Beam Bending Stress

Mechanical Engineering

The engineers' bending formula, and what the section modulus buys you.

Bending stress varies linearly across the depth: zero at the neutral axis, largest at the outer fibre.

$$\sigma = M\,y \div I \cdot \sigma_{max} = M \div Z$$

M = 10 kN·m, Z = 100 cm³ — **σ = 100 MPa**

10^7 N·mm ÷ 10^5 mm³.

Rectangle, b by h — **$Z = bh^2 \div 6$**

From I ÷ (h ÷ 2).

Double the depth — **Stress falls four times**

Z rises as h^2.

THE COMMON MISTAKE

× **Taking y as the full depth**

✓ **y is measured from the neutral axis**

For a symmetric section the outer fibre sits at half the depth. Using the full depth doubles the calculated stress.

Assumes small deflection, linear-elastic material, and a section symmetric about the plane of loading.