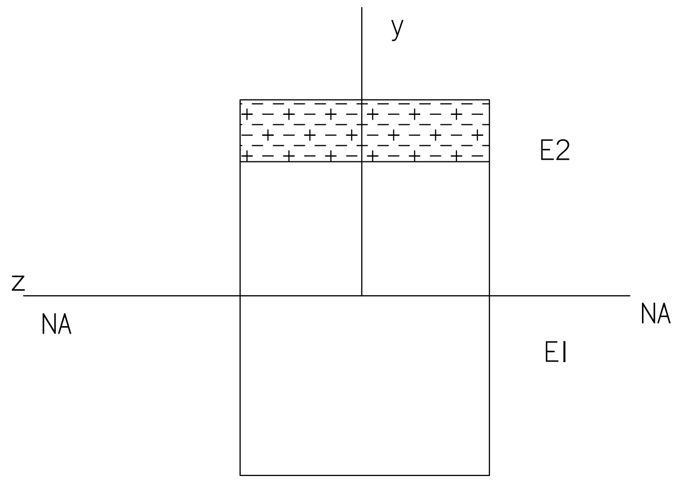
Dissimilar material such as a composite structure:

what if E and I are not constant??

assuming bending only; Mz applied; determine Iz

In this cross section, the upper region has a modulus = E2 where the remainder has modulus E1

as with Euler bending, plane sections remain plane etc....



$$\varepsilon_x = \frac{-y}{R}$$

ε is axial strain

y the distance from the neutral (z) axis

R the radius of curvature

$$\sigma_x = E\cdot\varepsilon_x = \frac{-E\cdot y}{R}$$

Hooke applies (although E is now dependent on y)
signs consistent with Shames 11.2

pure (only) bending => $F_x = \int \sigma_x \, dA = 0 = -\int \frac{E(y)\cdot y}{R} dA$ net axial force = 0

suppose we define a parameter Ti such that $T_i = \frac{E_i}{E_1}$ that is, a fraction of a reference modulus E1

then: $-\int \frac{E(y)\cdot y}{R} dA = \frac{-E_1}{R} \int T_i(y)\cdot y \, dA$

"transfer" Ti to the area, in such a way that y is not affected => $T_i(y)\cdot y\cdot dA = y\cdot\left(T_i(y)\cdot dA\right) = y\cdot dy\cdot\left(T_i(y)\cdot dz\right)$

which means "transfer" to dz, and in rectangular shape, equivalent to applying to z dimension, for thin walled vertical sections that's the thickness. that is over the different moduli:

$$\int T_i(y)\cdot y \, dA = T_i\cdot b\cdot \int y \, dy$$