MATERIALS AND STRUCTURES QUIZ FORMULA AND FACT SHEET

Three Great Principles: Equilibrium, Compatibility, Constitutive Relations

Two Pretty Good Principles: Superposition and Symmetry

Equilibrium: $\quad\quad \sum \underline{F}^{(i)} = 0 \quad \sum \underline{M}^{(i)} + \sum \underline{r}^{(i)} \times \underline{F}^{(i)} = 0 \quad \underline{F}$ = force vector, $\underline{r}$ = position vector of point on line of action of the force, $\underline{M}$ = moment vector.

Structural Analysis: Usually consists of four steps:

1) Idealization of a physical reality to a simpler, idealized model (i.e. a truss with idealized support conditions)

2) Replacement of boundary conditions (pin, roller, clamp, frictional slider) by equipollent forces and moments

3) Calculation of support reactions - usually using a free body diagram

4) Calculate internal forces (stresses) and displacements (strains)

Idealized supports:
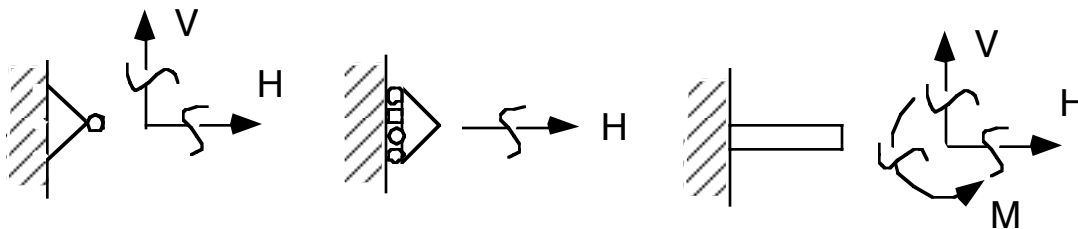
Pin Jointed Trusses - Idealizing assumptions

1. All bars are straight
2. Bar joints are <u>frictionless</u> pins
3. Bars are massless and perfectly rigid (for loading analysis)
4. All loads and reactions are applied at the joints.
5. Loads in members are colinear (axial). In analysis usually represent unknown forces as tensile

Tension = Positive
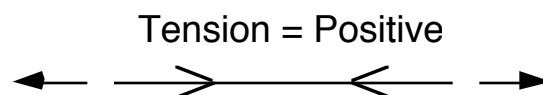
Method of sections and method of joints can be used to analyze for bar forces, by isolating a part of the structure, replacing the bars "cut" in the process of isolating the section of interest by the bar forces and evaluating them by applying appropriate equilibrium conditions. All unknown forces must be included.
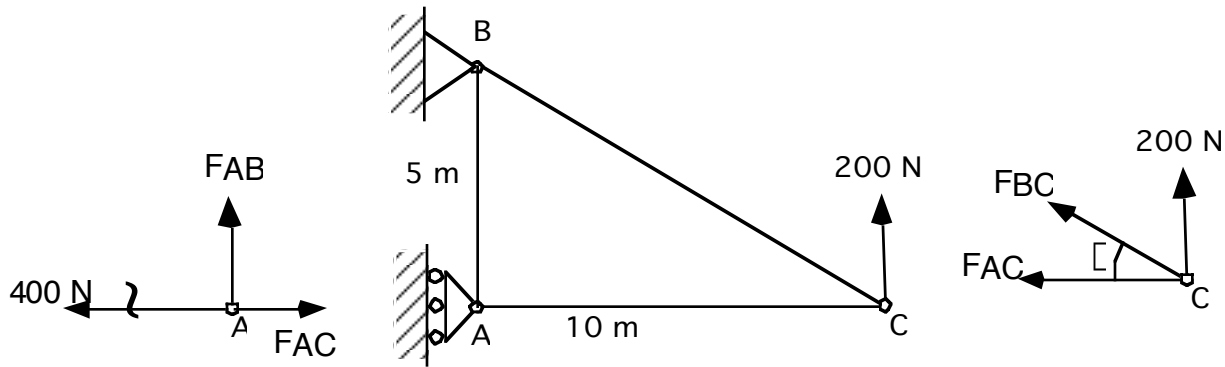
Constitutive relations for elastic bars under axial loading and temperature changes:

$$\delta = \frac{FL}{AE} + \alpha \Delta T L$$

E = Young's modulus, L = bar length, A = bar cross-sectional area, F = bar force, α = coefficient of thermal expansion, ΔT = change in temperature from a stress free temperature, δ = bar extension

Displacement Diagrams for Pin-Jointed Trusses

1) Assume small deflections - extensions occur parallel to original bar direction
2) Rotations are approximated as translations perpendicular to original direction of bar