UNIVERSITY OF CALIFORNIA, BERKELEY Department of Civil and Environmental Engineering
Spring Semester, 2005 Instructor: A. K. Chopra

CE 130 – MIDTERM EXAMINATION NO. 2

Please Note:

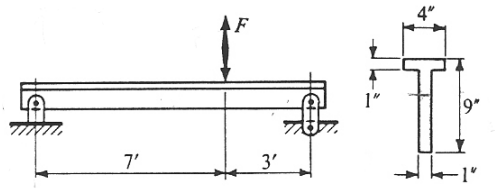
1. Write your answers on these sheets.

2. Show all computations; identify your answers.

Problems	Maximum Points	Points Scored
1	8	
2	10	
3	12	
Total	30	

NAME: _____

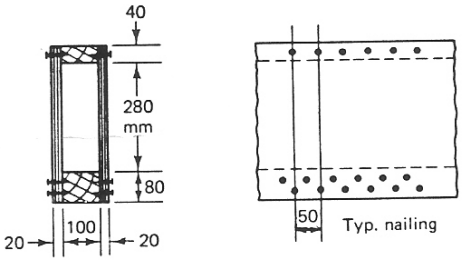
1. A T-beam shown in the figure is made of a material with tensile proportional limit of 3000 psi and a compressive proportional limit of 6000 psi. If these stresses are not to be exceeded, find the magnitude of the largest force F which may be applied to this beam in (a) downward direction (b) upward direction. Consider only the bending stresses obtained from the flexure formula. For the given T-section the neutral axis (n-a) is 5.5 in. from the bottom and $I = 97$ in^4 about the n.a.



2. A box beam is fabricated by nailing plywood sides to two longitudinal wooden pieces, as shown in the figure. If the vertical shear at a section is $V = 12$ kN, determine:

   (a) shear stress in the plywood at the neutral axis.
   (b) shear force in one of the nails near the top of the beam.

   The neutral axis of the cross-section is 180 mm from the bottom of the section and moment of inertia of the section about the neutral axis is 541×10^6 mm^4.



3. A machine bracket is loaded as shown in Fig. (a).

a) Stress analysis of the bracket gives the following stress components acting on element A: 100 psi due to bending, 1500 psi due to axial force, and 600 psi due to shear. (Note that these are stress magnitudes only; their directions and senses must be determined by inspection). Indicate the resulting stresses on a drawing of the element.

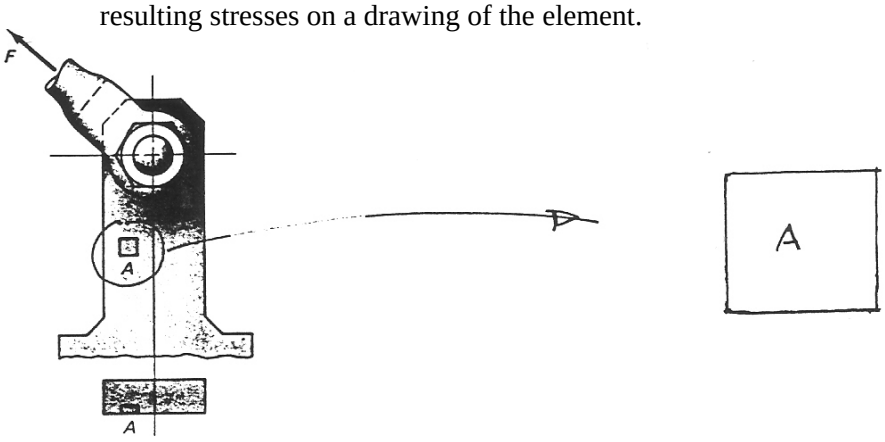


Fig. (a)

b) If the stresses at some other point are as shown in Fig. (b), find the principal stresses. Show the results on a properly oriented element.

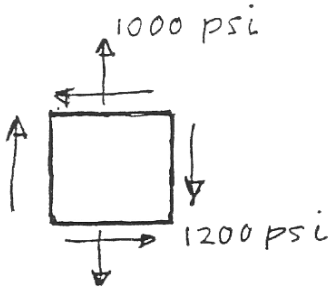


Fig. (b)

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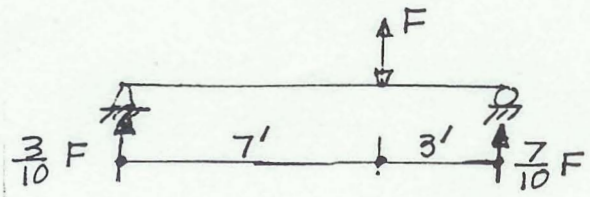
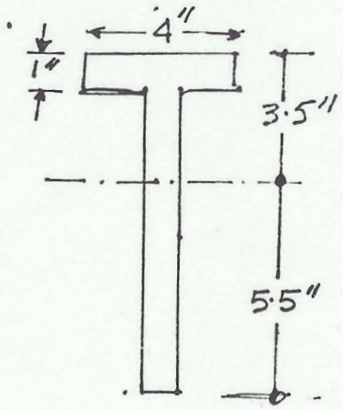




1. Max Bending moment

Occurs at F

$M = \pm\left(\frac{3}{10}F\right)7 = \pm 2.1F$ lb-ft

$= \pm 25.2F$ lb-in

2. F acting downward

Top in compression Bottom in tension

$\sigma_{top} = 6000 = \frac{25.2F \times 3.5}{97} \Rightarrow F = 6599$ lb

$\sigma_{bot} = 3000 = \frac{25.2F \times 5.5}{97} \Rightarrow F = 2100$ lb

$\therefore \sigma_{bot}$ governs $\Rightarrow$ $\underline{\underline{F = 2100 \text{ lb}}}$ ←

3. F acting upward

Top in tension Bottom in compression

$\sigma_{top} = 3000 = \frac{25.2F \times 3.5}{97} \Rightarrow F = 3299$ lb

$\sigma_{bot} = 6000 = \frac{25.2F \times 5.5}{97} \Rightarrow F = 4199$ lb

$\therefore \sigma_{top}$ governs $\Rightarrow$ $\underline{\underline{F = 3299 \text{ lb}}}$ ←

2.

a) τ @ plywood in N.A.

$$\tau = \frac{VQ}{It} = \frac{(12\,kN)(1.768\times10^6\,mm^3)}{(541\times10^6\,mm^4)(40\,mm)} = \underline{\underline{0.98\ N/mm}}$$

$$Q = (100\times40)(200) + 2(20\times220)(110) = 1.768\times10^6\ mm^3$$

b) Force on nail

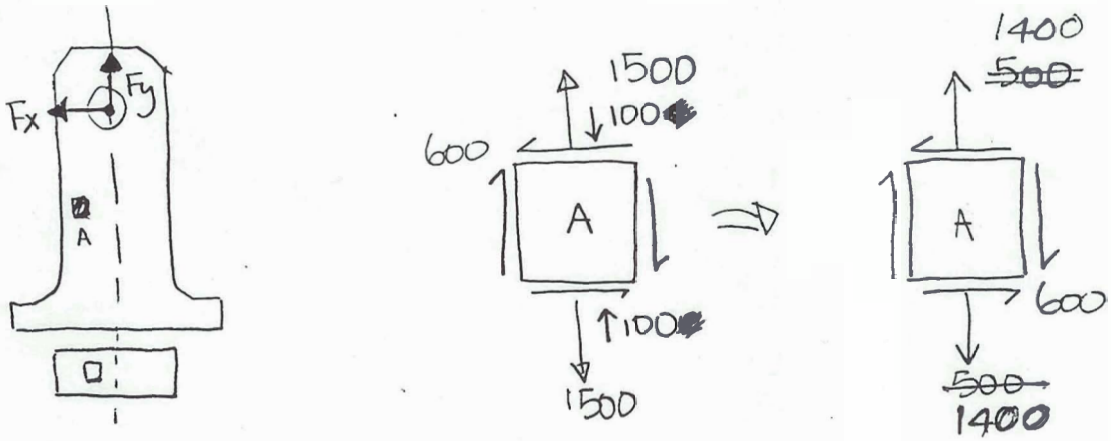
$$q = \frac{VQ}{I} = \frac{(12\,kN)(8.0\times10^5\,mm^3)}{(541\times10^6\,mm^4)} = 17.7\ N/mm$$

$$Q = (100\times40)(200) = 8.0\times10^5\ mm^3$$

$$F = \frac{(50\,mm)(17.7\,N/mm)}{2} = \underline{\underline{444\ N}}$$

3.

a



b 1 Determine principle stresses

$$\sigma_{1,2} = \frac{1000}{2} \pm \sqrt{\left(\frac{1000}{2}\right)^2 + (1200)^2} \Rightarrow \begin{matrix}\sigma_1 = 1800 \\ \sigma_2 = -800\end{matrix}$$

2 Determine orientation

$$\tan 2\theta_1 = \frac{-1200}{(-1000)/2} \Rightarrow \theta_1 \begin{matrix}\nearrow 33.7^\circ \\ \searrow 123.7^\circ\end{matrix}$$

3. σ_1 acts on which plane?

$$\sigma_{x'} = \frac{1000}{2} + \frac{-1000}{2}\cos 2(33.7°) + (-1200)\sin 2(33.7)$$

$$= -800$$