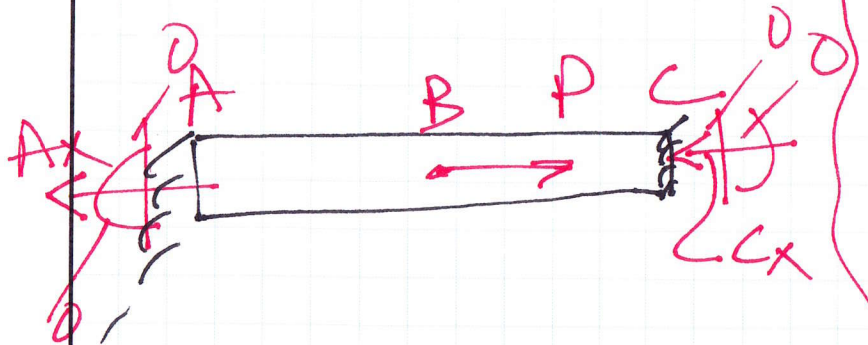


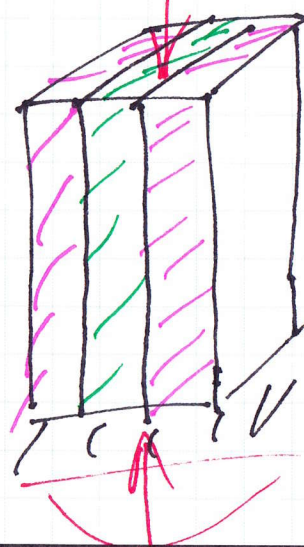
Statically Indeterminate Problems — the basic equilibrium equations are not sufficient.

Deformation Relationships —  
Three Types of Problems

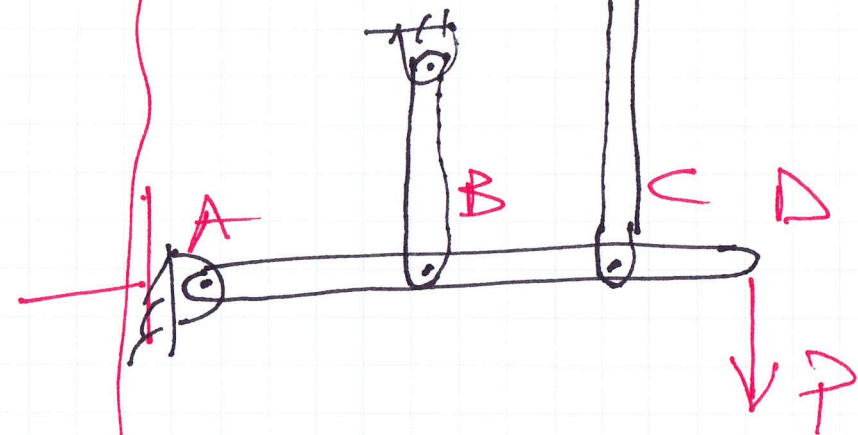
Constrained Bar



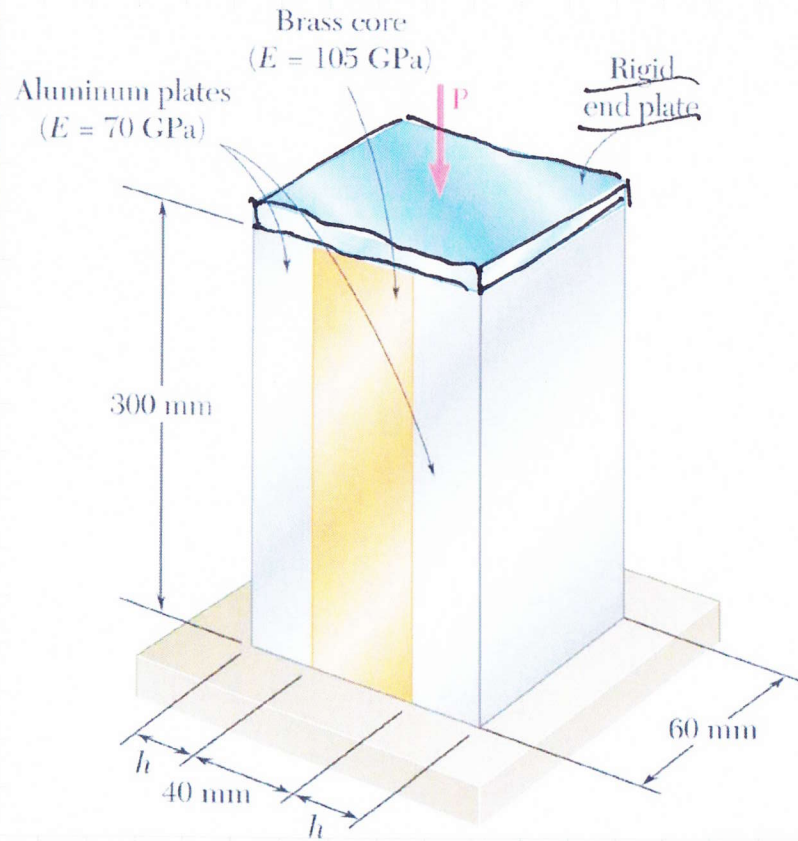
Composite Bar



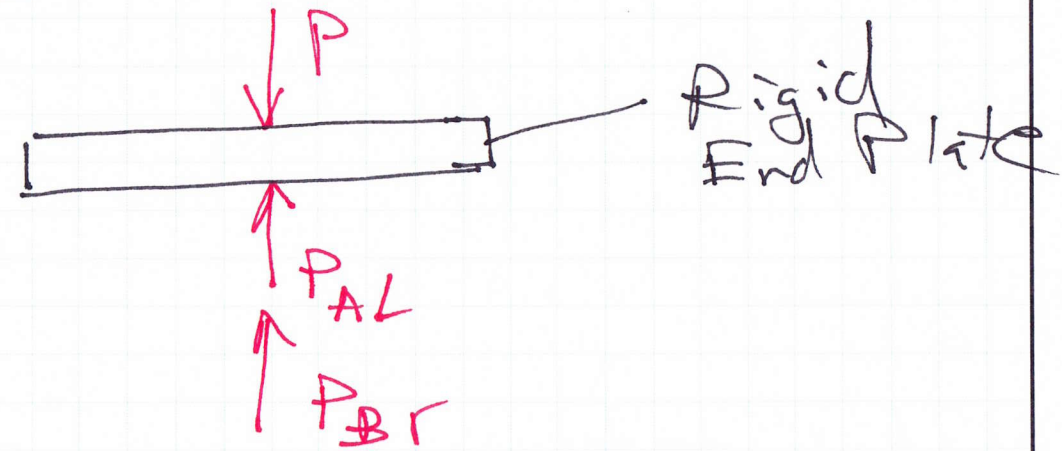
Hinged Bar



## Statically Indeterminate Problems -- Composite Bar



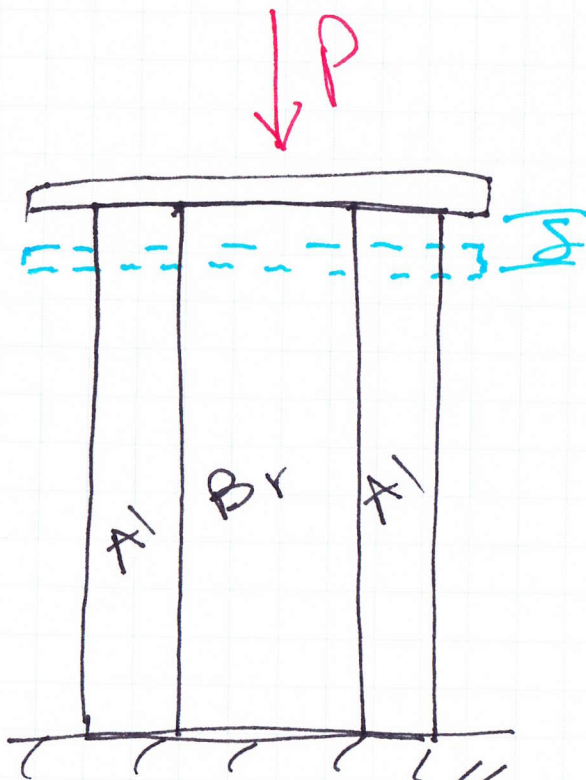
Equilibrium



$$+\uparrow \sum F_y = 0$$

$$P_{AL} + P_{BR} - P = 0$$

$$P = P_{AL} + P_{BR}$$



$$\delta_{A1} = \frac{P_{A1}}{A_{A1}}$$

$$\delta_{B2} = \frac{P_{B2}}{A_{B2}}$$

## Deformation Relationship

$$\delta_{B2} = \delta_{A1} = \delta$$

$$\frac{P_{B2} \cancel{L_{B2}}}{A_{B2} E_{B2}} = \frac{P_{A1} \cancel{L_{A1}}}{A_{A1} E_{A1}}$$

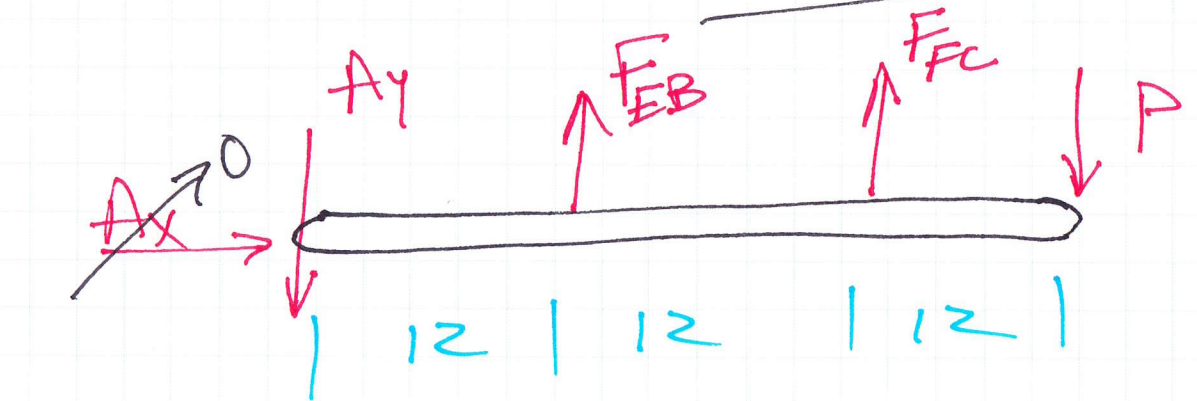
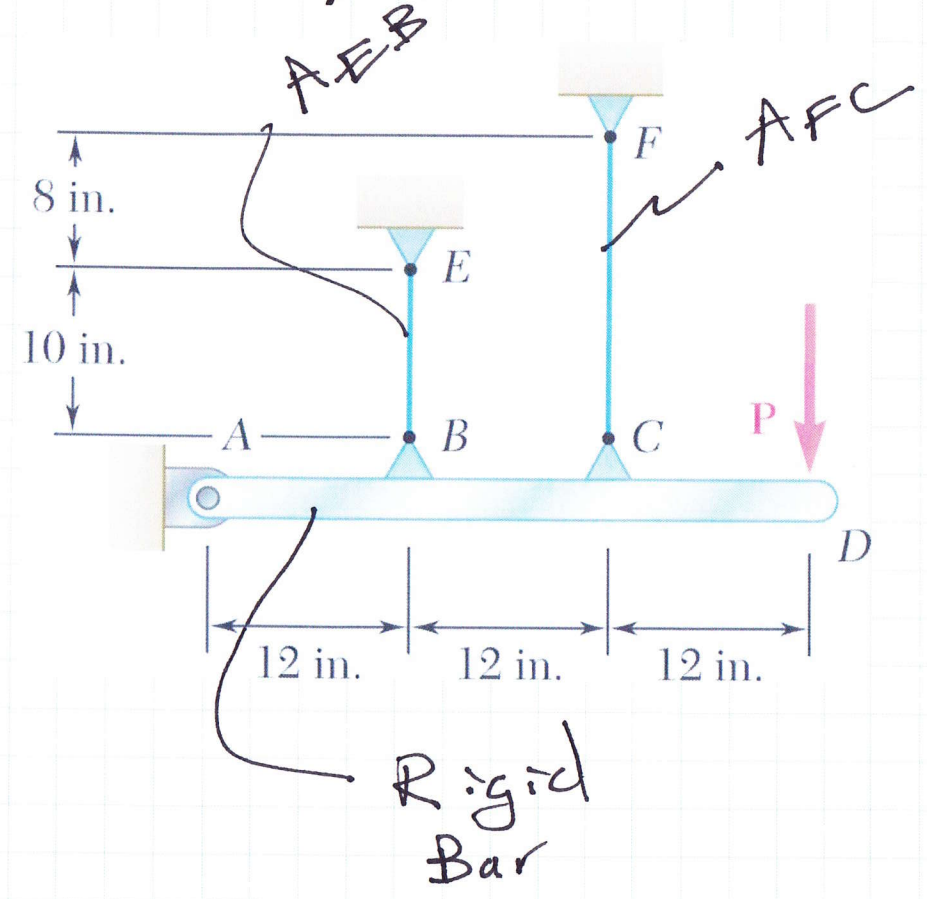
$$P_{B2} = \frac{A_{B2} E_{B2}}{A_{A1} E_{A1}} P_{A1}$$

$$P_{A1} = \frac{A_{A1} E_{A1}}{A_{B2} E_{B2}} P_{B2}$$

or

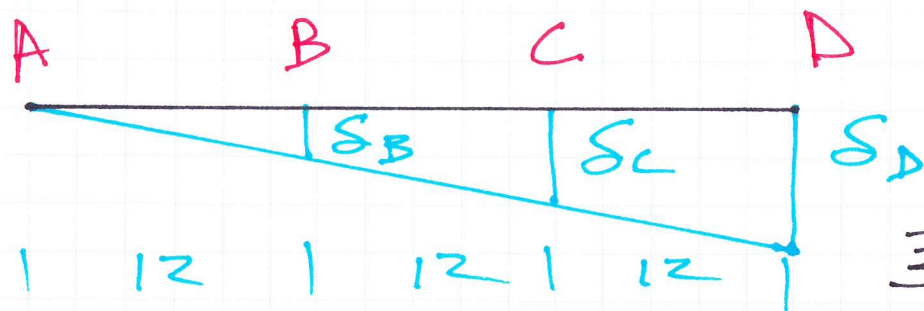
# Statically Indeterminate Problems -- Hinged Bar

$E = \text{const}$



$\sum M_A = 0$   
 $F_{EB}(12) + F_{FC}(24) - P(36) = 0$   
 $F_{EB} + 2F_{FC} = 3P$

## Deformation Relationship



$$\delta_B = \frac{12}{36} \delta_D$$

$$\delta_B = \frac{1}{3} \delta_D$$

$$\delta_C = \frac{24}{36} \delta_D$$

$$\delta_C = \frac{2}{3} \delta_D$$

Bar EB

$$\frac{1}{3} \delta_D = \delta_B = \frac{F_{EB} L_{EB}}{A_{EB} E_{EB}}$$

$$F_{EB} = F(\delta_D)$$

Bar FC

$$\frac{2}{3} \delta_D = \delta_C = \frac{F_{FC} L_{FC}}{A_{FC} E_{FC}}$$

$$F_{FC} = G(\delta_D)$$