



$$\Delta = \Delta_b = \Delta_s$$

$$\Delta_b = \text{expansion of beam} = \epsilon_{th} L - \frac{P}{K_b}$$

$$\Delta_s = \text{contraction of spring} = \frac{P}{K_s}$$

$$\alpha \Delta T L - \frac{P}{K_b} = \frac{P}{K_s}$$

$$\alpha \Delta T L = P \left(\frac{1}{K_b} + \frac{1}{K_s} \right)$$

multiply both sides
by $K_b = AE/L$

$$AE \alpha \Delta T = P \left(1 + \frac{K_b}{K_s} \right)$$

$$P = \frac{AE \alpha \Delta T}{1 + K_b/K_s}$$

$$\Delta = \Delta_s = \frac{P}{K_s}$$