1. \((1.2-10)\) **cable takes a tensile force** \(T\)

\(A\) is a pin joint

- \(H = 1.6\ m\)
- \(C = 30\ \text{m} \times 1.5\ \text{m}\)

\[\Sigma M_{A_x} = -P(4.5) + T \sin \theta \ (3) = 0\]

\[\theta = \tan^{-1}\left(\frac{1.6}{3}\right) = 28.1^\circ\]

\[T = \frac{P(4.5)}{3 \sin \theta} = 3.19\ P\]

If \(P = 32\ \text{kN}\) \(\Rightarrow T = 102\ \text{kN}\)

**cable has area of** \(481\ \text{mm}^2 = 481 \times 10^{-6}\ \text{m}^2\)

**stress in cable** \(\sigma = \frac{102,000}{481 \times 10^{-6}} = 212 \times 10^6\ \text{Pa}\)

\(\sigma = 212\ \text{MPa}\)

**cable length** \(= \sqrt{1.6^2 + 3^2} = 3.4\ \text{m}\)

**strain in cable** \(\varepsilon = \frac{6.1 \times 10^{-3}}{3.4} = 0.0018 = \varepsilon\)
2. (1.2-12)

All cables run through a common point. By symmetry they have the same tension.

The slab weight is \( p g V = 8 V \)

\[ W = 24 \text{ kN/m}^3 \left[ 2.5 \right] \left[ 2.5 \right] \left[ 0.225 \right] = 33.75 \text{ kN} \]

will be taking \( \Sigma F_z = 0 \)
so want \( z \)-component of cable force

\[ (A\beta) = \sqrt{(1.25)^2 + (1.25)^2 + (0.6)^2} = 2.384 \]

force in \( z \)-direction is \( T \left[ \frac{0.6}{2.384} \right] = 0.671 \text{ kN} \)

\[ \Sigma F_z = 4 \left[ 0.671 \text{ kN} \right] - 33.75 = 0 \Rightarrow T = 12.6 \text{ kN} \]

Area \( A = 190 \text{ mm}^2 = 190 \times 10^{-6} \text{ m}^2 \)

\[ \sigma = \frac{12,600}{190 \times 10^{-6}} = 66,2 \times 10^6 \text{ Pa} = 66.2 \text{ MPa} \]
From plot, can see that $\sigma$ vs. $\varepsilon$ is linear from low loads up to $\approx 12500$ lb

Find slope of line using change in stress over change in strain

\[
E \approx \frac{64405 - 9985}{0.00215 - 0.0003} = 29.4 \times 10^6 \text{ psi}
\]
Find proportional limit from where curve deviates from linear
use a millimeter scale on graph

\[ \text{P.L.} = 60,000 + 20,000 \left[ \frac{6}{18} \right]^2 = 66,700 \text{ psi} \]
\[ \text{P.L.} = 66,700 \text{ psi} \]

Draw line parallel to initial linear part

\[ 0.1\% \text{ offset} = 60,000 + 20,000 \left[ \frac{8}{18} \right]^2 = 68,900 \text{ psi} \]
\[ 0.1\% \text{ offset} = 68,900 \text{ psi} \]

Final elongation between gage marks is 0.12
\[ \frac{0.12}{2} = 0.06 = 6 \% \]

Final diameter = 0.42" \Rightarrow \text{Area} = 0.139 \text{ in}^2

Initial area = \( \frac{\pi}{4} (0.505)^2 = 0.200 \text{ in}^2 \)

\% reduction in area = \( 100 \left[ \frac{0.200 - 0.139}{0.200} \right] \)
\[ \text{Area Reduction} = 30.7 \% \]
\[ \sigma = \frac{P}{A} = \frac{2500}{\pi(0.3)^2} = 35,400 \text{ psi} \]

\[ E = \frac{\sigma}{\varepsilon} = \frac{35,400}{25 \times 10^6} = 1.41 \times 10^{-3} \]

\[ \delta = L \varepsilon = (15) (1.41 \times 10^{-3}) = 0.0212'' \]

Transverse strain \( \varepsilon_t = -\nu \varepsilon \)

\[ \varepsilon_t = -0.32 (1.41 \times 10^{-3}) = -4.53 \times 10^{-4} \]

Final diameter \( = 0.3 + (-4.53 \times 10^{-4})(0.3) \)
\[ = 0.29986'' = d_f \]

Area (final) = \( \frac{\pi}{4} d_f^2 = 7.06218 \times 10^{-2} \)

Area (initial) = \( \frac{\pi}{4} (1.3)^2 = 7.0685 \times 10^{-2} \)

\( \% \) change = \( 100 \left( \frac{7.06218 \times 10^{-2} - 7.0685 \times 10^{-2}}{7.0685 \times 10^{-2}} \right) \)

\[ \approx 0.91 \% \text{ decrease in area} \]
5. (16-2)

\[ pA = (2 \times 10^6 \text{ N/m}^2)(0.15)(0.06) = 1.8 \times 10^4 \text{ N} \]

By symmetry or sum of moments, \( F_{b_1} = F_{b_2} \)

\[ \sum F_z = -1.8 \times 10^4 + 2F_b = 0 \]

\[ F_b = F_{b_2} = 9000 \text{ N} \]

**Bearing pressure (average) on flange on bolt**

Bearing area is

\[ (12)(15) = 180 \text{ mm}^2 = 180 \times 10^{-6} \text{ m}^2 \]

\[ \text{Bearing} = \frac{9000}{180 \times 10^{-6}} = 50 \times 10^5 \text{ Pa} = 500 \text{ MPa} \]

**Shear stress (average)**

\[ \tau = \frac{9000}{\frac{4}{3}(0.15)^2} = 50.9 \text{ MPa} \]
Shear stress has a different value in four regions.

\[ V = 1800 \text{ N} \quad \text{same for } D \rightarrow E \]

\[ V = 1200 \text{ N} \quad \text{same for } C \rightarrow D \]

Max shear stress is
\[
\tau = \frac{1800}{\frac{\pi}{4} (0.006)^2} = 63.7 \text{ MPa}
\]

Bearing forces relate to forces on plates. Largest plate force is 3000 N.

Bearing area = (plate thickness)(bolt diameter)

\[ \sigma_{\text{bearing}} = \frac{3000}{(0.005)(0.006)} = 100 \text{ MPa} \]
7. (1.6-9) \[ \tau = \frac{V}{(a)(b)} = \frac{1200}{(5)(16)} \]
\[ \tau = 40 \text{ psi} \]

Shear strain is displacement \[ \frac{\text{displacement}}{\text{thickness}} = \frac{0.24}{1.5} = 0.16 \]

Shear modulus \( G \) relates \( \tau \) to \( \gamma \)
\[ \tau = G \gamma \]

\[ \Rightarrow G = \frac{\tau}{\gamma} = \frac{40}{0.16} = 250 \text{ psi} \]