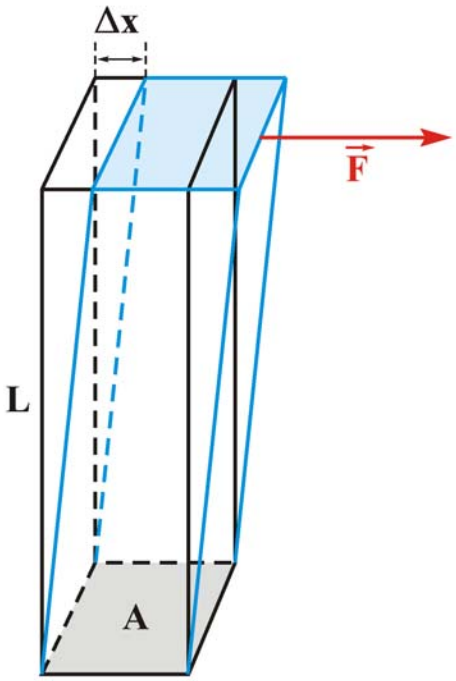
SHEAR MODULUS



The shear modulus is the elastic modulus we use for the deformation which takes place when a force is applied parallel to one face of the object while the opposite face is held fixed by another equal force.

When an object like a block of height **L** and cross section **A** experiences a force **F** parallel to one face, the sheared face will move a distance **Δx**. The **shear stress** is defined as the magnitude of the force per unit cross-sectional area of the face being sheared (**F/A**). The **shear strain** is defined as **Δx/L**.

The shear modulus **S** is defined as the ratio of the stress to the strain.

$$\mathbf{S} \equiv \frac{\text{shear } \mathbf{stress}}{\text{shear } \mathbf{strain}} = \frac{\frac{\mathbf{F}}{\mathbf{A}}}{\frac{\Delta \mathbf{x}}{\mathbf{L}}} = \frac{\mathbf{F\,L}}{\mathbf{A}\,\Delta \mathbf{x}} \quad \textbf{(}\text{units are Pascals}\textbf{)}$$

The bigger the shear modulus the more rigid is the material since for the same change in horizontal distance (strain) you will need a bigger force (stress). This is why the shear modulus is sometimes called the modulus of rigidity.

To a first approximation there is no change in volume in this deformation. The planes of atoms merely slide sideways over one another. That is why the area **A** (which determines the number of atomic bonds) is important in defining the stress and not just **F**.

Note that in the diagram, since the block is not moving, there is a force **F** to the left on the bottom face which is not shown.