AE333

Mechanics of Materials

Lecture 20 - Combined loading

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schedule

- 25 Mar - Combined Loading, HW6 Due
- 27 Mar - Combined Loading
- 29 Mar - Combined Loading
- 1 Apr - Stress Transformation, HW7 Due

outline

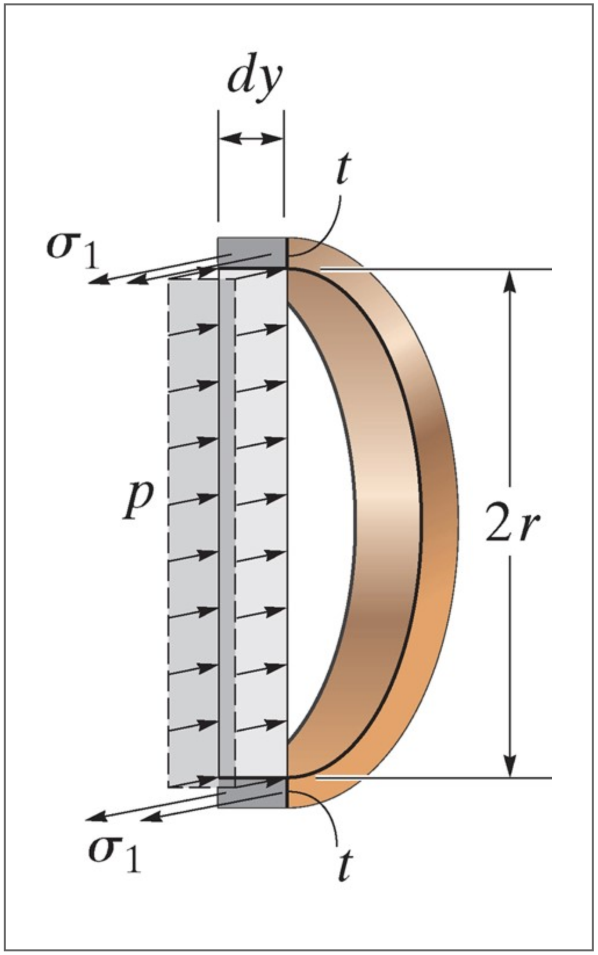
- thin-walled pressure vessels
- combined loading
- group problems

thin-walled pressure vessels

thin-walled pressure vessels

- If the radius to wall thickness ratio is 10 or more, we can treet a pressure vessule as “thin-walled”
- Cylindrical pressure vessels will have two primary sources of stress, and serve as an introduction to more general states of combined loading

cylindrical vessels

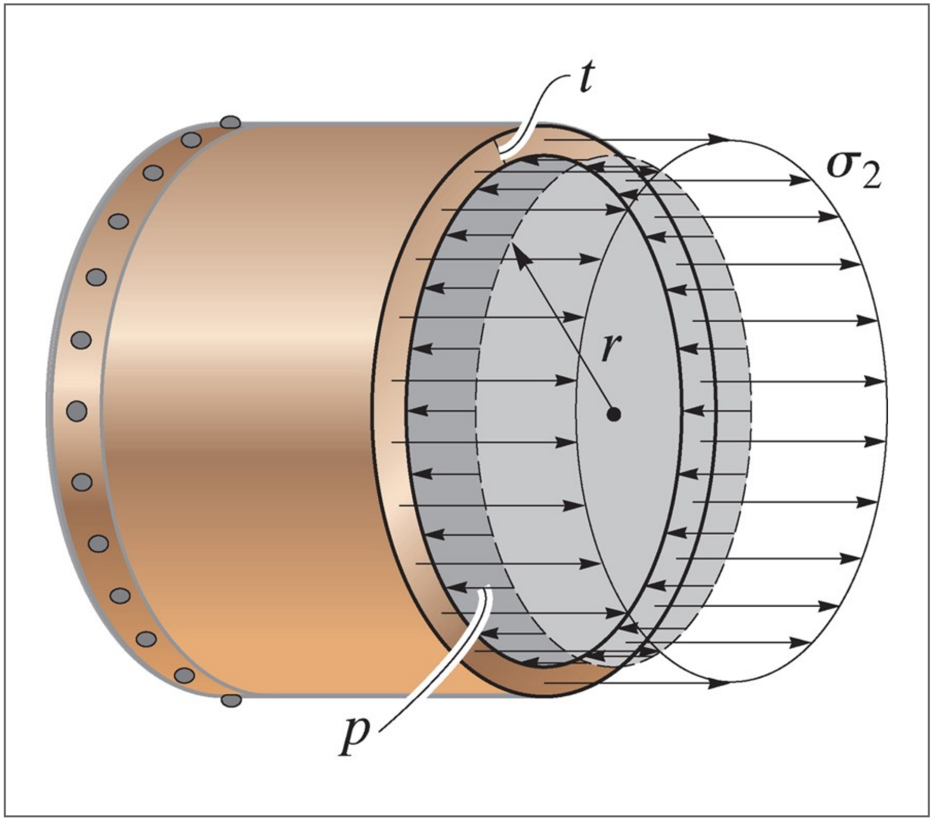


cylindrical vessels

- From equilibrium of a section of a cylindrical vessel, we see that

$$\begin{aligned}\sum F_x &= 0 \\ &= 2(\sigma_1 t dy) - p(2r)dy \\ \sigma_1 &= \frac{pr}{t}\end{aligned}$$

cylindrical vessels



cylindrical vessels

- Considering another section we can find the longitudinal stress

$$\begin{aligned} \sum F_y &= 0 \\ &= \sigma_2(2\pi r t) - p(\pi r^2) \\ \sigma_2 &= \frac{pr}{2t} \end{aligned}$$

spherical vessels

- We can find the stress in spherical vessels using an identical section to the longitudinal section for a cylindrical vessel, and we find that $\sigma = \frac{pr}{2t}$
- Which is valid everywhere in a cylindrical vessel

example 8.1

- A cylindrical pressure vessel has an inner diameter of 4 ft and a thickness of 1/2 in.
- Determine the maximum internal pressure it can sustain if the maximum stress it can support is 20 ksi.
- What is the maximum internal pressure a spherical pressure vessel could sustain under identical conditions?

combined loading

combined loading

- We can use the principle of superposition to treat various loading conditions separately and then add them together to find the total stress

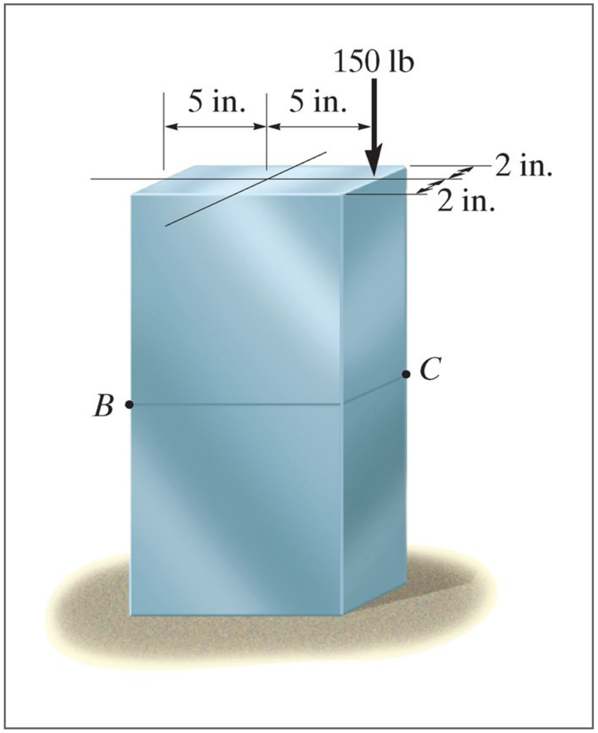
procedure

- Section the member at the point of interest, internal force components should be drawn acting through the centroid of the section
- Moment components should be calculated about the centroidal axis

stress components

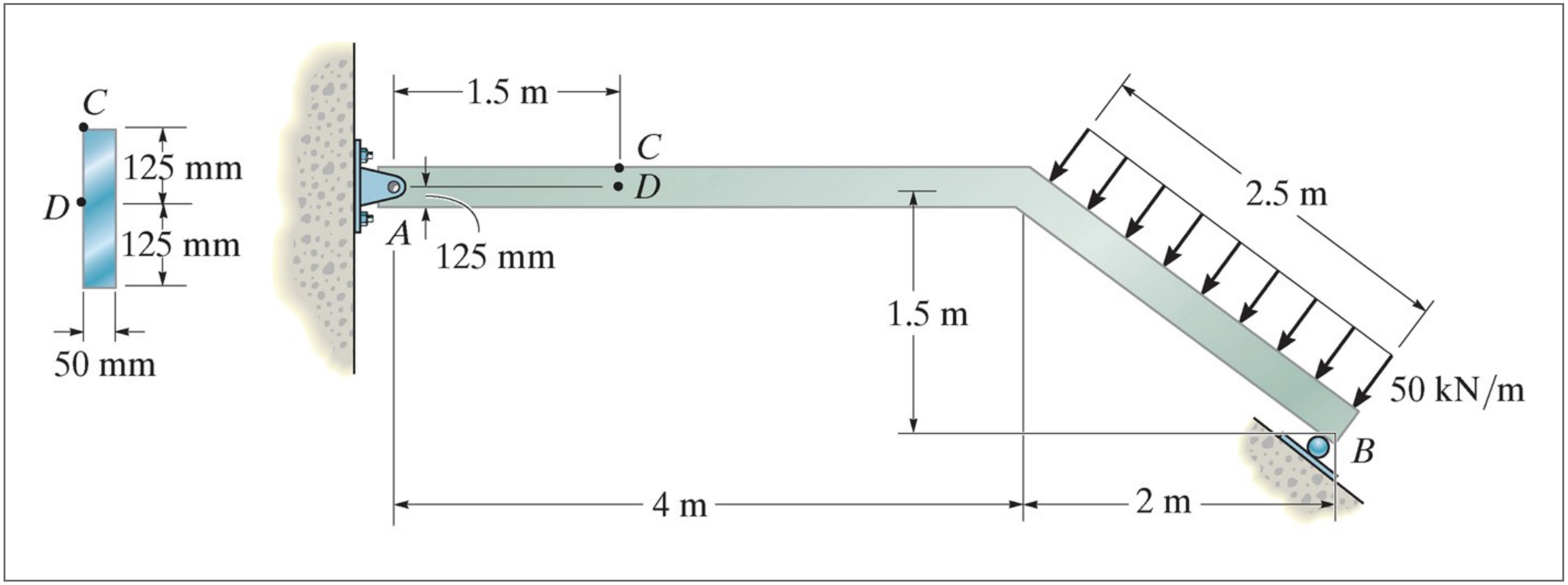
- Normal stress: $\sigma = N/A$
- Shear: τ = Q/It
- Bending: σ = y/I
- Torsion: τ = ρ/J
- Pressure Vessels: σ_1 = r/t, σ_2 =r/2t

example 8.2



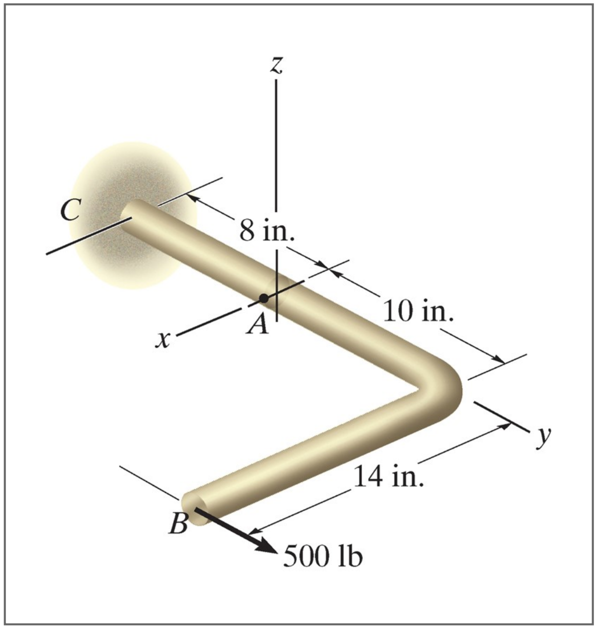
Neglect the weight of the member and find the stress at B and C.

example 8.4



Determine the stress at C and D.

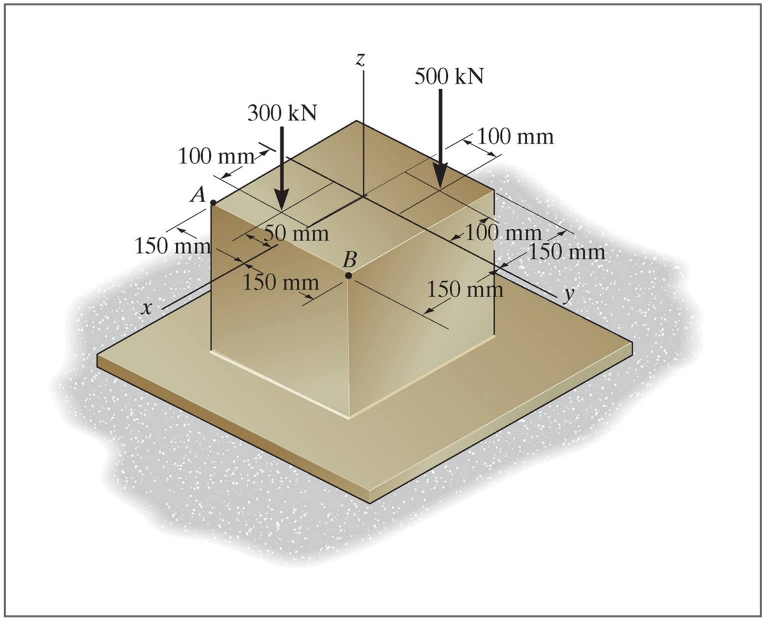
example 8.5



The rod shown has a radius of 0.75 in. Find the stress at A.

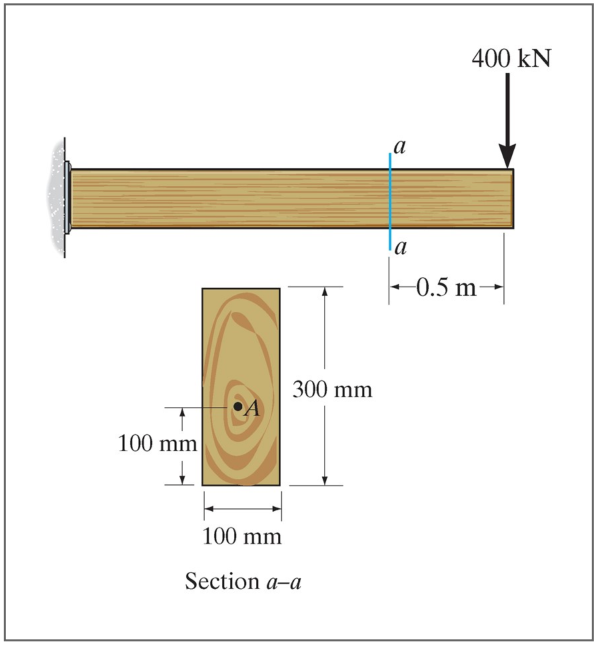
group problems

group one



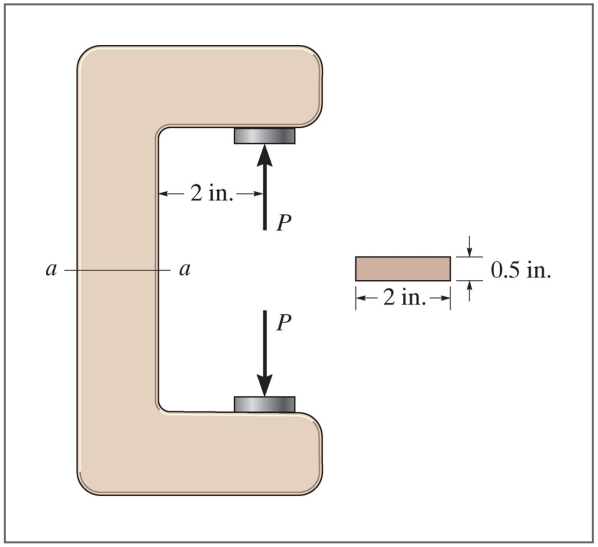
Find the stress at the corners A and B for the column shown.

group two



Find the stress at point A for the cantilever beam shown.

group three



Find the load P that will cause a maximum normal stress of σ=30 ksi along the section a-a.