FLUID MECHANICS

INTRODUCTION

- **Fluid :-** A fluid may be defined As a substance which is capable of flowing and offers practically no resistance to the change of shape.
- **Types Of Fluids :-**

1. **Ideal Fluids :-** The fluids which are incompressible and have no viscosity and surface tension are called ideal fluids.
2. **Real Fluids :-** The fluids which possess properties such as viscosity and surface tension and compressibility are called real fluids.

   These are further subdivided into the following categories :

   (i) Newtonian fluids,

   (ii) Non-Newtonian fluids,

   (iii) Ideal Plastic fluids,

   (iv) Thyxotropic Fluids.

- **Fluid Mechanics :-** It is the branch of science which deals with the behaviour of fluids at rest as well as in motion.

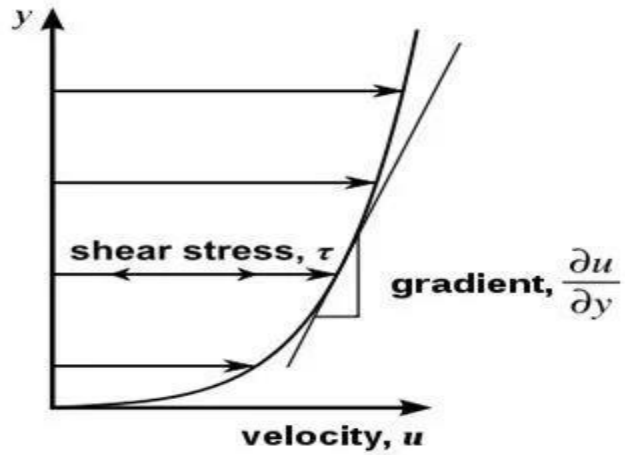
1. **Hydrostatics :** The study of liquids at rest Is called hydrostatic.
2. **Hydrokinematics :** The study of liquids in motion, when pressure forces are not considered, is called hydrokinematics.
3. **Hydrodynamics :** The study of liquids in motion, when pressure forces are considered, is called hydrodynamics.

- **Hydraulics :-** It is the branch of science which deals with water at rest or in motion.

PROPERTIES OF FLUIDS

1. **Mass Density :-** It may be defined as mass of fluid per unit volume. It is generally denoted by **Rho.** Its S.I. Unit is **kg/m3**. The mass density of water is taken as **1000 kg/m3** at **4°C**.
2. **Specific Weight :-** It may be defined as weight of fluids per unit volume. It is generally denoted by **w**. It's S.I. Unit is **N/m3.** The specific weight of water is taken as **9810 N/m3** at **4°C**.
3. **Specific Volume :-** It may be defined as the volume occupied by the fluids per unit mass. It is generally denoted by **v.** It's S.I. unit is **m3/kg**. Specific volume is reciprocal of mass density.
4. **Specific Gravity :-** It may be defined as the ratio of specific weight of fluid to the specific weight of a standard temperature I.e. 4°C. It is generally denoted by **S**.

- **Viscosity :-**It is the property of fluid by virtue of which it offers resistance to the movement of one layer of fluid over an adjacent layer. The unit of viscosity is **Pa.s**



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

Where,

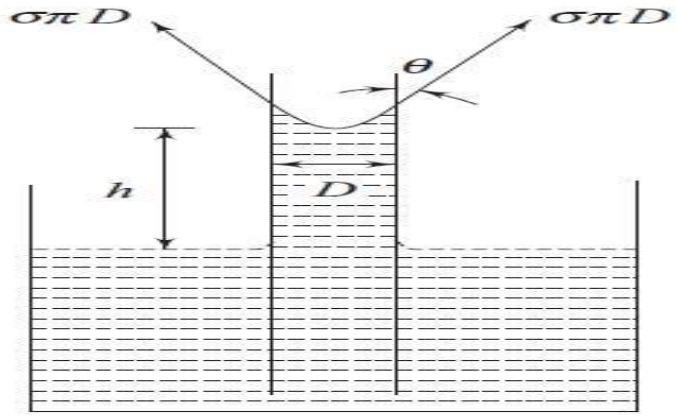
μ = Dynamic viscosity

τ = Shear stress= F/A

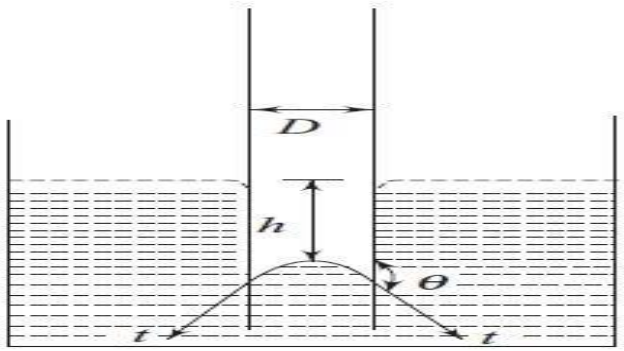
$\frac{du}{dy}$ = Rate of shear deformation

- **Vapour Pressure :-** The partial pressure exerted on its surface by the vapours of the same liquid which gathers into the container containing the liquid, above the surface of the liquid due to evaporation.
- **Cohesion :-** It is the property of liquid by virtue of which it can withstand slight tension.
- **Adhesion :-** It is the property of liquid by virtue of which it adheres to the solid body with which it is in contact.

- **Surface Tension :-** The properties of liquid by virtue of which the free surface of the liquid acts as a stretched elastic membrane capable of bearing a slight amount of tension is called surface tension. It's S.I. unit is N/m.
- **Capillarity :-** It is the phenomenon by which a liquid rises up or falls down in a thin glass tube in compresion to the general liquid level in the vessel, when the glass tube is dipped into the mass of liquid. The rise of liquid is known as capillary rise whereas the fall of liquid is known as capillary depression.



Capillary rise
Adhesion > cohesion
liquid wets the surface



Capillary depression
Adhesion < cohesion
liquid stays away from
the surface

- **Compressibility :-** It may be defined as the property by virtue of which the fluid undergoes a change in volume under the action of external pressure. It's S.I. Unit is **m2/N**. It may be expressed as the reciprocal of bulk modulus of elasticity (K).

HYDROSTATIC PRESSURE

- **Pressure Of A Liquid :-** When a liquid is contained in a vessel, it exerts force on the sides and bottom of the vessel due to its weight. It is generally denoted by **P** and its S.I. Unit is **Newton (N)**.
- **Intensity Of Pressure :-** The presure exerted by the liquid per unit area is called intensity of pressure. The S.I. Unit of intensity of pressure is **N/m2**.
- **Pressure Head Of Liquid :-** When pressure is expressed in terms of height of liquid, it is commonly called pressure head. It is denoted by **h**.
- **Pascal`s Law :-** This law states that the liquid at rest transmits pressure with equal intensity in all the directions and the direction of liquid pressure is always perpendicular to the surface on which it acts.
- **Total Pressure :-** It may be defiend as the force exerted by a static liquid on a surface when the liquid comes in contact with it.

- **Centre Of Pressure :-** It may be defiend as the point through which the total pressure acts on the surface.

There are three cases of immersed surfaces on which the total pressure and centre of pressure is to be found. These surfaces are as under :

1. Horizontal Plane Surface Immersed In a Liquid

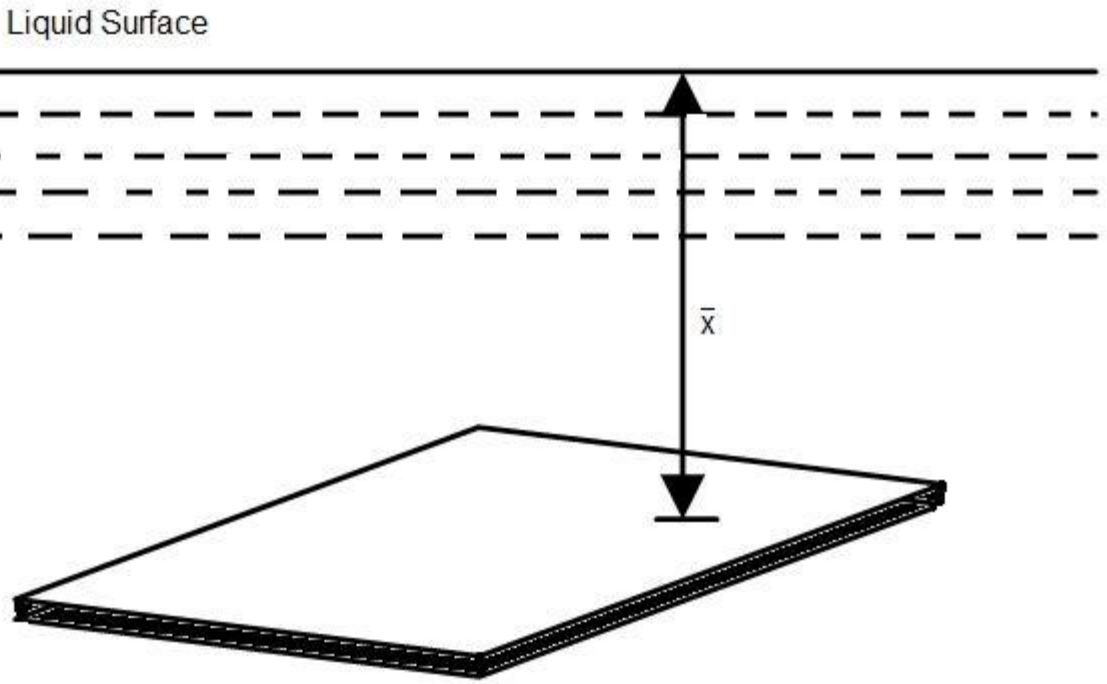
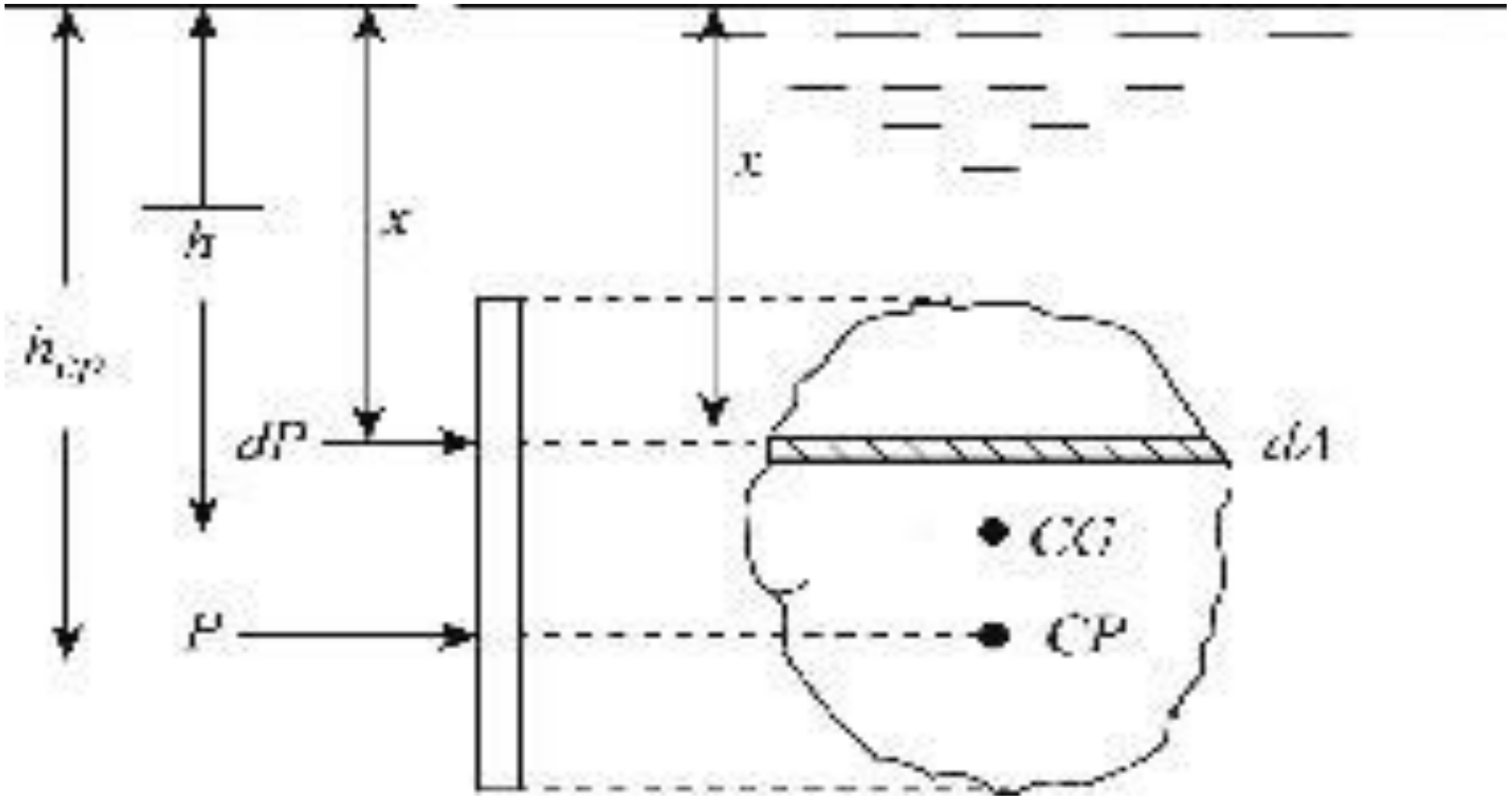


Fig 1: Horizontally Immersed Surface

2. Vertical Plane surface Immersed in a Liquid



3. Inclined Plane Surface Immersed in a Liquid