Assignment 13 ...

1. Stock glulam beams are often layed up with a constant radius curvature to give the beam camber. For a lamination thickness of 1-1/2 in., 1500 ft radius camber, and considering a MOE value of 1,900,000 psi, determine:

   a) the associated 'pre-stress',

   b) the percentage of theoretical capacity loss if the allowable flexure stress is 2400 psi.

2. Determine the extreme fiber bending stress for a 2 x 10 piece of dimension lumber if it is laid 'flat' (like a plank, or piece of decking), subject to a bending moment of 300 lb-ft.

3. Determine (Part a) the extreme fiber bending stress for a 6-in. diameter ROUND section, subject to 1000 lb-ft of bending moment. Hint: look up the MOI for a round section (make sure you get the right MOI) ... determine the distance from the neutral axis to the extreme fiber, and crunch the number ...
   \[ \sigma_{\text{max}} = \frac{M y_{\text{max}}}{I} \]
   Also, answer the following ... (Part b)
   
   Is the round section more or less efficient than a square section with the same cross sectional area? (Explain, or show some numbers to convince me, or both.)

4. 2 x 12 dim. lumber joists spaced at 24 in. o.c. carry a total area load of 75 psf (Snow load, dead load, and self weight). The joists span 10 ft and are simply supported at their ends. Determine:

   a) Show the load/Rxn, V, and M diagrams for the joist

   b) Determine the max M, and it's location

   c) Determine the maximum extreme fiber bending stress (extreme fiber stress at the location of maximum bending moment).

   d) Perform the 'Unity Check' if the Allowable bending stress is 1200 psi.

Due Monday, 9/29.
1. \[ \sigma = \frac{E y}{I} = \frac{19,000 \text{ psi}}{1500 \times 12 \text{ in}^2} = \frac{19 \text{ psi}}{\text{part a}} \]

\[ \text{part b) if the allowable is 2400 psi...} \]

\[ \frac{19}{2400} = 3.3\% \]

\[ \text{hmmm} \]

2. This is the problem we did in class as an example... except now the lumber is laid flat.

\[ f_b = \frac{P A}{S} = \frac{6}{S} = \frac{b h^2}{6} = \frac{(1.25)(1.5)^3}{6} = 5.203 \text{ in}^3 \]

\[ f_b = \frac{3 \sigma (b - f_t) x 12 \text{ in}}{12 \text{ in}^3} = 692 \text{ psi} \]

\[ \text{Contrasted to for the 2x10 on edge...} \]
Day 13, p. 2 Solution

3.

\[ a) \quad f_b = \frac{M}{A} \]

\[ M = 1200 \text{ lb ft} = 12000 \text{ lb in}\]

\[ S = \frac{f}{c} \]

\[ I = \frac{\pi d^4}{64} \quad (d \approx 8.93, \text{ near top}) \]

\[ = \frac{\pi (6)^4}{64} \text{ in}^4 \]

\[ = 63.6 \text{ in}^4 \]

\[ c = d/2 = \frac{6}{2} = 3 \text{ in} \]

\[ S = \frac{f}{c} = \frac{63.6}{3} = 21.2 \text{ in}^3 \]

\[ f_b = \frac{1200 \text{ lb in}}{21.2 \text{ in}^3} = 566 \text{ psi} \]

\[ \text{Part b) Well, let's see...} \]

\[ A = \frac{\pi (6)^2}{4} = 28.3 \text{ in}^2 \]

equine square section would be...
\[ \sqrt{28.3} = 5.32 \times 5.32 \]

\[ S_x = \frac{bh^2}{6} = \frac{5.32(5.32)^2}{6} = 2.506 \text{ in}^3 \]

\[ f_b = \frac{M}{S} = \frac{12000}{25.06} = 479 \text{ psi} \]

Hmmmm... 526 > 479... so the round is LESS efficient.

Discussion... well, yeah, of course! Looking at the round section the material is distributed closer to the \( x \)-axis... less I, so more stress!

4) See next page
Area load is 75 psf

\[ \text{Area} = 2 \times \frac{1}{2} \times 2 \text{ ft} = 2 \text{ ft}^2 \]

So, line load is \( 2 \times 75 \text{ psf} = 150 \text{ plf} \)

\[ \text{Load} \]

\[ \text{150 plf} = w \]

\[ \begin{array}{c}
\text{10 ft} \\
\text{10 ft} \\
\text{10 ft} \\
\text{10 ft} \\
\text{10 ft} \\
\end{array} \]

Reactions are, by inspection \( \frac{Wl}{2} \), where \( l \) is the length.

\[ \text{Reactions} = 150 \text{ plf} \times \frac{10 \text{ ft}}{2} = 750 \text{ lb each} \]

Shear starts at 750 and decreases at rate of 150 lb/ft thru zero (in middle) and to -750 at other end.

Moment starts at zero... increases by the amount of the area under the V curve between end and
\[ M_{\text{middle}} = M_0 + \Delta M \text{ to middle} = 0 + \frac{1}{2} bh = \frac{1}{2}(750)(5) = 1875 \text{ lb-ft} \]

So, Part a)

\[ \begin{array}{c}
\text{Load/Reaction}
\end{array} \]

\[ \begin{array}{c}
\text{Shear}
\end{array} \]

\[ \begin{array}{c}
\text{Moment}
\end{array} \]
the case of the simply supported beam with uniformly distributed load shows up so often. You may as well memorize the formula:

\[ M_{\text{max}} = \frac{WL^2}{8} = \frac{150(10)^2}{8} = 1875 \text{ lb-ft} \]

b) \[ \max M = 1875 \text{ lb-ft} = 22,500 \text{ lb-in} \]

at the mid-span.

c) \[ f_b = \frac{M}{S} \quad S = \frac{bh^2}{6} \quad b = 1.5 \text{ in} \quad h = 11.25 \text{ in} \]

\[ S = 1.5 \left(11.25\right)^2 \quad \frac{6}{6} = 31.6 \text{ in}^3 \]

\[ f_b = \frac{22,500}{31.6} \text{ lb-in} = 711 \text{ psi} \]

d) Unit Check ...

is \[ \frac{fb}{F_b} = \frac{711}{1200} = 0.59 \leq 1.00? \]

Yes Good