AE333

Mechanics of Materials

Lecture 21 - Combined loading

Dr. Nicholas Smith
Wichita State University, Department of Aerospace Engineering

8 April, 2020

schedule

- 8 Apr - Combined Loading
- 10 Apr - Stress Transformation
- 13 Apr - Stress Transformation, HW7 Due
- 15 Apr - Strain Transformation

outline

- combined loading
- group problems
- plane stress transformation

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

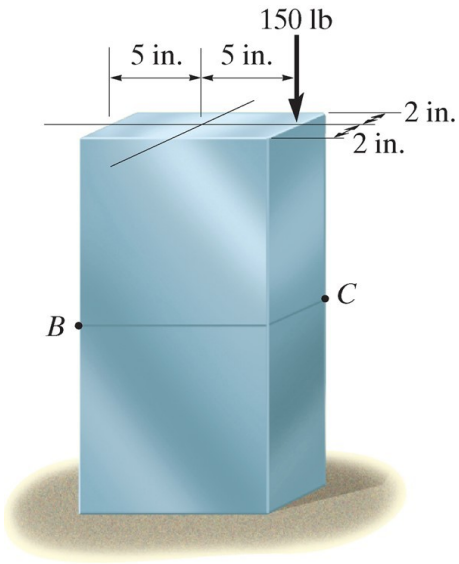
procedure

- 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

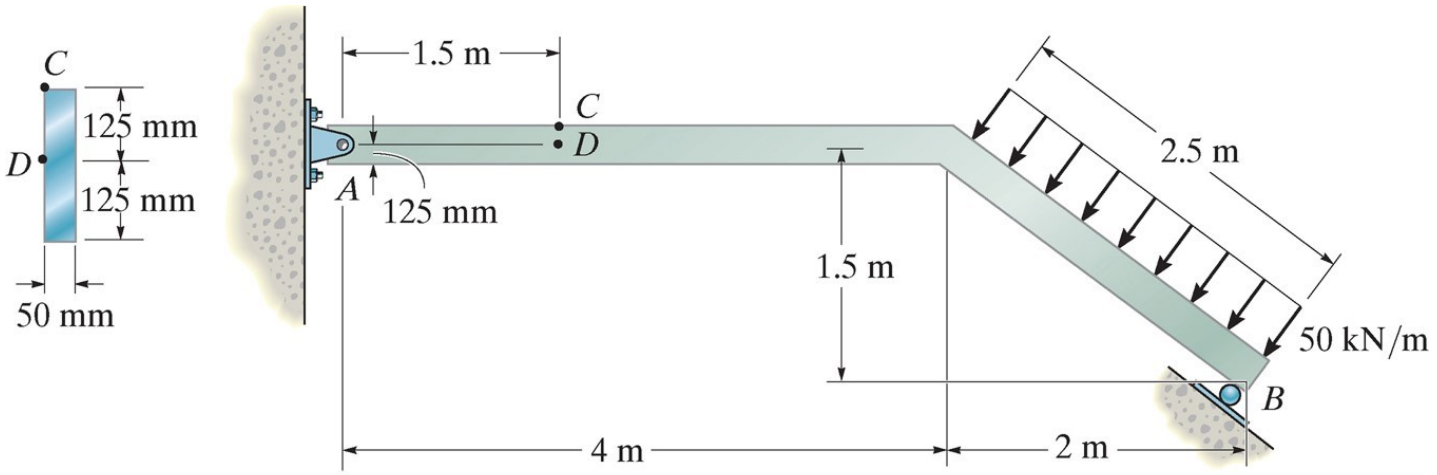
- Normal stress: $\sigma = N/A$
- Shear: τ = Q/It
- Bending: σ = y/I
- Torsion: τ = ρ/J
- Pressure Vessels: σ_1 = r/t, *σ_2 =$r/2$*t

example 8.2



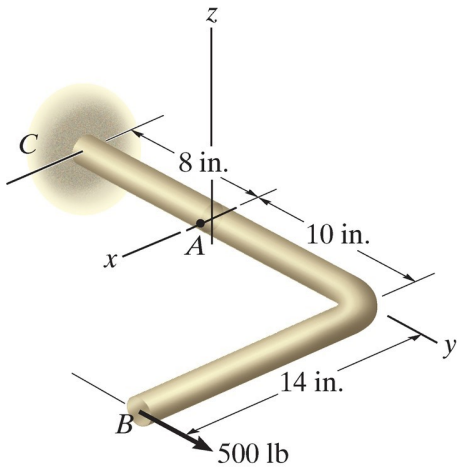
Neglect the weight of the member and find the stress at B and C.

example 8.4



Determine the stress at C and D.

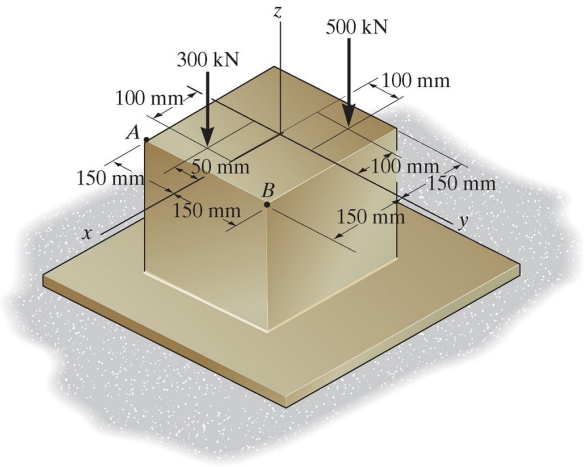
example 8.5



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

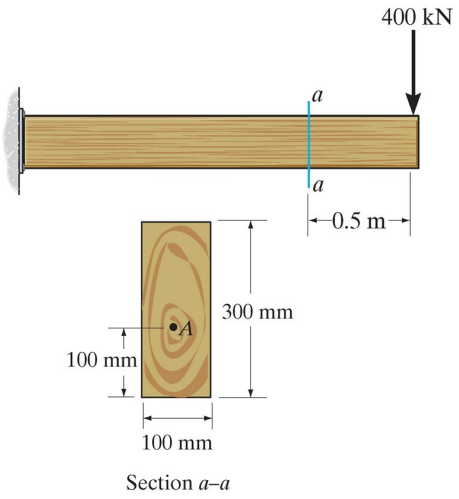
group problems

group one



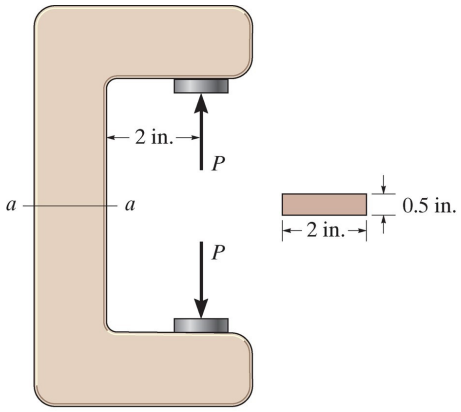
Find the stress at the corners A and B for the column shown.

group two



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

group three



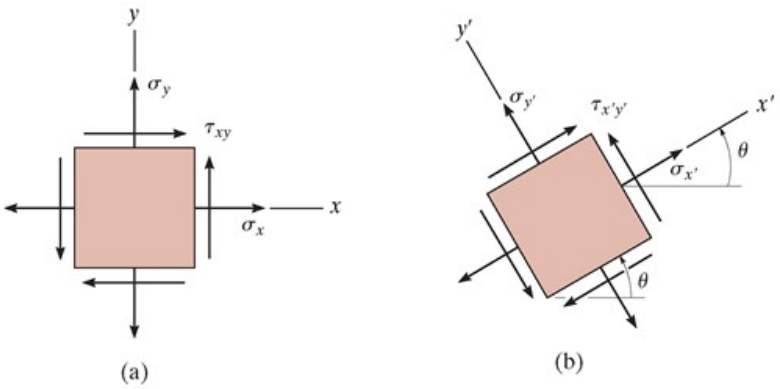
Find the load P that will cause a maximum normal stress of σ=30 ksi along the section a-a.

plane stress transformation

plane stress

- In general, the state of stress at a point is characterized by six stress components
- In practice, this is rare, as most stresses and forces act in the same plane
- This case is referred to as plane stress

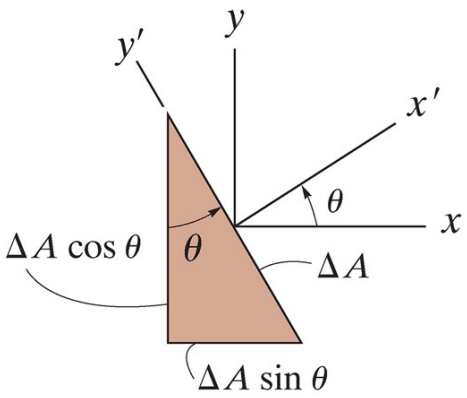
transformation

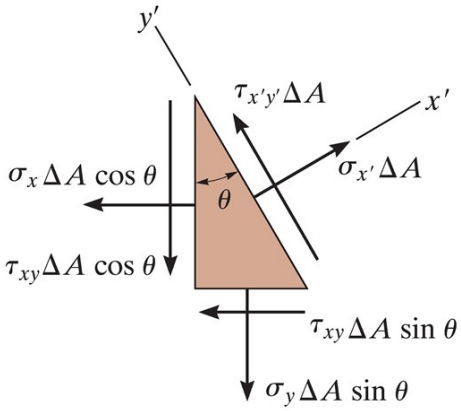


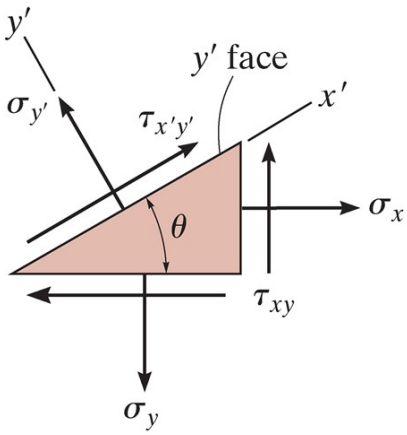
procedure

- If the state of stress ($\sigma_x, \sigma_y, \tau_{xy}$) is known for a known axis system x and y, we can find the stress relative to some rotated coordinate system
- We do this by considering a section of the element perpendicular to the x' axis
- Sum of forces in x and y will give $\sigma_{x'}$ and $\tau_{x'y'}$
- A second section is needed to find $\sigma_{y'}$, perpendicular to the y' axis

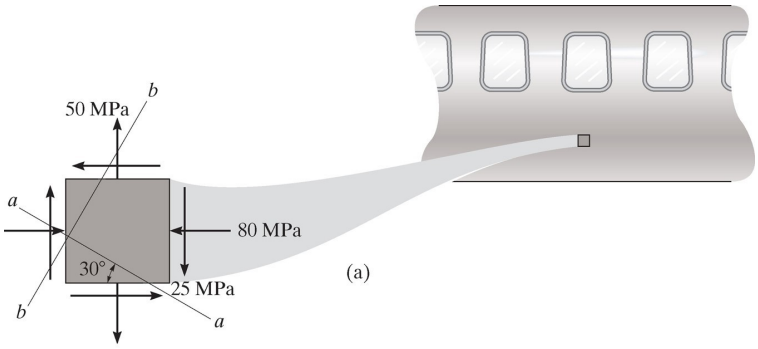
procedure


y′
y
x′
θ
x
ΔA cos θ
θ
ΔA
ΔA sin θ


y′
τx′y′ΔA
x′
σx ΔA cos θ
θ
σx′ ΔA
τxy ΔA cos θ
τxy ΔA sin θ
σy ΔA sin θ


y′
y′ face
σy′
τx′y′
x′
θ
σx
τxy
σy

example 9.1



Represent the state of stress shown on the fuselage section on an element rotated 30° clockwise from the position shown.