Exam 1

100 points

February 8, 2017

You are allowed to use a calculator and drawing equipment, only.

50 minute time limit

Given Formulae:
Normal stress $\sigma = \frac{F}{A}$, where $F$ is the force that is normal to the cut and $A$ is the area of the cut.
Shear stress $\tau = \frac{V}{A}$, where $V$ is the force that is parallel to the cut and $A$ is the area of the cut.

BONUS QUESTIONS (0.1 POINTS EACH):
“ology” Words: “the study of”. Provide the field of study for each ology word.

1. Cryptozoology – the study of beings from folklore etc (e.g., Bigfoot)
2. Cytology – the study of cells.
3. Cosmology – the study of the origin of the universe
4. Cosmetology – the “study” of cosmetics (hairstyling, makeup, etc.)
5. Epistemology – the branch of philosophy concerned with the theory of knowledge
6. Rheology – the study of the flow of matter in its liquid state.
7. CalciumAnthropology – the study of Milkmen, a bogus term, but it exists in Urban Dictionary (based on a joke by the comedian Steven Wright).
8. Phlebology – the study of veins (as in: blood)
10. Ichthyology – the study of fish
11. Entomology – the study of insects (not to be confused with Etymology, which is the study of the origin and history of words)
1. (25 points). Two pieces of wood are cut at the 30° angle shown, connected by a 3/8” diameter bolt, and subjected to the 1 kip force, shown. The cross-section of the wood is 2” x 4”. The bolt is perpendicular to the cut-plane. Determine the shear and normal stress on the bolt cross-section (cut a-a).

\[ A_b = \pi \left( \frac{3}{16} \right)^2 = 0.1104 \text{ in}^2 \]

\[ \tau_{\text{bolt}} = \frac{0.866 \text{kips}}{0.1104 \text{in}^2} = 7.84 \text{ksi} \]

\[ \sigma_{\text{bolt}} = \frac{0.5 \text{kips}}{0.1104 \text{in}^2} = 4.53 \text{ksi} \]

**Final Answers – Stresses on Bolt Cross-Section**

\[ \tau_{\text{bolt}} = 7.84 \text{ ksi} \]

\[ \sigma_{\text{bolt}} = 4.53 \text{ ksi} \]
2. (25 points). Determine the maximum force \( P \) that may be applied to the bolted connection without failure, considering:
   a. Failure of the bolts, in shear.
   b. Failure of a plate, in normal stress at holes (on net area) =>

   Given:
   - (6) ½” diameter bolts in 9/16” diameter holes: \( \tau_{ult} = 36 \text{ ksi}, \sigma_{ult} = 60 \text{ ksi} \)
   - (3) Plates. Each plate has a cross-section that is ¼” x 4”, as shown and \( \tau_{ult} = 30 \text{ ksi}, \sigma_{ult} = 50 \text{ ksi} \)

   b. Plate Fracture at holes

   \[
   \begin{align*}
   a). & \quad A_{bolt} = \pi \left( \frac{1}{2} \right)^2 = 0.1963 \text{ in}^2 / \text{bolt} \\
   & \quad 6 \text{ bolts, DLBV} \implies A_{v} = (6)(2)A_{bolt} = 2.356 \text{ in}^2 \\
   & \quad P = (36 \text{ ksi})(2.356 \text{ in}^2) = 84.8 \text{ kips} \\
   b). & \quad A_{net} = (4" - 3 \left( \frac{3}{16} \right)) \frac{1}{4}" = 0.5781 \text{ in}^2 \\
   & \quad P = (50 \text{ ksi})(0.5781 \text{ in}^2) = 28.9 \text{ kips} \\
   \end{align*}
   \]

   Final Answer: Maximum \( P \) (kips)

   \[ P_{max} = \boxed{28.9} \text{ kips} \]
3. (50 points). Determine the internal normal force $N$, shear force $V$, and bending moment $M$ at the midpoint of AB, indicating the signs, for each.

Given: BE and CD are pin-ended members. A and F are pinned supports.

Summary:
- $N = 919\text{ lb}$
- $V = 200\text{ lb}$
- $M = 31.25\text{ lb*ft}$