In this lesson, we will:

- Define fluid mechanics – What is a *fluid*? What is *mechanics*?
- Discuss normal stresses and shear stresses

INTRODUCTION

What is Fluid Mechanics?

Fluid – what is a ***fluid***?

liquid or a gas

If compressibility effects are negligible and there are no ***free surfaces*** (e.g., water surface exposed to air), then liquids and gases behave the same – we analyze ***fluids*** without worrying whether the fluid is a gas or a liquid.

Examples:

1. Human powered submarine tested in a wind tunnel
2. Jet engine exhaust tested in a water tunnel

	Actual fluid	Test fluid
1.	water	air
2.	air	water

Exceptions:

1. Liquids with free surface effects → e.g., waves due to boat on surface of a lake
2. Gases in high-speed flow → rockets → compressibility effects are significant

Definition of a **fluid**

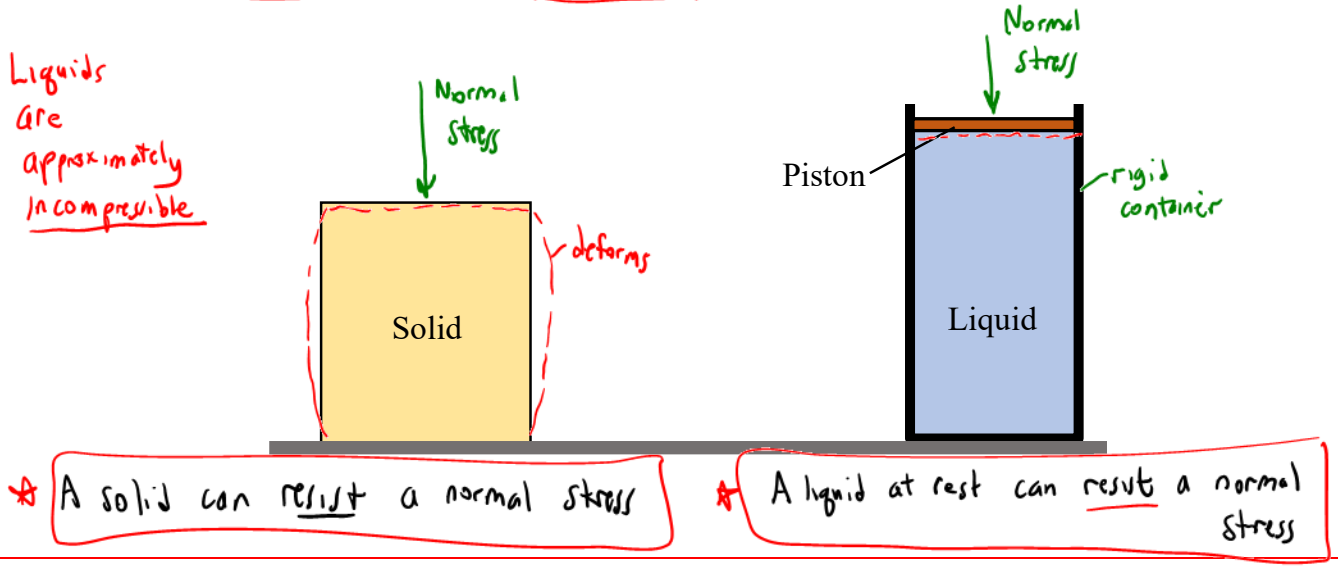
A fluid is a substance that deforms continuously under the application of a shear stress.

So, we need to define **stress**.

Definition of **stress**

Stress is a force per unit area acting on a surface.

There are both **normal stresses** and **shear stresses** as illustrated on the surfaces of an object:

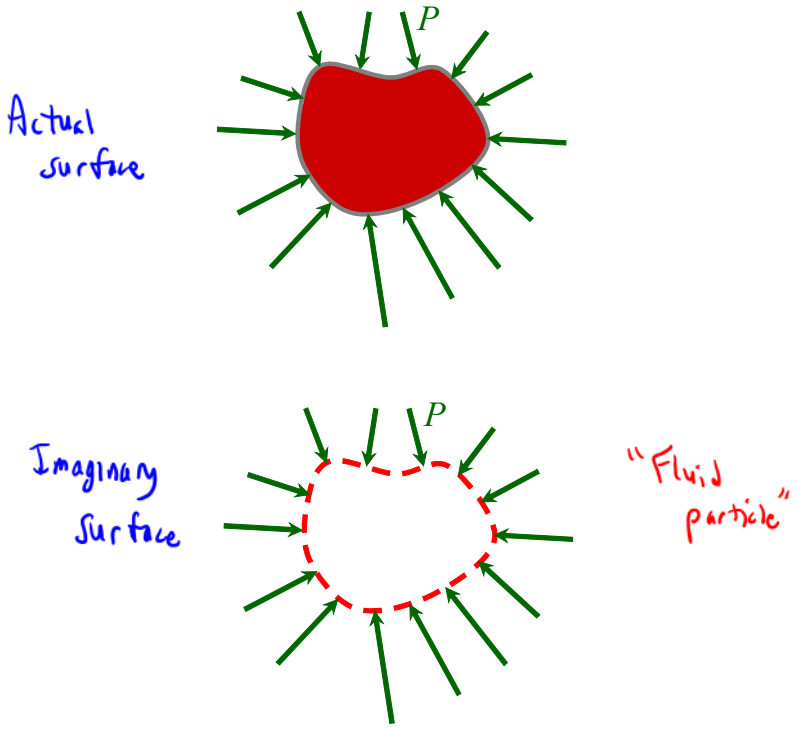


Pressure

Pressure is an example of a **normal stress**.

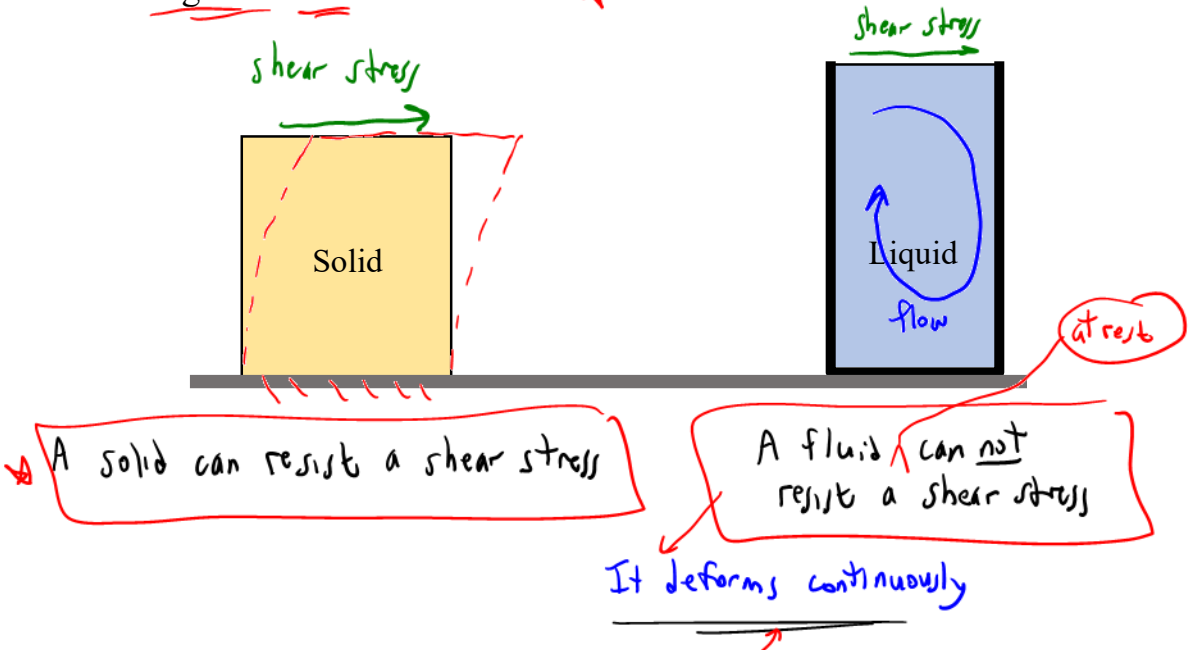
In fact, in a fluid at rest, the only normal stress is the pressure stress.

Pressure always acts inward and normal to a surface



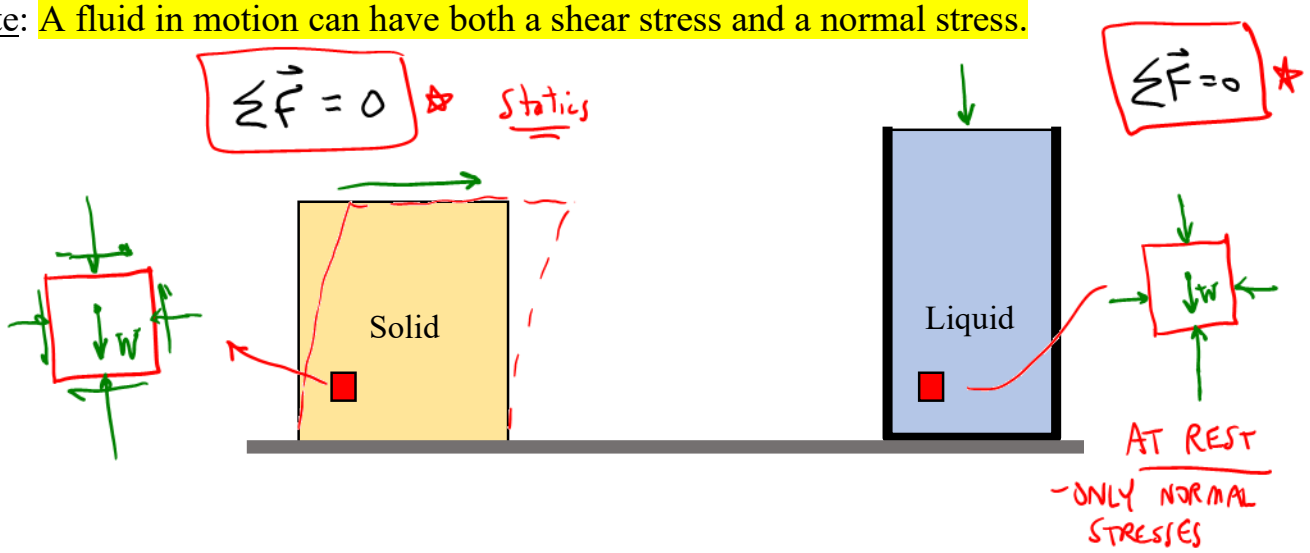
Shear stress

Shear stress is a tangential stress on a surface



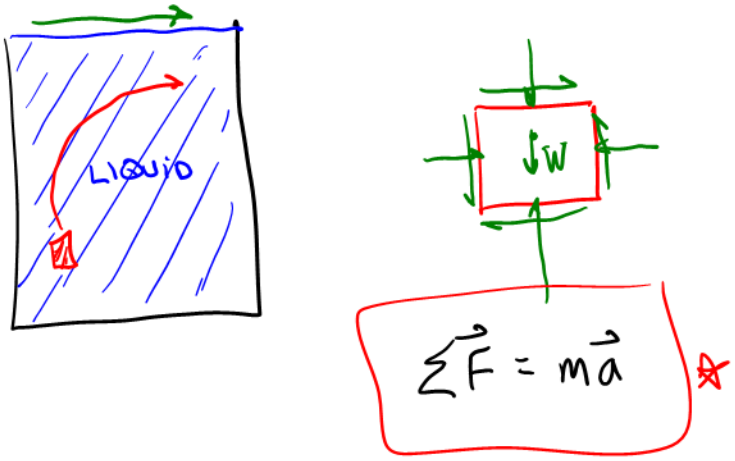
Bottom line: A fluid at rest cannot resist a shear stress.

Note: A fluid in motion can have both a shear stress and a normal stress.

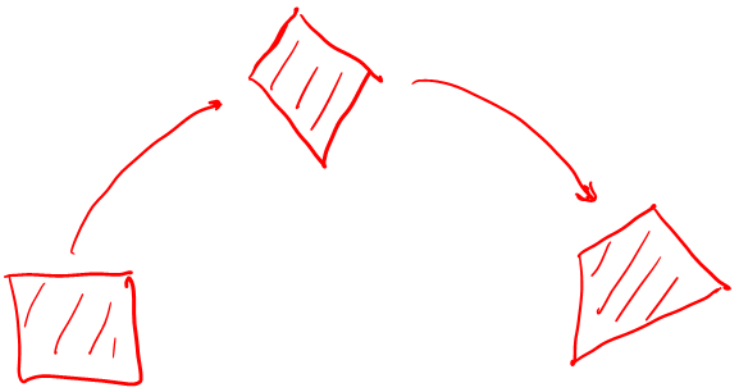


Examine all the stresses on a little element of the solid or the liquid by using a **free-body diagram**.

LIQUID with shear added



Further complication with fluids



Now let's return to our definition of ***fluid mechanics***. We defined ***fluid***. Now define ***mechanics***.

Mechanics – what is ***mechanics***?

Definition of a **mechanics**

Mechanics is the application of the laws of force and motion…there are two branches, **statics** and **dynamics**.

We will study both in this course:

1. Fluid statics (Hydrostatics) — Fluids at rest — use free-body diagrams — $\sum \vec{F} = 0$

FLUID MECHANICS

2. Fluid dynamics (fluids in motion) — $\sum \vec{F} = m\vec{a}$

Finally, our definition of fluid mechanics:

Fluid mechanics is the application of the laws of force and motion on a fluid, which is a substance that deforms continuously under the application of a shear stress.