

50.5: Volume Stress

The other types of stress described so far (longitudinal and transverse) deform a solid body, but do not change its volume. A third type of stress, the volume stress (or hydrostatic pressure), involves a change in volume. It typically occurs with the compression or expansion of a gas.

For a gas, the volume stress is just the gas pressure P . Pressure in SI units is measured in Pascals (Pa), named for the French mathematician and physicist Blaise Pascal. One pascal is equal to 1 N/m^2 .

Strain

For volume stress, the strain is the fractional change in volume:

$$\varepsilon = -\Delta V/V_0, \quad (50.5.1)$$

where $\Delta V = V - V_0$ is the change in volume, V_0 is the original (unstressed) volume and V is the stressed volume. If the gas is compressed, then ΔV is negative and the strain ε is positive; if the gas expands, then ΔV is positive and the strain ε is negative.

Bulk Modulus

In the case of volume stress, the appropriate elastic modulus is the bulk modulus B . Since the elastic modulus is the ratio of the stress to the strain, we have

$$B = -\frac{P}{\Delta V/V_0} \quad (50.5.2)$$

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