessary.

→ Development of agricultural crops in desert area :- The ~~design~~ desert where rainfall is very low, the irrigation system is required.

Benefits of irrigation

→ Yeild of crops :- In the period of low rainfall or drought, the yield of crops may be increased by the irrigation system.

water-distribution efficiency

The effectiveness of irrigation is measured by distribution efficiency.

It is denoted by η_d.

$$\eta_d = \left(1 - \frac{d}{D}\right)$$

Consumptive use or Evapotranspiration (Cu)

→ consumptive use for particular crop may be defined as the total amount of water used by the plant in transpiration and evaporation from adjacent soils or from plant leaves in a specified times.

→ It is denoted by Cu.

Modull-II (canal irrigation)

Classification of canals

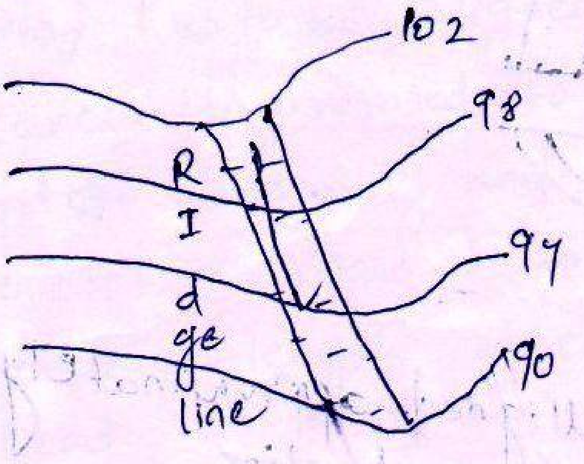
(I) Based on alignment

Depending its alignment canals are designate as (i) Ridge or watershed canal

(ii) contour canals

(iii) side slope canal..

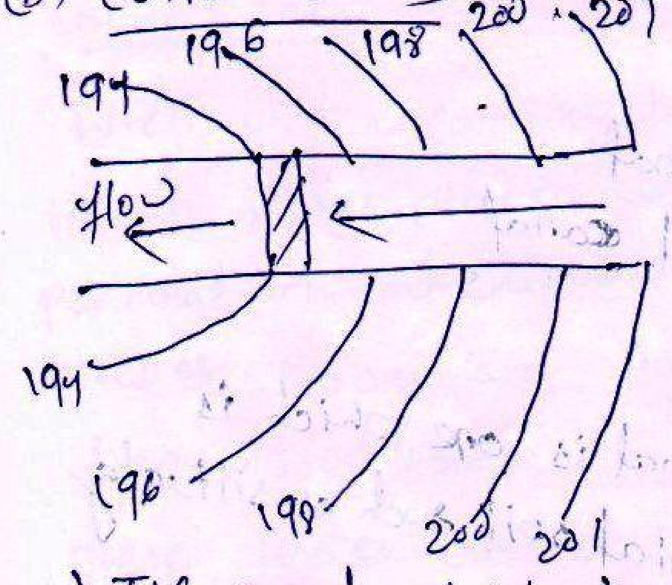
(a) Ridge or water shed canal



→ The canal which is aligend along rigde line (water shed line) is known as ~~rigd~~ ridge or water-shed canal.

→ The advantage of this type of canal is that it can irrigat its area both side of its canal.

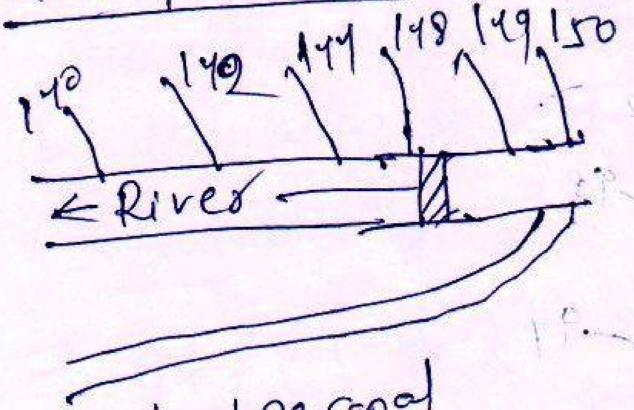
(b) contour canals



→ The canal which is aligned approximately parallel to the countour lines is known as contour canal.

→ These canal can irrigate only one side

Side slope canals



Side slope canal

→ These canals are alligned approximately at right angle to the contour line

→ These area can irrigate only one side

(2) Based on financal output

(a) productive canal
(b) protective canal

(3) classification based on boundry surface.

(a) Alluvial canal
(b) Nonalluvial canal

Alluvial canal

→ Alluvial canal canal is one which is excavated in alluvial soil such as silt, clay

Nonalluvial canal

The ridge bandry canal are those which have

Canal Alignment

A canal has to be aligned in such a way that it covers its proposed to be irrigated with shortest possibility and its cost including the cost of cross-drainage work.
A shorter length of canal ensures less loss of head.
loss of discharge due to seepage and evaporation so that aditional area can be brought into cultivation.
According to allignment canals are classified as following
(i) Ridge canal
(ii) contour canal

Canal losses

When water continously flow throug a canal losses takes place due to seepage, deep percolation and evaporation.
theses losses are sometimes known as transmisson losses
these losses are classified into 3 types
(i) Evaporation losses (ii) Transmisson losses
(iii) seepage losses

Cross drainage work

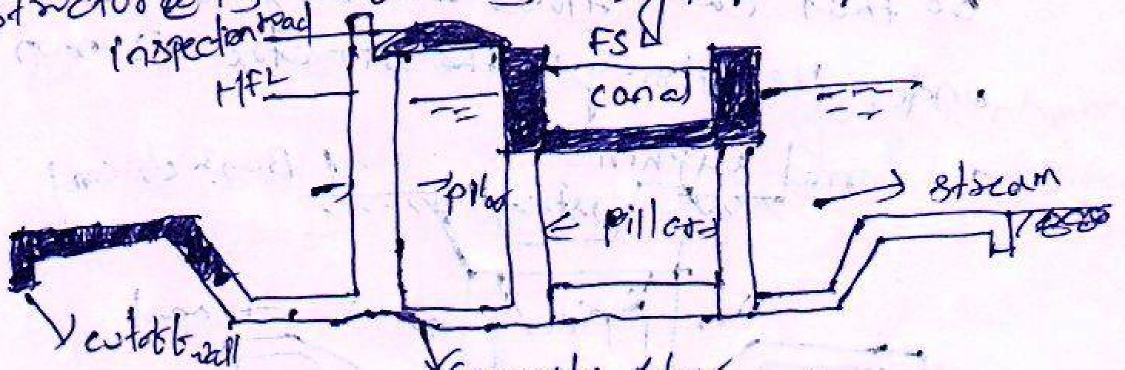
1) Aqueduct

→ In these work the canal is taken over the natural drain such that the drainage water runs bellow the canal freely.

→ When the HFL of drain is sufficiently bellow the bottom of canal, so that the drainage water flows freely under gravity, the structure is known as aqueduct.

Syphon Aqueduct

If the HFL of the drain is higher than the canal bed, and the water passes through the aqueduct barrels under syphonic action the structure is known as syphon aqueduct.

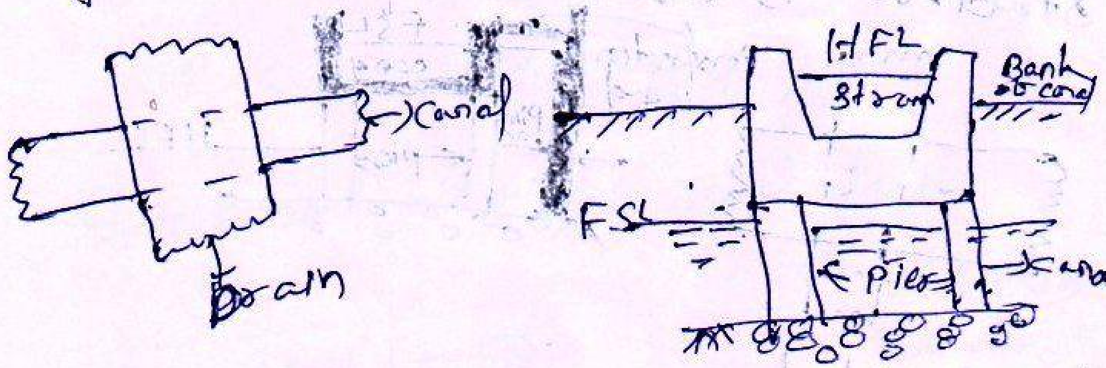


syphon aqueduct

Super passage

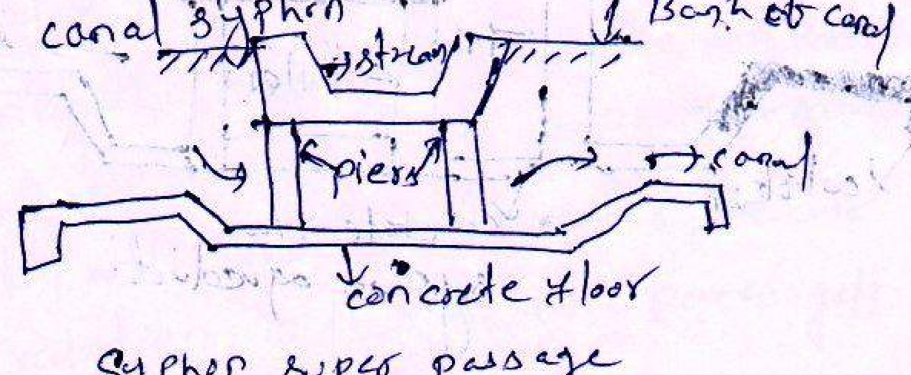
→ In these case, the drain is taken over the canal such that the canal water runs bellow the drain freely.

→ When FSL of canal is sufficiently bellow the bottom of the drain through so that canal water flows freely under gravity of structure is called super passag.



Syphon super passage

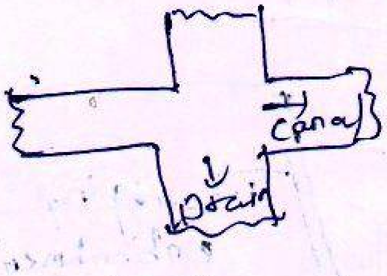
→ If the FSL of the canal is sufficiently above the bed level of drainage through so that canal flows under syphonic action under the through the structure is known as canal syphon

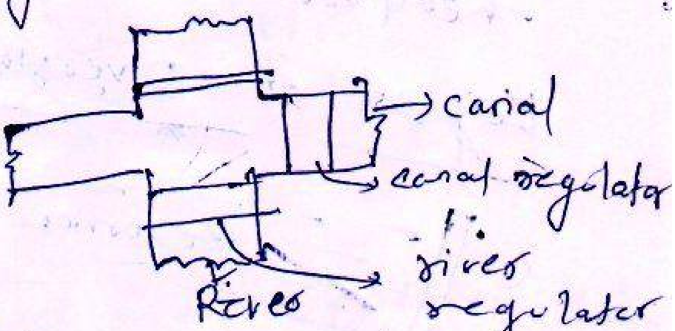


Syphon super passage

level crossing

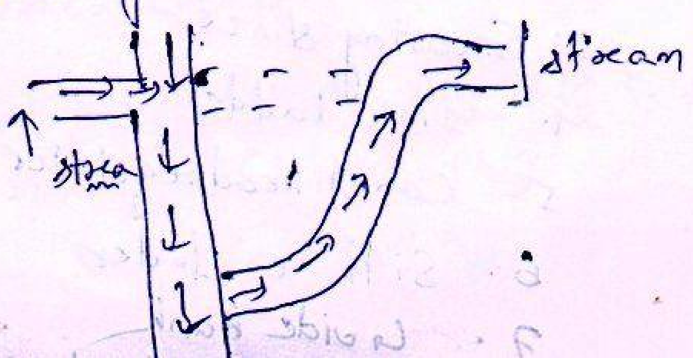
- In this type of cross drainage work, the canal water and drain water are allowed to intermingle with each other.
- A level crossing is generally provided when a large canal and huge drainage approach each other practically at same level.





Inlet & outlet

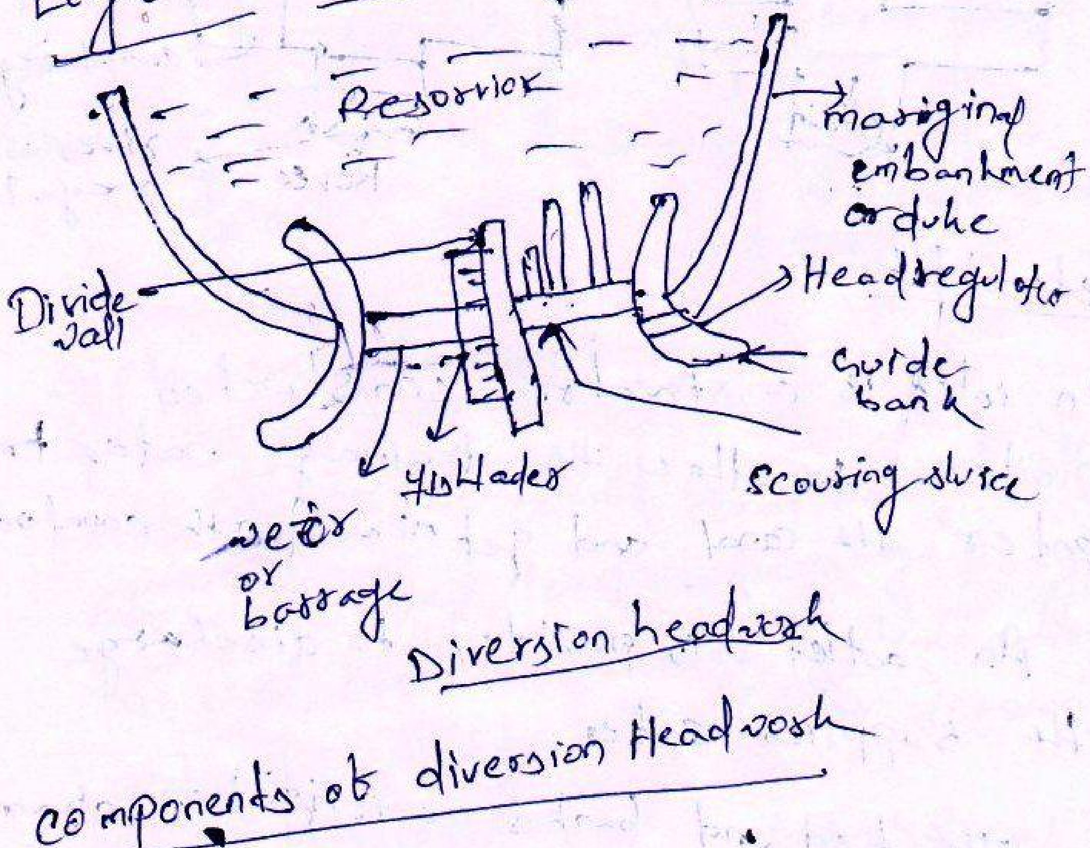
- An inlet is a structure constructed in order to allow the drainage water to enter the canal and get mixed with canal water.
- An outlet is provided to discharge the supplies water.
- The bed and banks of irrigation channel b/w inlet and outlet points should be protected by stone pitching.



Diversion Headwork

→ The ~~water~~ works, which is constructed at the head of the canal inorder to divert the river water towards the canal so as regulated continious supply of silt free water with a certain minimum head in to canal is known as diversion headwork.

Layout of Diversion Headwork



Diversion headwork

Components of diversion Headwork

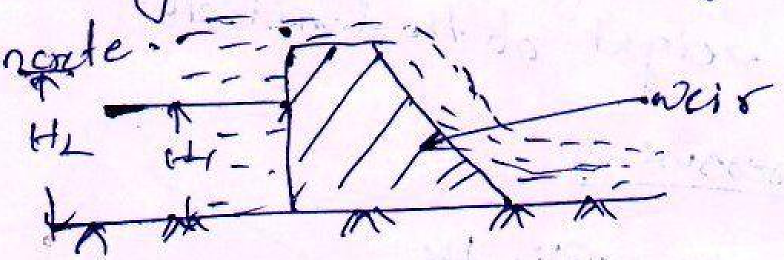
1. weir or barrage
2. Divide wall
3. Scouring sluice
4. fish ladder
5. Canal headregulator
6. Silt excluder
7. Guide bank

weir.

→ when the bed level of canal is at higher than the river level the water cannot be diverted towards the canal

→ So as to raise the water level an obstruction is constructed called weir

→ It may be constructed through masonary or concrete.



Barrage

→ when the water level on the upstream side of the weir is required to be raised to different levels at different times, then the barrage is constructed.

Lane's weighted creep theory

→ Lane on the basis of his analysis carried out on about 200 dams.

→ So he suggested a weightage factor of 1/3 for the horizental creep as against 1.0 for vertical creep.

$$L_L = (h_1 + h_2) + \tfrac{1}{3} S_1 + (h_2 + h_3) + \tfrac{1}{3} S_2 + (h_3 + h_3)$$

$$= \frac{1}{3}(S_1 + S_2) + 2(h_1 + h_2 + h_3)$$

$$= \frac{1}{3} S + 2(h_1 + h_2 + h_3)$$

EARTHEN DAM

→ Earthen dam are constructed purely by earthwork in trapezodial action

→ These are most economical and suitable for weak foundation.

→ It can be easily constructed

Types of Earthen Dam

→ homogenous embankment type

→ zoned embankment type

→ Diaphragram type

→ hydraulic-fill type

→ Rolled fill Dam

Spillways

→ A spillway is a structre constructed at dam site for effectively disposing of surplus water from upstream to down stream

→ The spillways are opening provided at the body of discharge safely excess water or flood water when water level rises above normal level

Types of spillway

(i) straight drop spillway

(ii) ogee spillway

(iii) chute spillway

(iv) side channel spillway

(v) shaft spillway

(vi) syphon spillway.

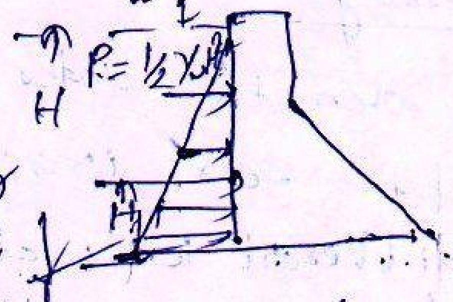
Module-IV

Force acting on gravity dam

(I) water pressure
(II) uplift pressure
(III) pressure due to earthquake force
(IV) silt pressure
(V) wave pressure
(VI) weight of the dam itself.

water pressure

→ water pressure (P) is the most major external force acting on a dam



→ The horizontal water pressure exerted by the wt of the water stored in the upstream side of dam can be estimated from rule of hydraulic pressure distribution

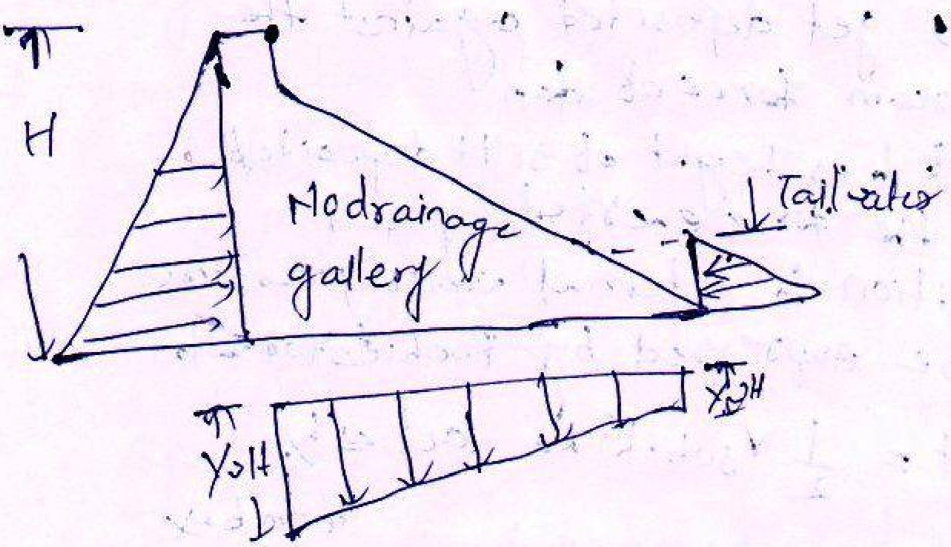
γ_w = unit weight = 9.81 kN/m²

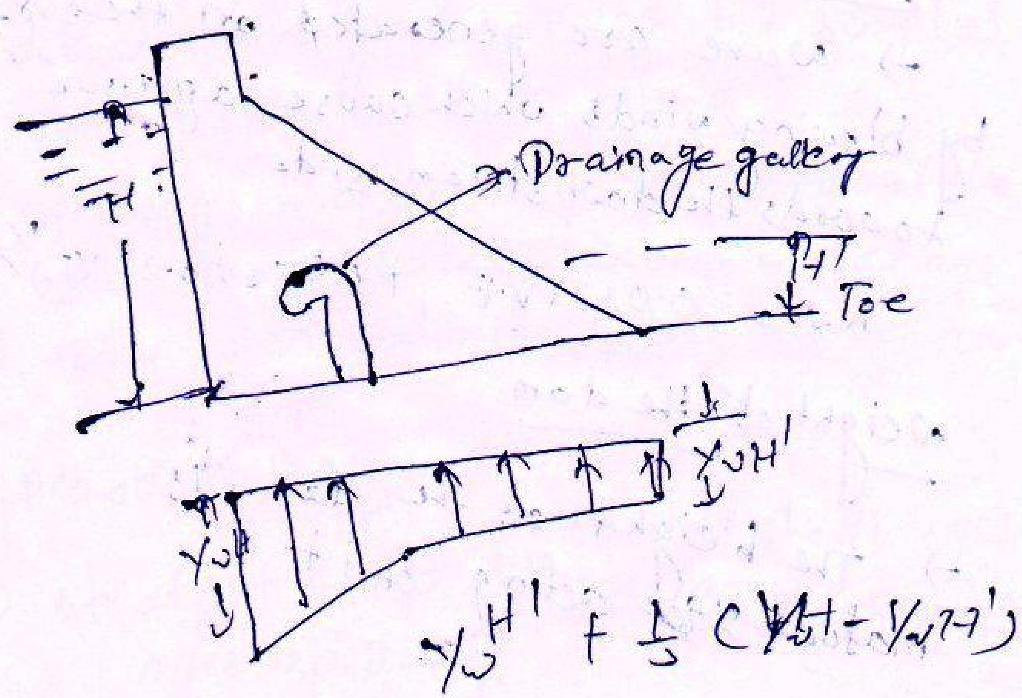
→ γ_w = unit weight of water
H – depth of water

Resultant force = $\frac{1}{2}\gamma_w H^2$

uplift pressure

- → water seeping through the pores, cracks and fissures of the foundation material and water seeping through dam and its foundation at the base.
- → such an uplift force vertically reduces the downward weight of the dam hence acts against dam stability.





Earthquake force

-) For dam design allowance must be made for the stresses genered by earthquake

(1) effect of vertical acclen (av)

(ii) effect of horizenal accn (a_h)

Siltpressure

-> Silts get deposited against the upstream force of dam.

-> of h is height of silt deposited then the force exerted by silt in addition to external water pressure can be expressed by Rankie's formula

$P_{silt} = \frac{1}{2} \gamma_{sub} \cdot h^2 k_a$ act as $h/3$ from base

wavepressure

-) wave are generated on the surface by blowing winds which cause a pressure towards the downstream side

$h_w = 0.032\sqrt{V \cdot F} + 0.763 + 0.271(F)^{1/4}$

weight of the dam

-) The weight of the dam is major force acting on it