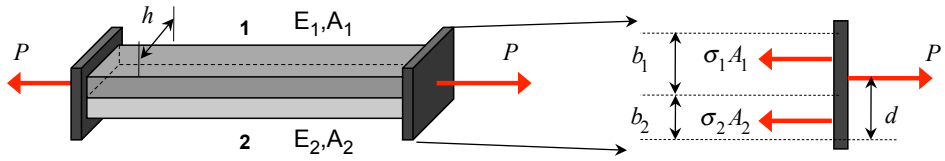
Example 6.2

Example shown below is made up of two members extending the full length of the composite element. The two members below experience identical strains $\varepsilon_1 = \varepsilon_2 = \varepsilon$ due to end connections to rigid plates. Determine the stresses in each member and determine the distance d locating the point of application of the load P needed for equal strains in the two members.



For equilibrium of rigid plate on right end:

$$\sum F_x = P - \sigma_1 A_1 - \sigma_2 A_2 = 0 \quad \Rightarrow$$

$$P = \left(E_1 A_1 + E_2 A_2\right)\varepsilon \quad \Rightarrow$$

$$\varepsilon = \frac{P}{E_1 A_1 + E_2 A_2} = \frac{P}{\left(E_1 b_1 + E_2 b_2\right)h}$$

and

$$\sum M = -Pd + \left(\sigma_1 A_1\right)\left(\frac{b_1}{2} + b_2\right) + \left(\sigma_2 A_2\right)\left(\frac{b_2}{2}\right) = 0 \quad \Rightarrow$$

$$Pd = \left[\left(E_1 A_1\right)\left(\frac{b_1}{2} + b_2\right) + \left(E_2 A_2\right)\left(\frac{b_2}{2}\right)\right]\varepsilon \quad \Rightarrow$$

$$d = \frac{E_1 b_1\left(b_1/2 + b_2\right) + E_2 b_2\left(b_2/2\right)}{E_1 b_1 + E_2 b_2}$$

The stresses in each of the two members are given by, respectively:

$$\sigma_1 = E_1\varepsilon = \frac{PE_1}{\left(E_1 b_1 + E_2 b_2\right)h}$$

$$\sigma_2 = E_2\varepsilon = \frac{PE_2}{\left(E_1 b_1 + E_2 b_2\right)h}$$