CE30 – Discussion 7

Stress & Strain

Textbook: 8.1, 8,2, 8,3, 9.1

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Announcements

- HW7 Problems from the textbook:
  8.9, 8.19, 8.23, 8.31, 9.14, 9.16

- Midterm next Monday (03/11)

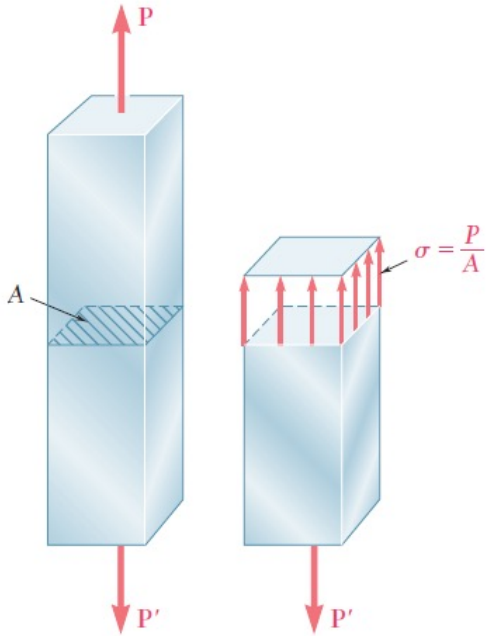
Concept of Stress

- Force per area

$$\sigma = \frac{P}{A}$$

- Units of stress: *Pascal (PA)*

$$PA = N/m^2$$

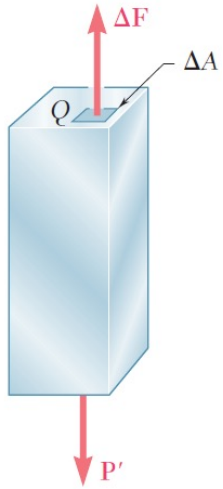


States of Stress

Normal Stress (σ)

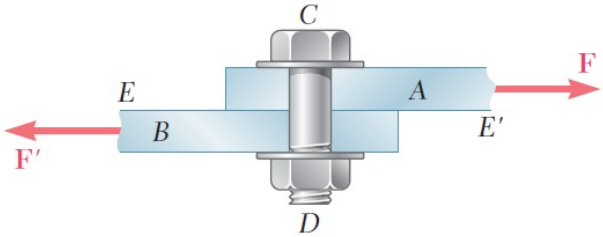
$$\sigma = \frac{P}{A}$$

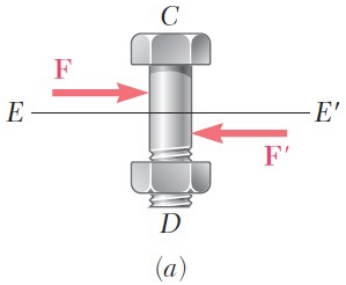
- Member is under axial loading
- Stress is the axial force per perpendicular area
- Uniform distributed across the section

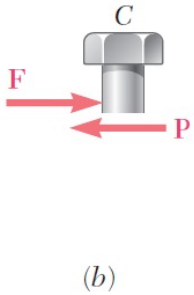


Shear Stress (τ)

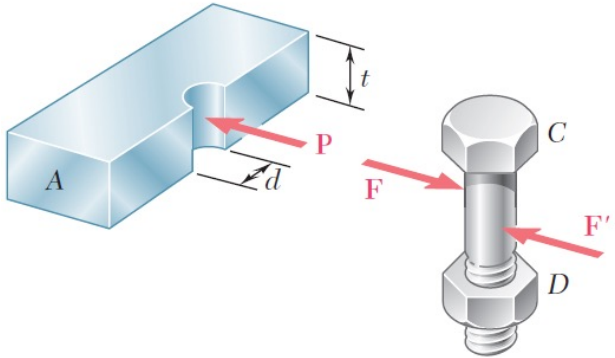
$$\tau_{Ave} = \frac{P}{A}$$

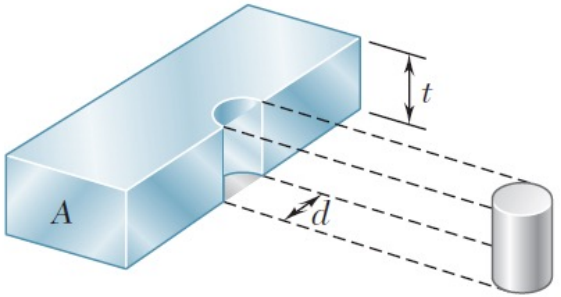






Bearing Stress in Connections

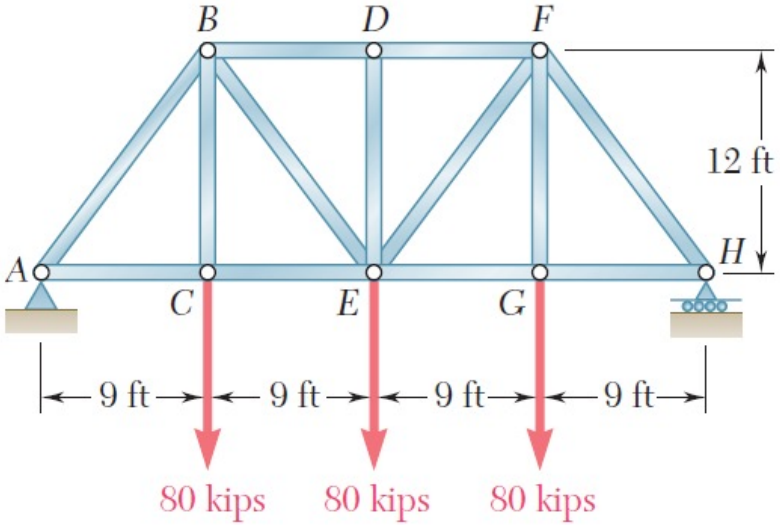




$$\sigma_b = \frac{P}{A} = \frac{P}{td}$$

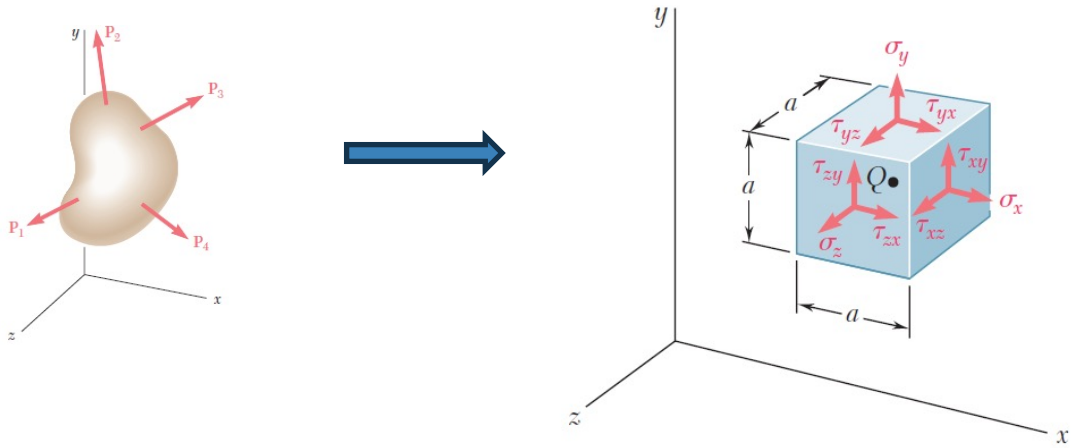
Practice – Similar to HW P8.9

For the Pratt bridge truss and loading shown, determine the average normal stress in member BE, knowing that the cross-sectional area of that member is 5.87 in^2.



Components of Stress

- Under general loading conditions, stress has six (independent) components

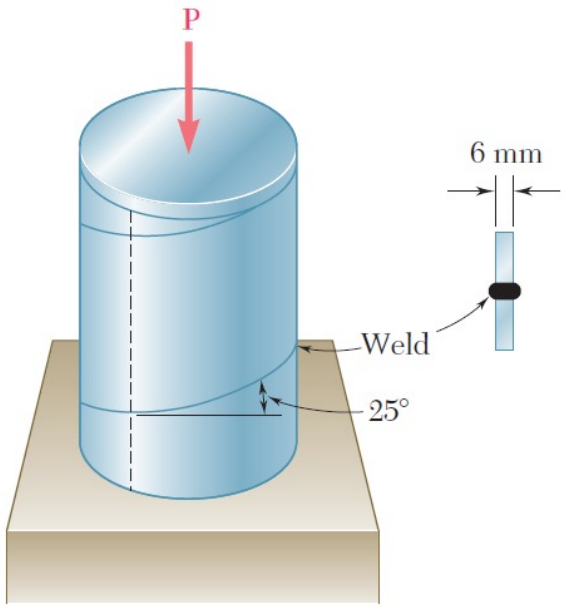


- From the equilibrium, the 9 stress components shown above reduce to 6

$$\tau_{xy} = \tau_{yx} \qquad \tau_{xz} = \tau_{zx} \qquad \tau_{yz} = \tau_{zy}$$

Practice – Similar to HW P8.31

A steel pipe of 300-mm outer diameter is fabricated from 6-mm-thick plate by welding along a helix that forms an angle of 25° with a plane perpendicular to the axis of the pipe. Knowing that a 250-kN axial force **P** is applied to the pipe, determine the normal and shearing stresses in directions respectively normal and tangential to the weld.

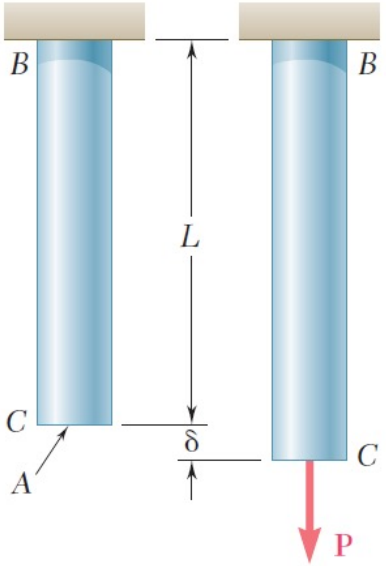


Strain

- Measure of relative deformation
- Deformation per unit length:

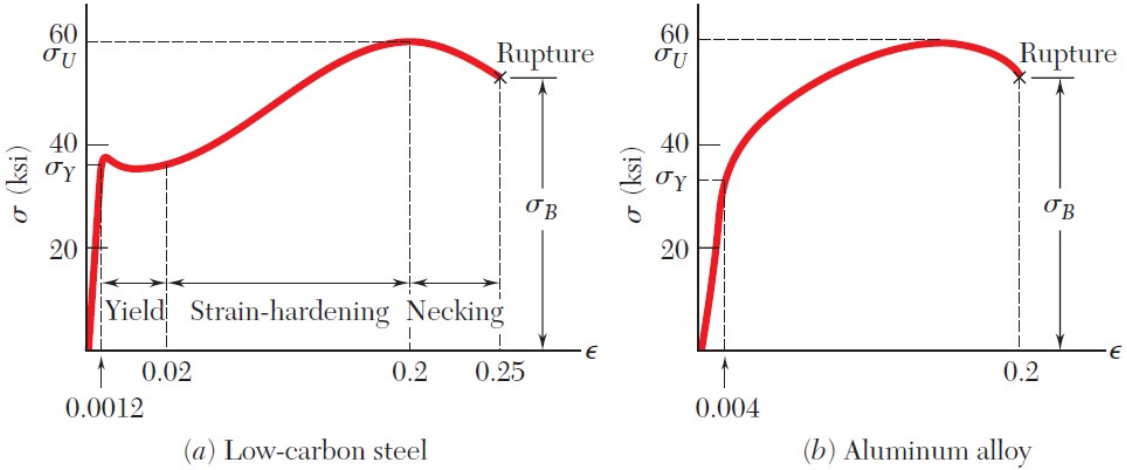
$$\epsilon = \frac{\delta}{L}$$

- Strain has no unit (dimensionless quantity)



Stress-Strain

- The relation between stress & strain depends on material characteristics
- Example Stress–Strain diagrams for two different materials:



(*a*) Low-carbon steel (*b*) Aluminum alloy

Hooke's Law

- For a lot of structures, the strains are small, and the resultant stress-strain is relation is linear.
- This linear relation is called the *Hooke's Law*:

$$\sigma = E\,\epsilon$$

"Stress is directly proportional to the strain"

- E is called, the *Elastic Modulus* of the material (units of stress)

Practice – Similar to HW P9.20

For the steel truss ($E = 29 \times 10^6$ psi) and loading shown, determine the deformations of members AB and AD, knowing that their cross-sectional areas are 4.0 in^2 and 2.8 in^2, respectively.