AE333
Mechanics of Materials

Lecture 19 - Transverse Shear

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

1 April, 2020

schedule

- 1 Apr - Transverse Shear
- 3 Apr - Combined Loading, HW6 Due
- 8 Apr - Combined Loading
- 10 Apr - Stress Transformation

outline

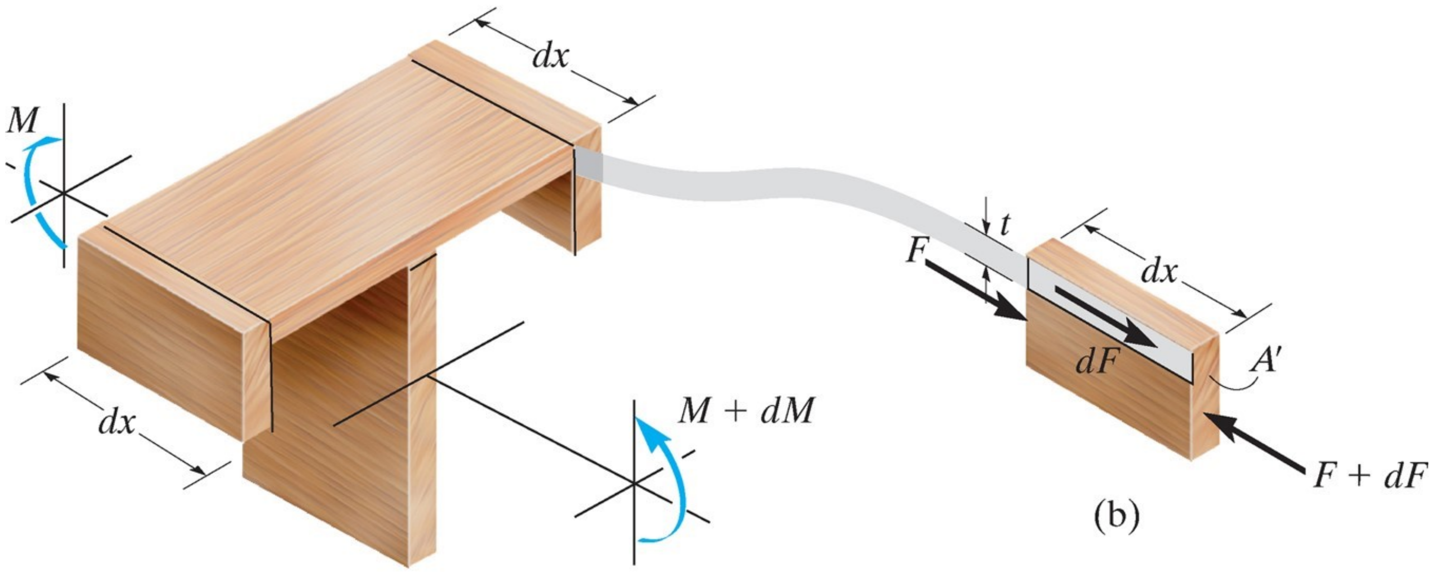
- shear flow in built-up members
- thin-walled pressure vessels

shear flow in built-up members

built-up members

- Often in practice, structural members are “built-up”
- This refers to parts that are comprised of several other parts to have greater strength in certain areas
- We need to analyze the shear between these members to choose appropriate adhesives or fasteners

equilibrium



(a)

equilibrium

- From equilibrium we see that

$$dF = \frac{dM}{I}\int_{A'} y dA'$$

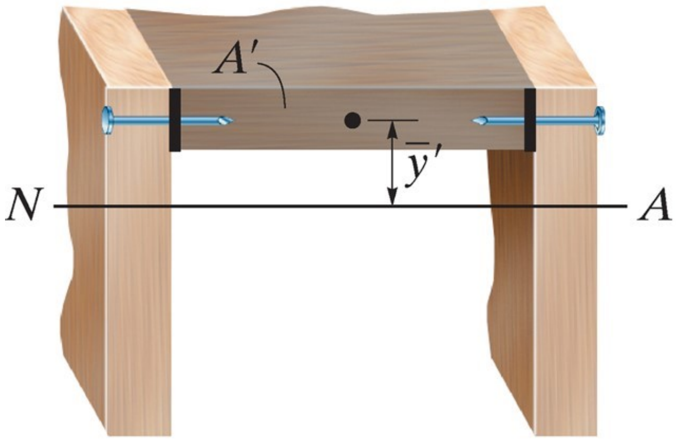
- We recall that this integral represents Q, we can also define the shear flow as $q = dF/dx$ and recall that $dM/dx = V$ to find

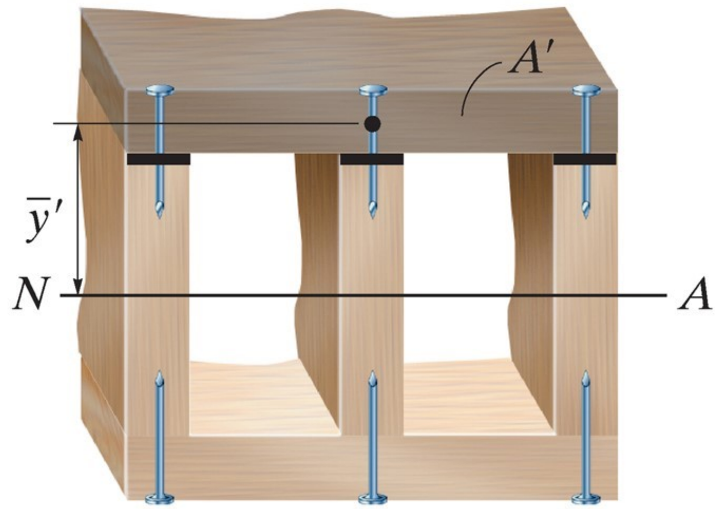
$$q = \frac{VQ}{I}$$

fastener spacing

- We can use shear flow to determine fastener spacing
- Say a fastener can support a shear force of F_0 before failure
- The shear flow (force/distance) times the spacing (distance) will give the shear force per fastener $F=qs$

multiple fasteners

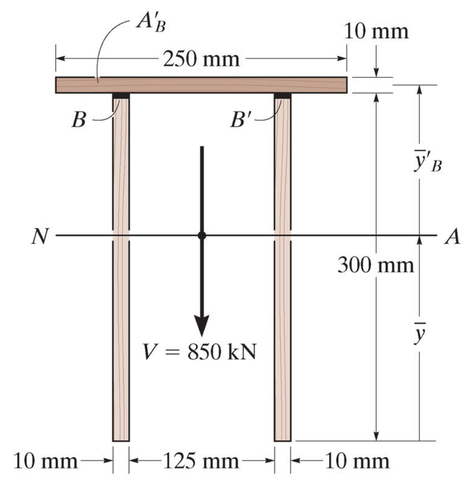




multiple fasteners

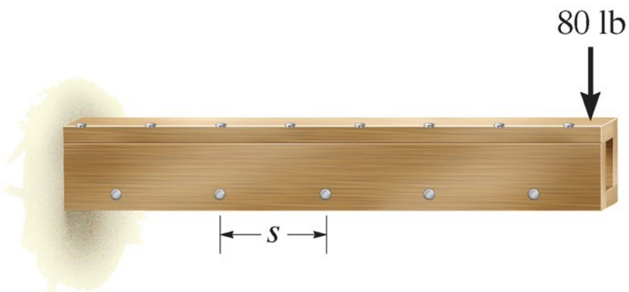
- When multiple arms are connecting the same area (as shown in the previous slide)
- The shear flow “seen” by each fastener is q/n where n is the number of fasteners per area

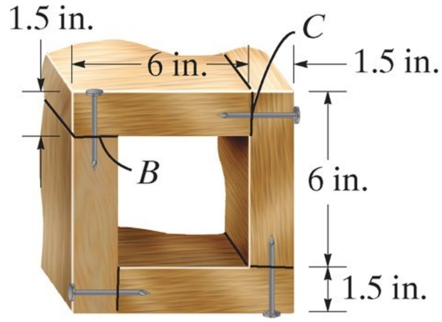
example 7.4



Determine the shear flow at B and B' that must be resisted by glue to bond the boards together.

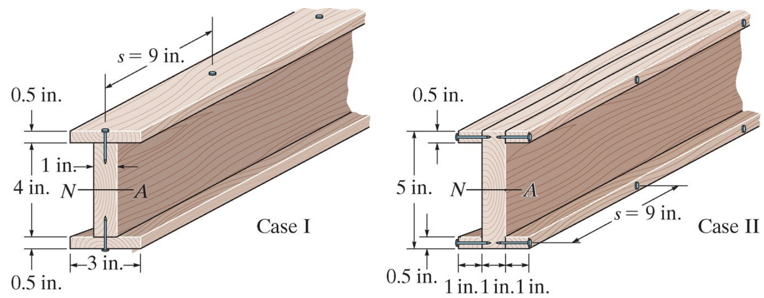
example 7.5





If each nail can support a maximum shear force of 30 lb, determine the maximum spacing of the nails at B and at C so that the beam can support the force of 80 lb.

example 7.6



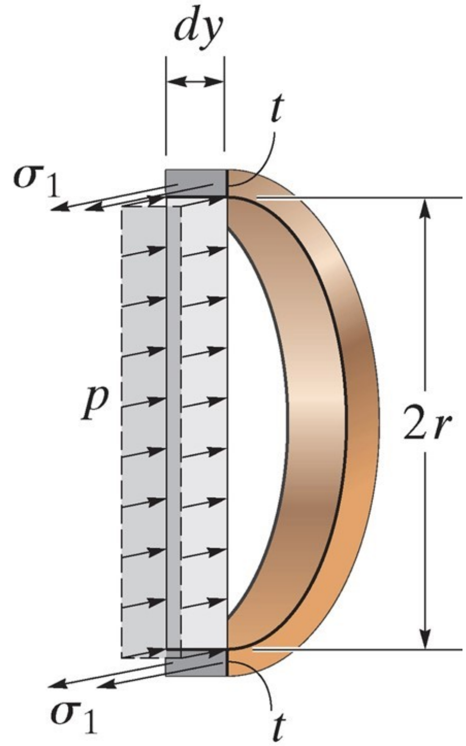
Nails with a shear strength of 40 lb are used in a beam that can be constructed as shown in Case I or Case II. If the nails are spaced at 9 in determine the largest vertical shear that can be supported.

thin-walled pressure vessels

thin-walled pressure vessels

- If the radius to wall thickness ratio is 10 or more, we can treat a pressure vessel 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

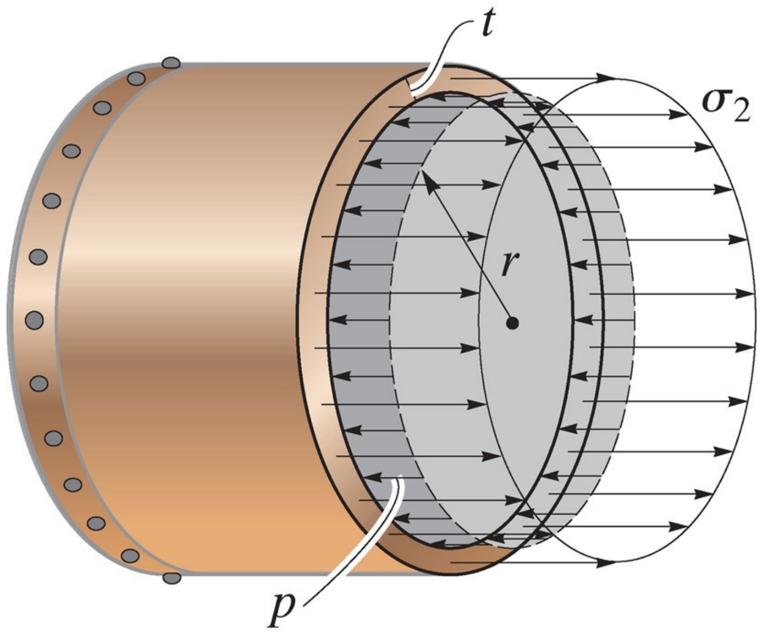


cylindrical vessels

- 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

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

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?