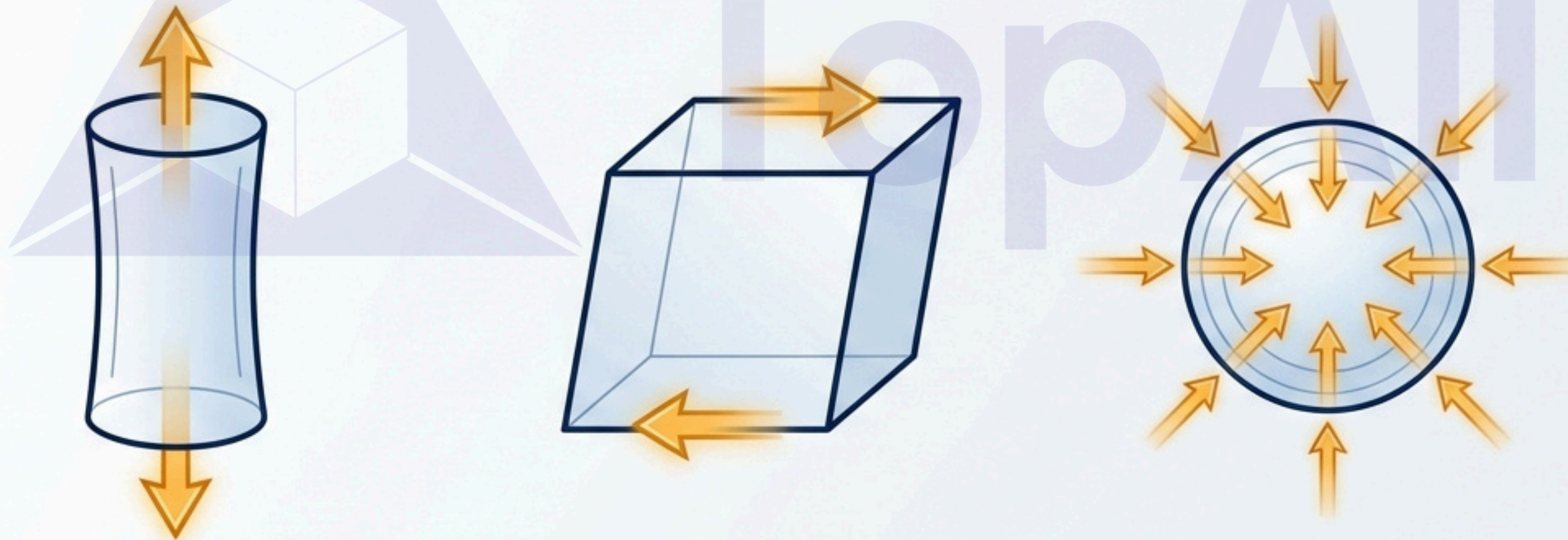


How solids respond when force is applied

8.2 Stress and Strain | Mechanical Properties of Solids



Stress: The Internal Restoring Force

When a body is subjected to a deforming force, it develops an internal restoring force.

This restoring force is equal in magnitude but opposite in direction to the applied force.



Exam Trap: Stress is defined by the restoring force, not the applied force. The body must be in static equilibrium.

$$\text{Stress} = \frac{F}{A}$$

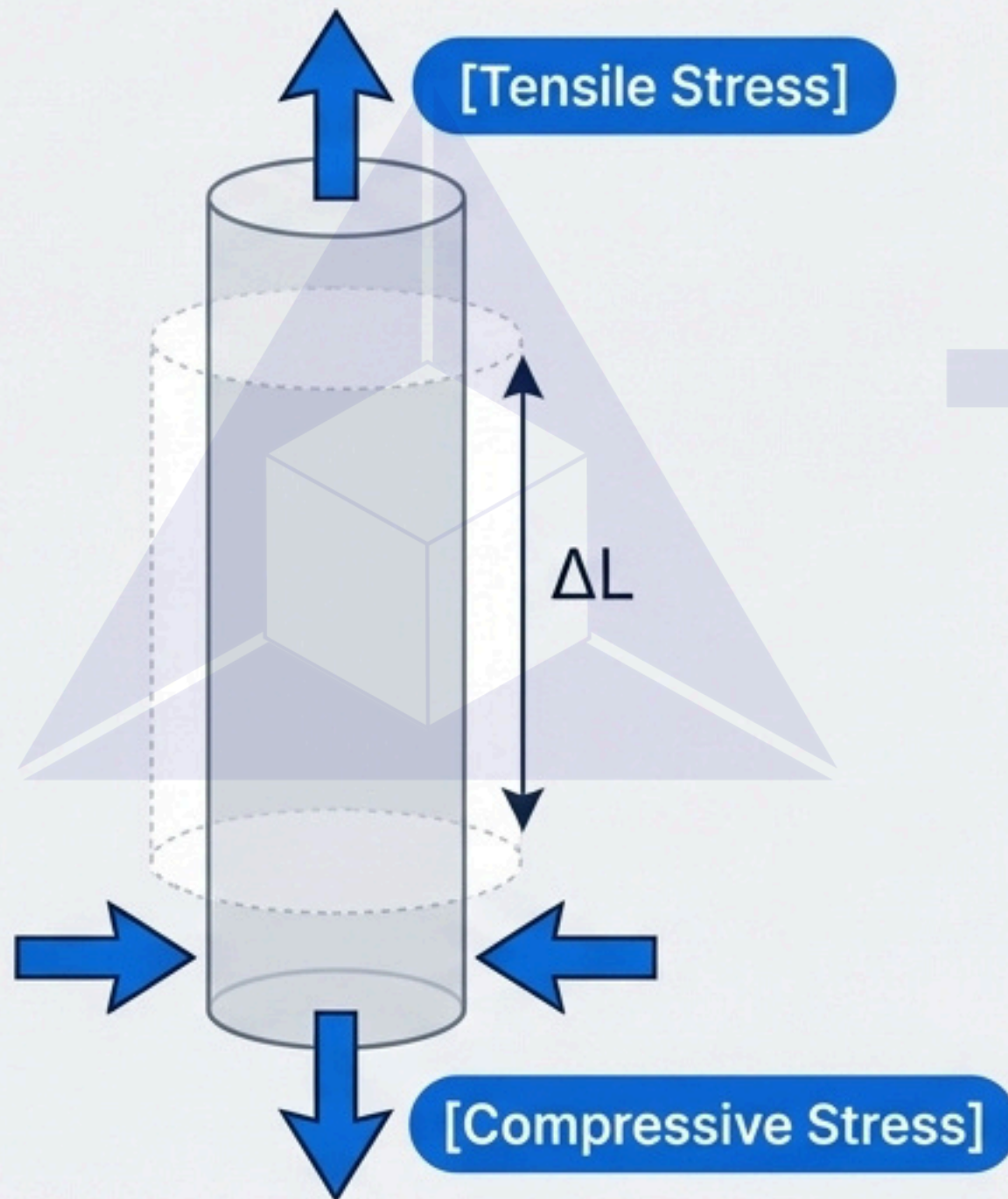
Force applied normal to cross-section

Area of cross-section

 SI Unit: Pascal (Pa) or N m^{-2}

 Dimensions: $[\text{M L}^{-1} \text{T}^{-2}]$

1D Deformation: Longitudinal Stress



When forces are applied normal to the cross-sectional area, the cylinder changes in length.

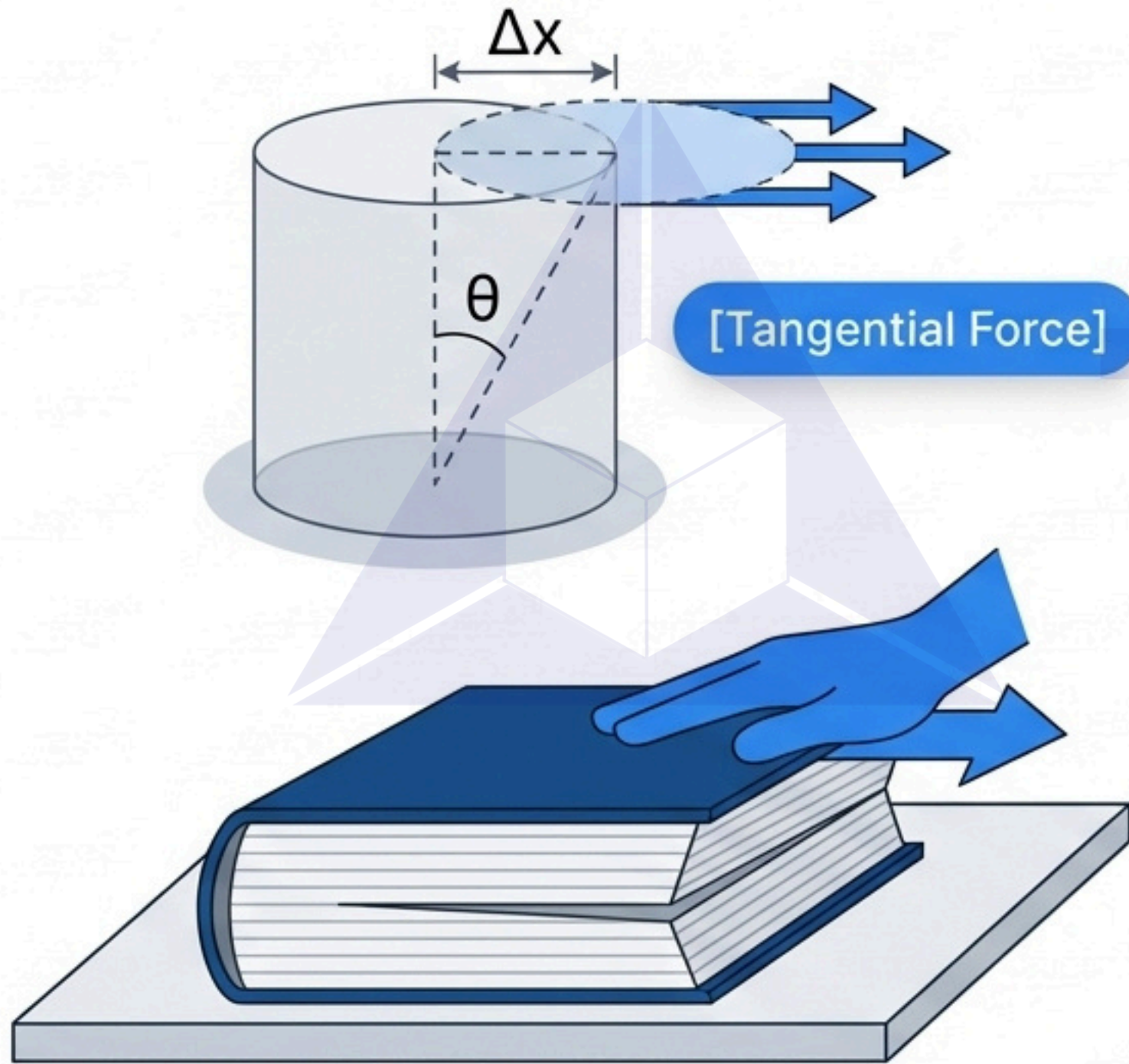
$$\text{Longitudinal Strain} = \frac{\Delta L}{L}$$

Strain measures the **fractional change**: ΔL (change in length) relative to L (original length).

SI Unit: Dimensionless

Dimensions: $[M^0 L^0 T^0]$

2D Deformation: Shearing Stress



Relative displacement between opposite faces due to an applied tangential force.

$$\text{Shearing Strain} = \frac{\Delta x}{L} = \tan \theta$$



Math Trick: Because the deformation is usually very small, $\tan \theta \approx \theta$. (At $\theta = 10^\circ$, the difference is only 1%).



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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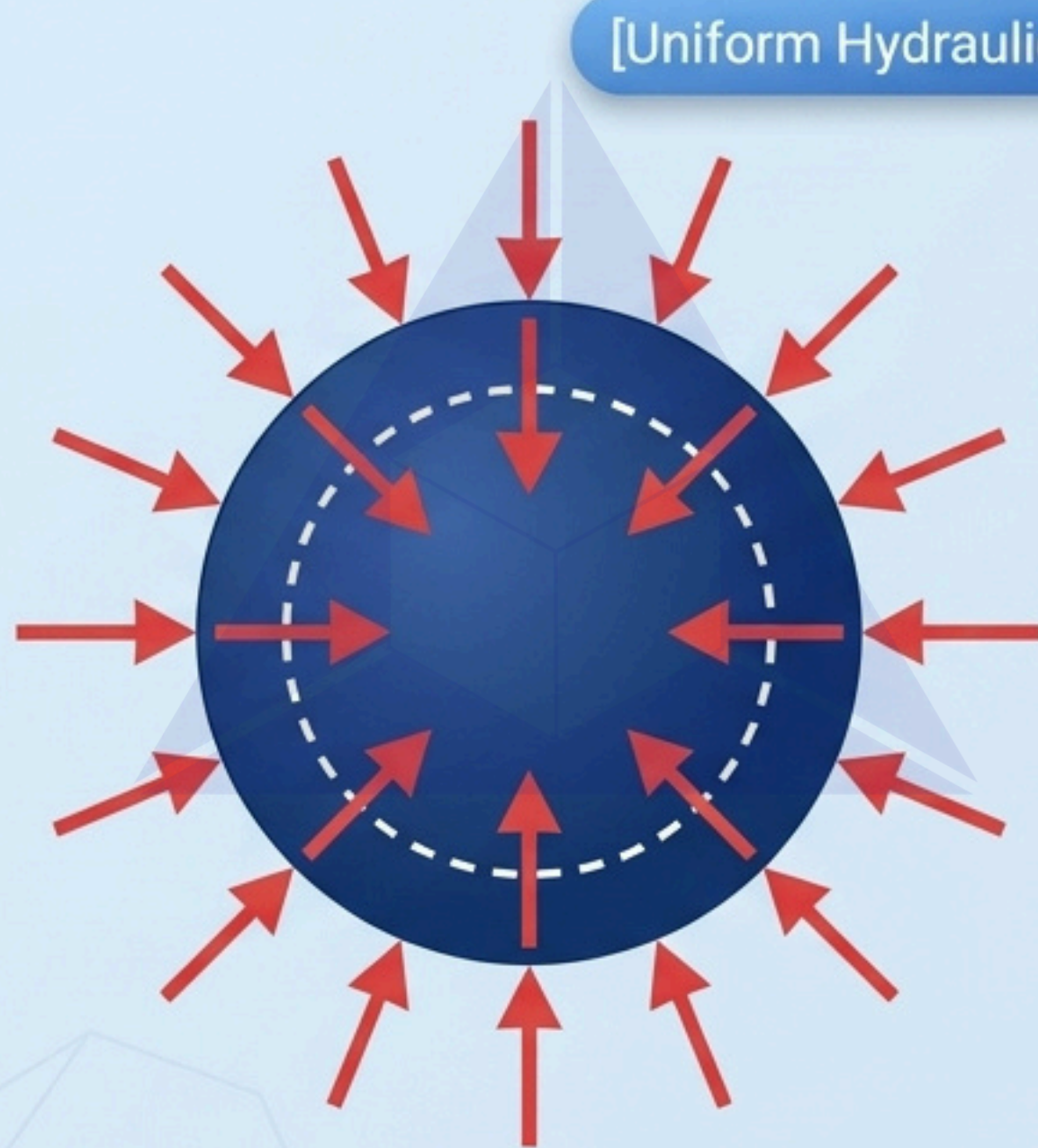
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3D Deformation: Hydraulic Stress



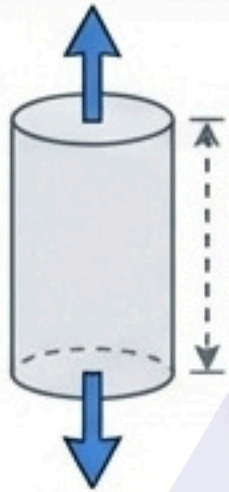
A body placed in fluid under high pressure is compressed uniformly on all sides.

$$\text{Volume Strain} = \frac{\Delta V}{V}$$

Volume **strictly decreases**, but the geometrical shape remains exactly the same.

At a Glance: Comparing the 3 Types of Strain

[Longitudinal]

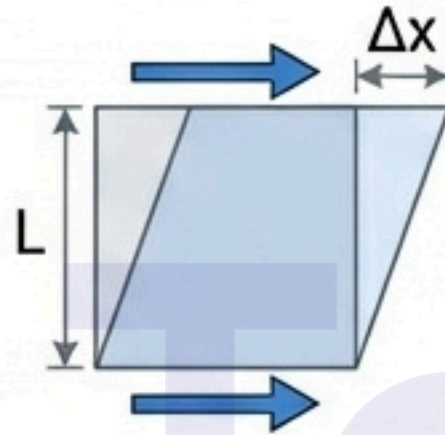


Force Direction: Normal to cross-section.

What Changes? Length (ΔL).

$$\frac{\Delta L}{L}$$

[Shearing]

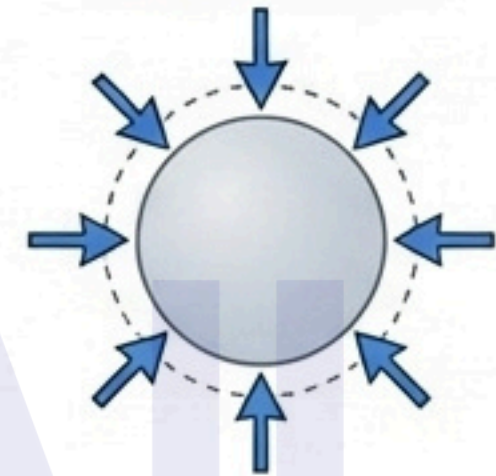


Force Direction: Tangential (parallel to surface).

What Changes? Relative face displacement (Δx).

$$\frac{\Delta x}{L} = \tan \theta$$

[Hydraulic]



Force Direction: Uniformly perpendicular from all sides.

What Changes? Volume (ΔV). No shape change.

$$\frac{\Delta V}{V}$$

Chapter Master Formulas

$$\text{Stress} = F / A$$

Magnitude of Stress

$$\text{Longitudinal Strain} = \frac{\Delta L}{L}$$

Longitudinal Strain

$$\text{Shearing Strain} = \frac{\Delta x}{L} = \tan \theta \approx \theta$$

Shearing Strain

$$\text{Volume Strain} = \frac{\Delta V}{V}$$

Volume Strain

[EXAM READY]

Final Revision & Exam Memory Cues

You're ready for the exam. Just remember...



Zero Dimensions

Strain is a ratio of identical dimensions (e.g., length/length). It has NO units and NO dimensional formula.



Pascal is King

The SI Unit of Stress is always N m^{-2} or Pascal (Pa).



Restoring, Not Applied

Stress measures the body's internal fight back to equilibrium, not the external force.



The Small Angle Trick

For shearing strain, always remember $\tan \theta \approx \theta$ because angular deformations in solids are typically tiny.



Shape vs. Volume

Hydraulic stress changes volume but preserves the exact geometrical shape.



You've Learned the Theory.

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