Achievable

FE CIVIL DUMP SHEET

Statics and mechanics of materials

Statics

- **Equilibrium:** $\sum F_x = 0, \sum F_y = 0, \sum M = 0$
- Centroids:
  - Rectangle: $\bar{x} = \frac{b}{2}, \bar{y} = \frac{h}{2}$
  - Composite: $\bar{x} = \frac{\sum A_i x_i}{\sum A_i}, \bar{y} = \frac{\sum A_i y_i}{\sum A_i}$
- Area moment of inertia:
  - Rectangle: $I = \frac{bh^3}{12}$
  - Parallel-axis theorem: $I = I_c + Ad^2$
- **Trusses, method of joints:** $\sum F_x = 0, \sum F_y = 0$ at each joint
  - Zero-force members, at an unloaded joint:
  - Two noncollinear members: both are zero
  - Three members, two collinear: the third is zero

Material properties

- **Modulus of elasticity, steel:** $E = 29{,}000 \text{ ksi}$
- **Unit weights** (lb/ft^3):
  - water 62.4
  - soil 100—130
  - concrete 150

Mechanics of materials

- Stress and strain:
  - Normal: $\sigma = \frac{P}{A}$
  - Bearing: $\sigma_b = \frac{P}{A_b}$
  - Shear: $\tau = \frac{VQ}{It}$
  - Hooke's law: $\sigma = E\varepsilon$
- **Axial deformation:** $\delta = \frac{PL}{AE}$
- Torsion:
  - $\tau = \frac{Tc}{J}$
  - $\theta = \frac{TL}{GJ}$
- Polar moment of inertia:
  - Solid: $J = \frac{\pi d^4}{32}$
  - Hollow: $J = \frac{\pi(d_o^4 - d_i^4)}{32}$
- **Bending stress:** $\sigma = \frac{Mc}{I}$
- Beam deflection:
  - Cantilever, load at the free end: $\frac{PL^3}{3EI}$
  - Simply supported, load at midspan: $\frac{PL^3}{48EI}$
- Mohr's circle:
  - $\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$
  - $\tau_{\max} = \frac{\sigma_1 - \sigma_2}{2}$