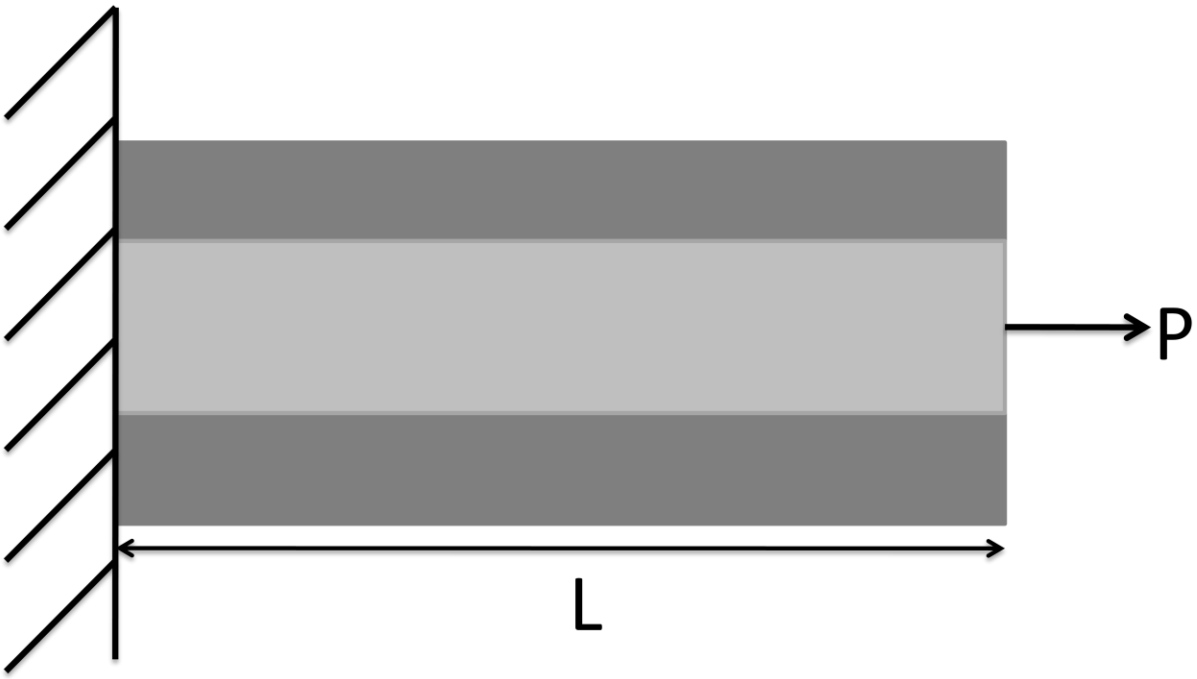
Example Problem:

A composite cantilever beam (L=100in) is axially loaded with a positive force of 2000 lbs. on its free, right end. The outer section of the beam is steel (E=30e6 psi) and has a cross-sectional area of 20 in^2. The inner section of the beam is aluminum (E=10e6 psi) and has a cross-sectional area of 10 in^2.



Solution:

$$P = P_{in} + P_{out}$$

$$\delta_{inner} = \delta_{outer}$$

$$\frac{P_{in} L}{A_{in} E_{in}} = \frac{P_{out} L}{A_{out} E_{out}}$$

$$P_{in} = P_{out} \frac{A_{in} E_{in}}{A_{out} E_{out}}$$

$$P = P_{out} + P_{out}\frac{A_{in}E_{in}}{A_{out}E_{out}} = P_{out}\left(1 + \frac{A_{in}E_{in}}{A_{out}E_{out}}\right)$$

$$P_{out} = \frac{P}{1 + \frac{A_{in}E_{in}}{A_{out}E_{out}}}$$

$$P_{out} = \frac{2000\ lb}{1 + \frac{10\ in^2\ 10e6\ psi}{20\ in^2 30e6\ psi}} = 1714.286\ lb$$

$$P_{in} = P - P_{out} = 285.714\ lb$$

$$\sigma_{out} = \frac{P_{out}}{A_{out}} = \frac{1714.286\ lb}{20\ in^2} = 85.714\ psi$$

$$\sigma_{in} = \frac{P_{in}}{A_{in}} = \frac{285.714\ lb}{10\ in^2} = 28.571\ psi$$

$$\delta = \frac{P_{out}\ L}{A_{out}\ E_{out}} = \frac{1714.286\ lb\ 100\ in}{20\ in^2\ 30e6\ psi} = 2.857\text{e-}4\ in$$