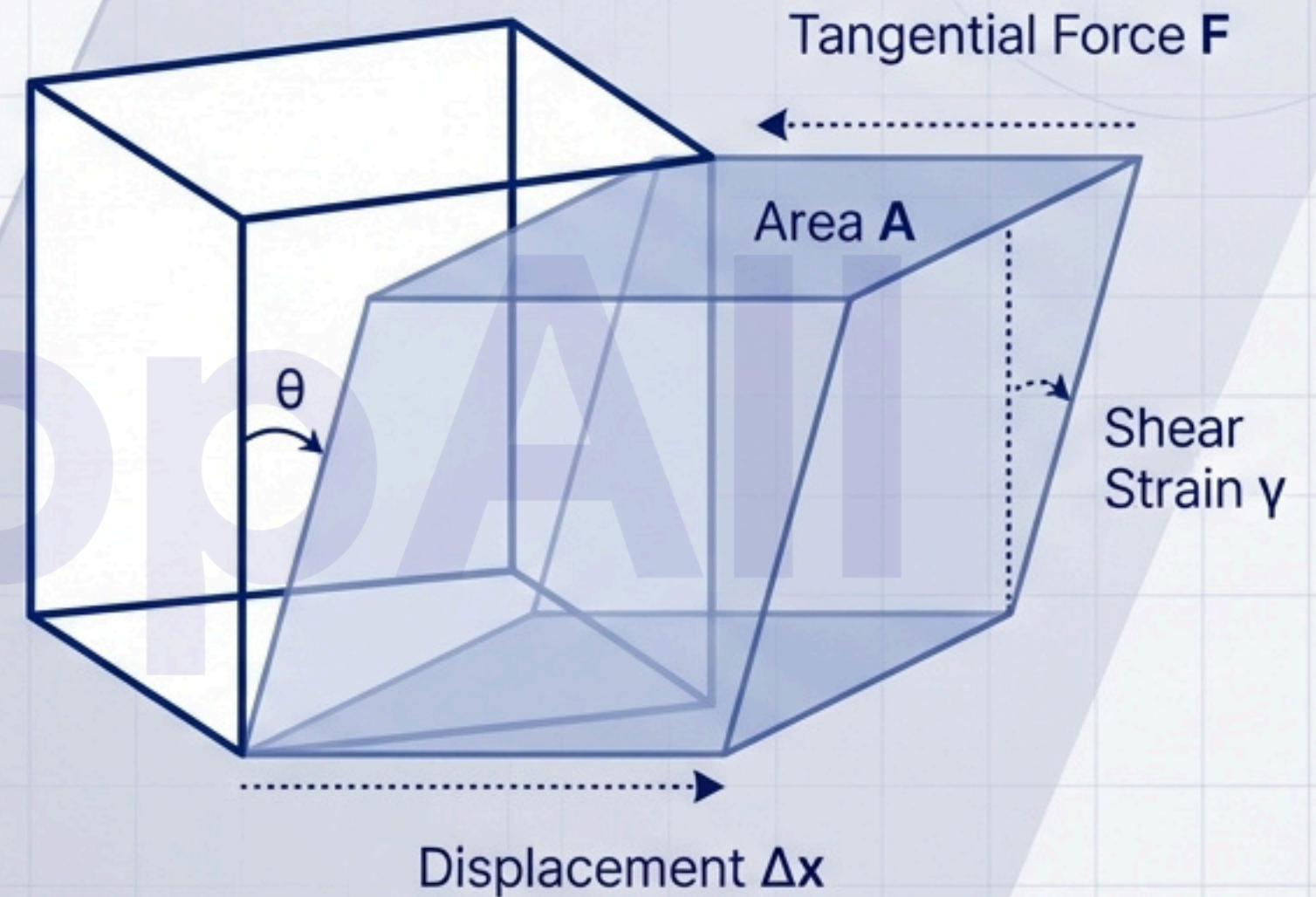


[Class 11 Physics]

[Chapter 8: Mechanical Properties of Solids]

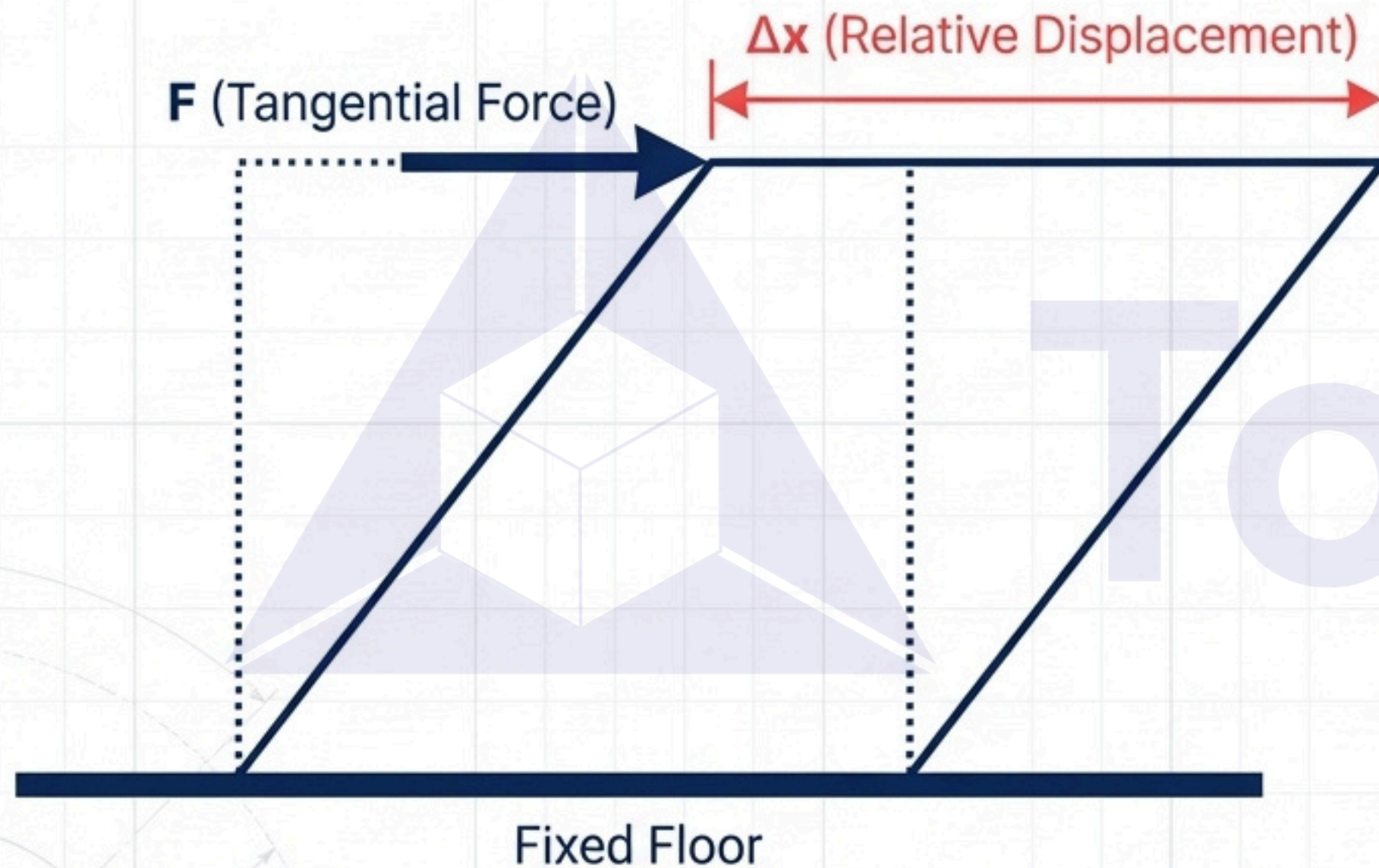
8.5.2 Shear Modulus

Understanding Tangential Stress, Strain, and the Modulus of Rigidity.



 Ready to master shear mechanics!

What is Shearing Deformation?



The Action

Forces are applied parallel (tangentially) to the upper and lower faces of a body.

The Result

The body's shape changes, but its volume remains exactly the same. The top face moves sideways relative to the bottom face.

⚠ Exam Trap: Remember, tensile stress pulls perpendicular to the surface. Shearing stress acts tangential (parallel) to the surface!

Defining the Shear Modulus

Shear Modulus (G)

The ratio of shearing stress to the corresponding shearing strain within the elastic limit.

💡 Also known as the **Modulus of Rigidity**.

Shearing Stress (σ_s)

$$\frac{F}{A}$$

(Force per unit area applied tangentially).

Shearing Strain

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

(Ratio of relative displacement to the vertical height of the block).

🎯 **Key Concept:** The Shear Modulus (G) represents how rigid a material is—meaning how much it resists changes to its shape. SI Unit: N m^{-2} or Pascal (Pa).



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

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



At prep.topall.app

Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



The Shear Formula Board



The Core Ratio (Eq 8.10)

$$G = \frac{\frac{F}{A}}{\frac{\Delta x}{L}} = \frac{F \times L}{A \times \Delta x}$$

The fundamental definition:
Shearing Stress divided by
Shearing Strain.

The Angle Version (Eq 8.11)

$$G = \frac{\frac{F}{A}}{\theta} = \frac{F}{A \times \theta}$$

Substituting strain with the
angular displacement θ .

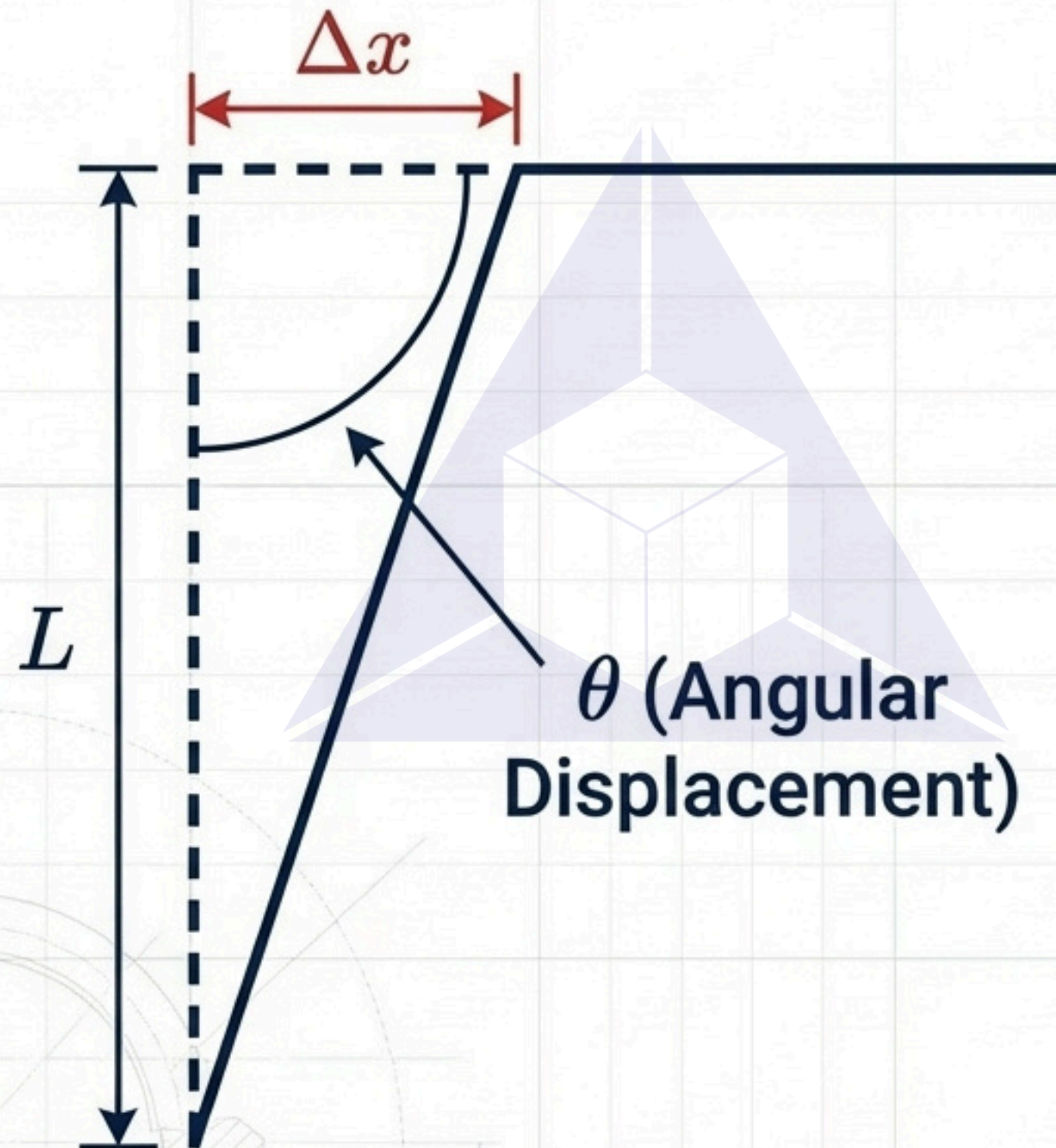
The Stress Focus (Eq 8.12)

$$\sigma_s = G \times \theta$$

Rearranged to solve for
shearing stress directly based
on the deformation angle.

🧠 Memory Cue: All three equations are just different arrangements of the exact same core rule. Know one, and you know them all!

The Angular Displacement Idea



Step 1: By basic right-triangle trigonometry,

$$\tan(\theta) = \frac{\text{Opposite}}{\text{Adjacent}} = \frac{\Delta x}{L}$$

Step 2: In solid materials, elastic deformations are microscopic. The angle θ is incredibly small.

Step 3: For very small angles, $\tan(\theta) \approx \theta$.

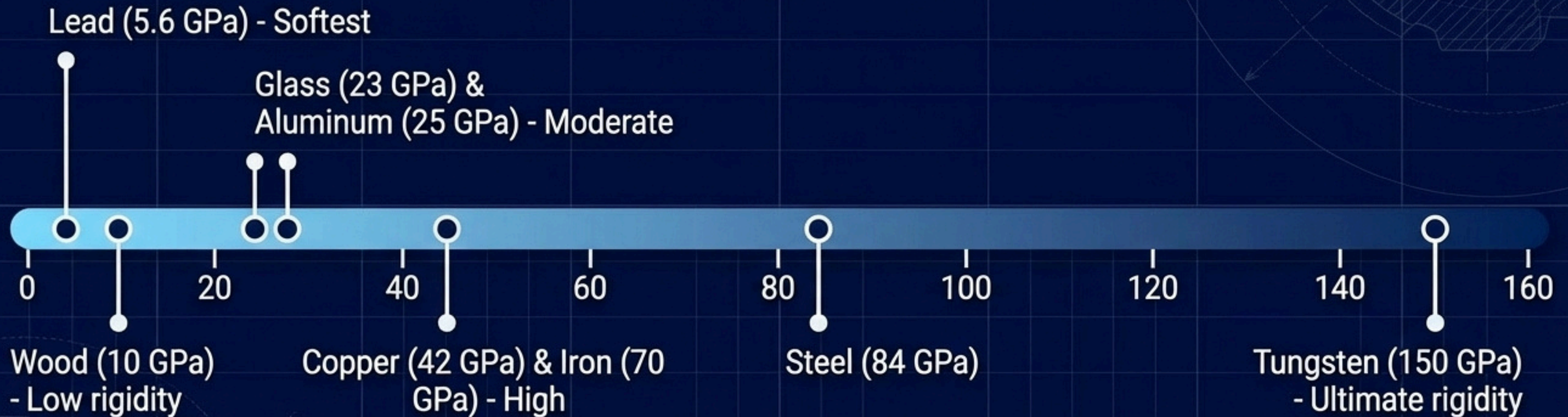
$$\text{Therefore, Shearing Strain} = \frac{\Delta x}{L} = \theta$$

 **Math Note:** When using θ in these formulas, the angle MUST be measured in radians, not degrees!

Modulus of Rigidity in the Real World



Comparing Shear Moduli (G) in 10^9 N m^{-2} (GPa) from Table 8.2

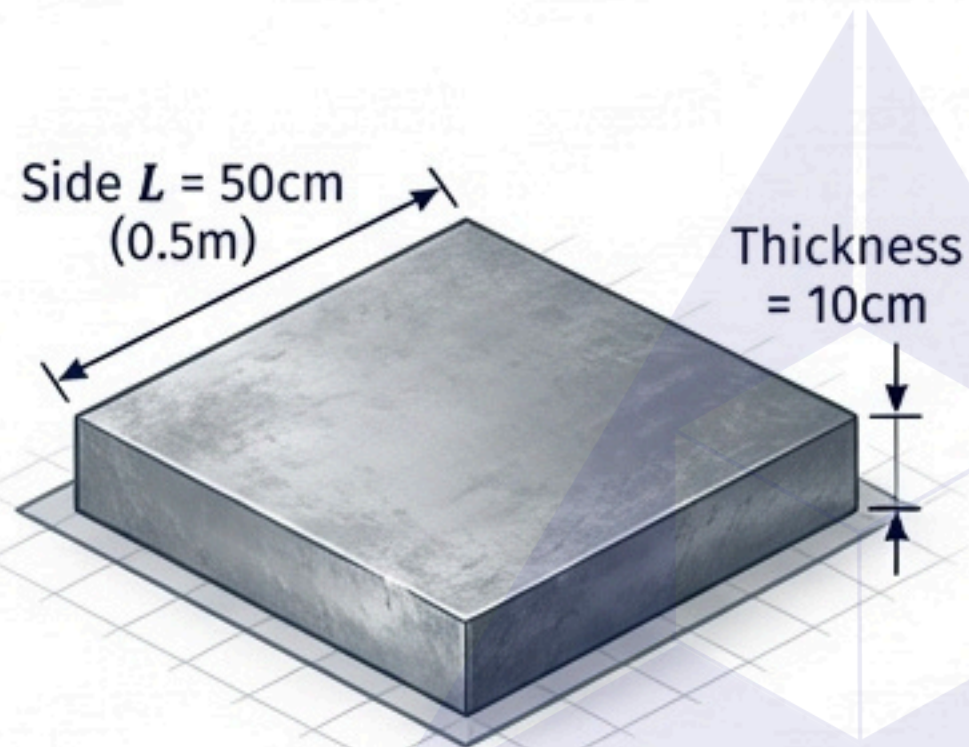


Observation: G is generally less than Young's Modulus (Y) for most materials (roughly $G \approx Y/3$).

Real-World Context: Tungsten resists shape change nearly 30 times better than lead!

Visualizing the Math: The Lead Slab (Example 8.4)

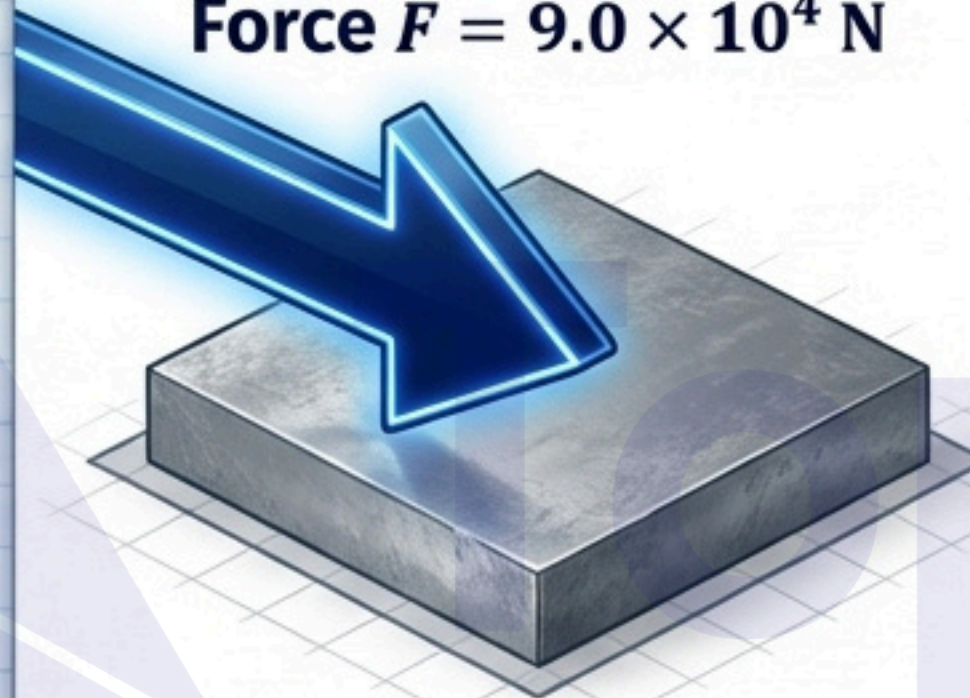
Panel 1: The Setup.



Area of narrow face
 $A = 0.5\text{m} \times 0.1\text{m} = 0.05\text{m}^2$

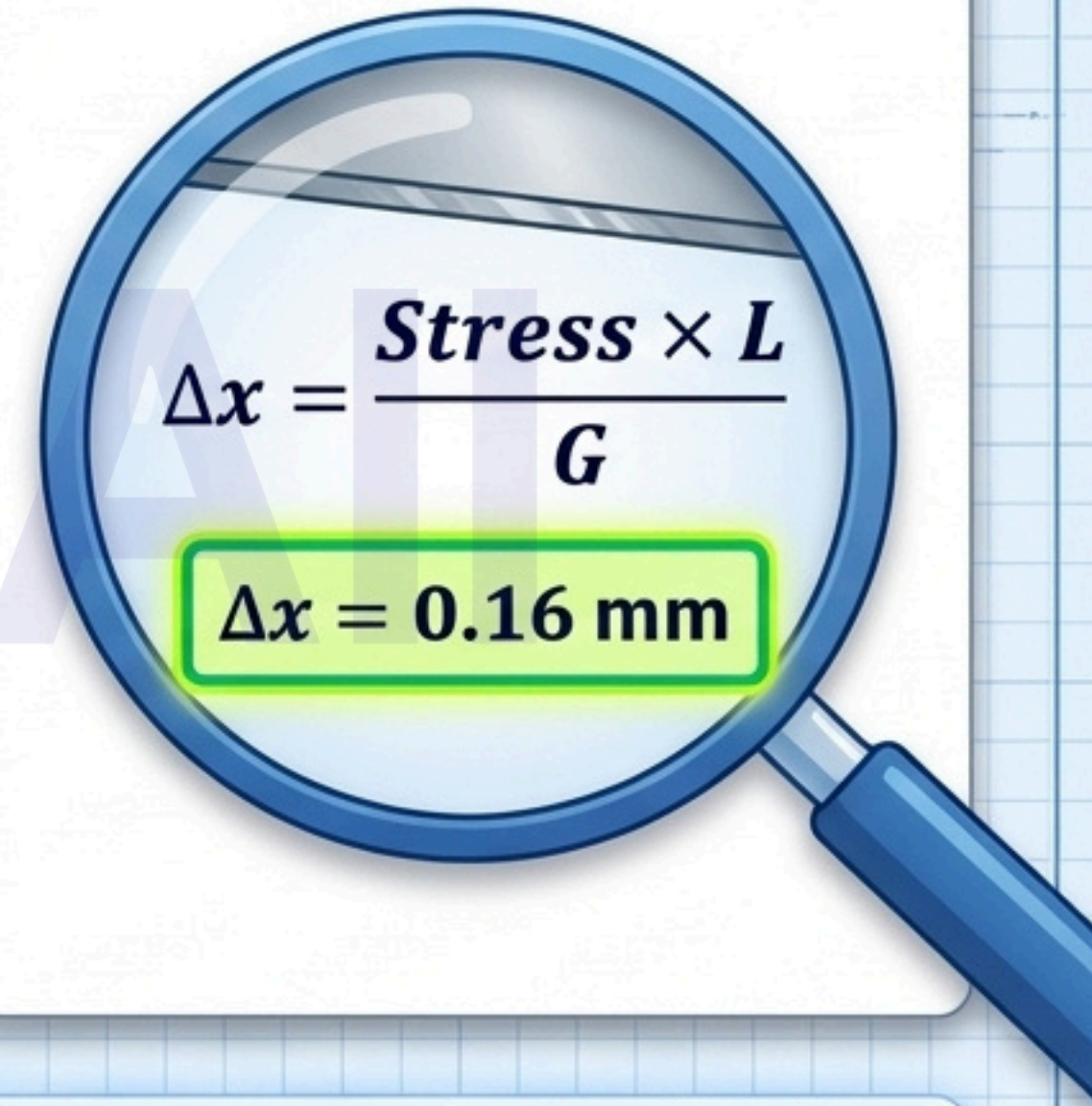
Panel 2: The Action.

Force $F = 9.0 \times 10^4 \text{ N}$



Lead ($G = 5.6 \times 10^9 \text{ Pa}$)

Panel 3: The Result.



💡 **Perspective:** Even when hit with a massive force of 90,000 Newtons, the solid lead slab only shifts by a fraction of a single millimeter!



Chapter 8.5.2: Rapid Revision

- ✓ **The Core Concept:** Shear deals with shape change via tangential force (volume remains constant).
- ✓ **The Terminology:** Shear Modulus is also called the Modulus of Rigidity (G).
- ✓ **The Strain:** Measured as the relative displacement ratio ($\Delta x/L$) or the small angular displacement (θ).
- ✓ **The Golden Rule:** $\sigma_s = G \times \theta$.
- ✓ **Material Fact:** Solids easily resist shear; softer materials like lead have a very low G , while ultra-rigid tungsten has a massive G .

You have covered everything you need to know about Shear Modulus!



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis