$T_1 = 315 - F(40mm)$

But

$F = \frac{-T_3}{80mm} = \frac{.464 T_1}{80mm}$

$T_1 = 315 - .464 \left(\frac{40mm}{80mm}\right) T_1$

$1.232\, T_1 = 315$

(26) $T_1 = 255.682\, N$

$T_1 = 630 - F(40mm)$

$1.232\, T_1 = 630$

$T_1 = 511.363\, N$

$T_1 = 945 - F(40mm)$

$1.232\, T_1 = 945$

$T_1 = 767.045\, N$

---

(27) $T_3 = 118.636\, N$ | $T_3 = 237.272\, N$ | $T_3 = 355.909\, N$

---

(28)

$\phi_E = \frac{T_3 L_3}{J_3 G_3}$

$= \frac{(118.636)N(.6m)}{(147{,}324)mm^4 \left(\frac{1}{1000}\right)(80 \times 10^9)}$

$= \frac{71.182\, Nm}{11{,}785.92}$

$= 6.038 \times 10^{-3}$ rad

12.076×10^{-3}

18.114×10^{-3}

(29)

$\phi_{C/B} = \frac{T_2 L_2}{J_2 G_2}$

$= \frac{(315)(850)}{79{,}522(80GPa)}$

$= .04208$

$.08417$

$.12626$

---

(30) $R_B \phi_B = R_E \phi_E$

$40\, \phi_B = 80\, \phi_E$

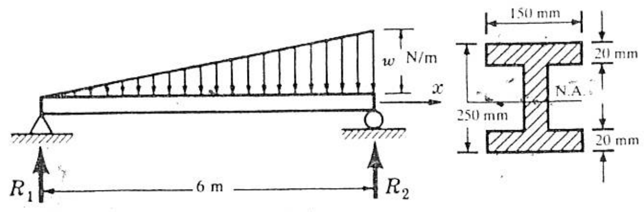
$\phi_{Jot} = 2\phi_E + \phi_{C/B} = .05416$

$.10832$

$.16248$

ME 304 Quiz #7

An I- beam is loaded as shown. Determine



(a)

$w = 50$ N/m

$I = \frac{1}{12} b h^3$

$I_{N/A} = I_{cm} + A d^2$

$\bar{y} = \frac{\Sigma \bar{y}_i A_i}{\Sigma A_i}$

$\sigma_x = -\frac{M y}{I}$

Version C

36. I = a) 47.5 x 10^6 mm^4 b) 75.0 x 10^6 mm^4 c) 95.0 x 10^6 mm^4 d) 107.5 x 10^6 mm^4 e) 120.0 x 10^6 mm^4

37. The distance (X max) from support 1 to location where M is a maximum a) 1.531 . b) 2.052 m c) 2.663 md) 3.464 m e) 5.196 m

38. The maximum bending moment = a) 115.47 N m b) 174.21 N m c) 230.94 N m d) 313.53 N m e) 364.41 N m

39. The magnitude of the maximum stress in the beam=a) 455.80 MPa b) 382.74 c) 303.87 MPa d) 255.25 MPa e) 151.93 MPa

40. The magnitude of the stress in the beam at the joint between the web and the flange for X max a) 455.80 MPa b) 382.74 c) 303.87 MPa d) 255.25 MPa e) 127.62 MPa

ME304 Quiz #7

$w = 50\,kN/m$ $\qquad$ $w = 100\,kN/m$ $\qquad$ $w = 150\,kN/m$

1) $I = \frac{1}{12} b_o h_o^3 - \frac{1}{12} b_i h_i^3$

$$= \frac{1}{12}(150)(250)^3 - \frac{2}{12}\left[65(210)^3\right] = 94.99 \times 10^6\,mm^4 \cong 95 \times 10^6\,mm^4$$

2) Zero crossing for $V(x)$

a) Find Rxns

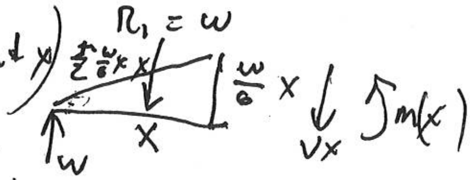
$R_1 + R_2 = \frac{1}{2} 6w = 3w$

$3w \cdot 4 = 6R_2$

$R_2 = 2w$

$R_1 = w$

Cut at x)



$$M(x) = wx - \frac{wx^2}{12}\frac{x}{3}$$
$$= wx - \frac{wx^3}{36}$$

$V(x) = w - \frac{wx^2}{12}$

set $= 0$

$\cancel{w}\left(1 - \frac{x^2}{12}\right) = 0 \quad x = \pm\sqrt{12} \qquad x = +3.464\,m$

3) at $x = 3.464$

$M(x) = 50\left(3.464 - \frac{3.464^3}{36}\right)$ $\qquad$ $100\left(3.464 - \frac{3.464^3}{36}\right)$ $\qquad$ $150\left(3.464 - \frac{3.464^3}{36}\right)$

115.47 kN·m $\qquad$ 230.94 kN·m $\qquad$ ~~364.4~~ kN·m 346.41

)

$\sigma_{max} = \frac{My}{I}$

$= \frac{(115.47\,N\cdot m)(.125\,m)}{95 \times 10^{-6}\,m^4}$

$\pm$ 151.934 MPa $\qquad$ 303.87 MPa $\qquad$ 455.80

At joint with web/flange

$\sigma = \frac{(115.47)(.105)}{95 \times 10^{-6}}$

$=$ 127.624 MPa $\qquad$ 255.249 MPa $\qquad$ 382.874 MPa

8.11. The simply supported beam shown in Fig. 8-23(a) is subject to a uniformly varying load having a maximum intensity of w N per meter of length at the right end of the bar. If the beam is a wide-flange section having the dimensions shown in Fig. 8-23, determine the maximum load intensity w that may be applied if the working stress is 125 MPa in either tension or compression. Neglect the weight of the beam.

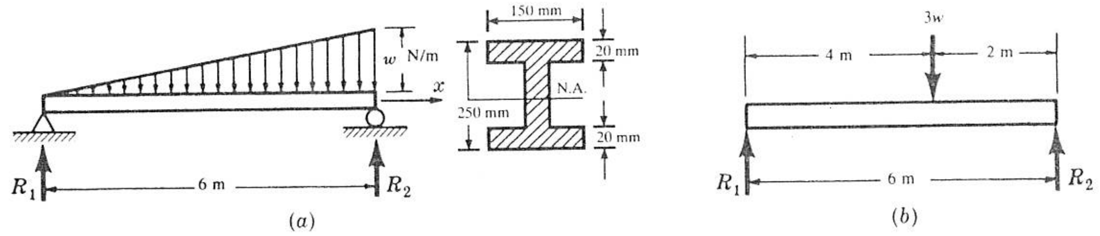


Fig. 8-23

The reactions R_1 and R_2 may readily be determined in terms of the unknown w by replacing the distributed load by its resultant. Since the average value of the distributed load is $w/2$ N/m acting over a length of 6 m, the resultant is a force of magnitude $6(w/2) = 3w$ N acting through the centroid of the triangular loading diagram, that is, 4 m to the right of R_1. This resultant thus appears as in Fig. 8-23(b). From statics we immediately have $R_1 = w$ N and $R_2 = 2w$ N.

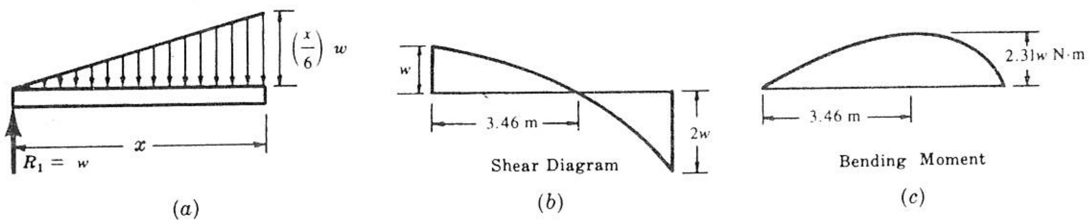


Fig. 8-24

The shearing force and bending moment diagrams for this type of loading were discussed in Problem 6.5. Let us introduce an x-axis coinciding with the beam and having its origin at the left support. Then at a distance x to the right of the left reaction, the intensity of load is found from similar-triangle relationships to be $(x/6)w$ N/m. This portion of the loaded beam between R_1 and the section x appears in Fig. 8-24(a). In accordance with the procedure explained in Problem 6.5, the shearing force V at the section a distance x from the left support is given by

$$V = w - \frac{1}{2}\left(\frac{x}{6}\right)wx = w - \frac{1}{12}wx^2$$

This equation holds for all values of x and from it the shear diagram is readily plotted, as shown in Fig. 8-24(b). The point of zero shear is found by setting

$$w - \tfrac{1}{12}wx^2 = 0 \qquad \text{from which} \qquad x = \sqrt{12} = 3.46 \text{ m}$$

This is also the point where the bending moment assumes its maximum value.

The bending moment M at the section a distance x from the left support is given by

$$M = wx - \frac{1}{2}\left(\frac{x}{6}\right)w\frac{x^2}{3} = wx - \frac{1}{36}wx^3$$

Again, this equation holds for all values of x and from it the bending moment diagram may be plotted as in Fig. 8-24(c). At the point of zero shear, $x = 3.46$ m, the bending moment is found by substitution in the above equation to be

$$M_{x=3.46} = 3.46w - \tfrac{1}{36}w(3.46)^3 = 2.31w \text{ N}\cdot\text{m}$$

This is the maximum bending moment in the beam.

The bending stress on any fiber a distance y from the neutral axis of the beam is given by $\sigma = My/I$. The moment of inertia I of the beam is found from

$$I_x = \frac{150(250)^3}{12} - 2\left[\frac{65(210)^3}{12}\right] = 95 \times 10^6 \text{ mm}^4$$

The maximum tensile stress occurs at the lower fibers of the beam where $y = 125$ mm at the section where the bending moment is a maximum. This stress is 125 MPa, and thus $\sigma = My/I$ becomes

$$125 \times 10^6 = \frac{(2.31w)(0.125)}{95 \times 10^6(10^{-12})} \qquad \text{or} \qquad w = 41 \text{ kN/m}$$

8.12. Determine the section modulus of a beam of rectangular cross section.

Let h denote the depth of the beam and b its width. Bending is assumed to take place about the neutral axis through the centroid of the cross section. The moment of inertia about the neutral axis is $I = bh^3/12$. At the outer fibers the distance to the neutral axis is $h/2$, and this is commonly denoted by c. The maximum bending stresses at these outer fibers are given by

$$\sigma_{\max} = \frac{Mc}{I} = \frac{M}{I/c}$$

The ratio I/c is called the *section modulus* and is usually denoted by Z. Then $\sigma_{\max} = M/Z$. For the beam of rectangular cross section,

$$Z = \frac{L}{c} = \frac{bh^3/12}{h/2} = \frac{bh^2}{6}$$

The section modulus Z has units of m^3 or in^3.

8.13. A beam is loaded by one couple at each of its ends, the magnitude of each couple being 5 kN · m. The beam is steel and of T-type cross section with the dimensions indicated in Fig. 8-25(b). Determine the maximum tensile stress in the beam and its location, and the maximum compressive stress and its location.

It is first necessary to locate the centroid of the cross-sectional area since the neutral axis is known to pass through the centroid. To do this we introduce the x-y coordinate system shown and use the methods of Chap. 7. The y-coordinate of the centroid is defined by

$$\bar{y} = \frac{\int y\, da}{A}$$

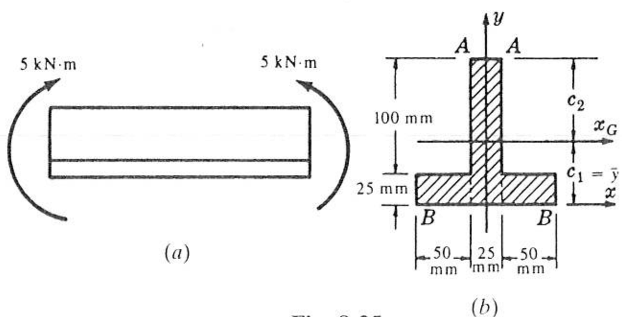
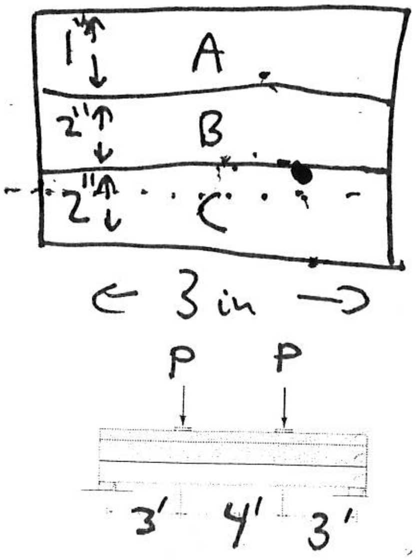


Fig. 8-25

ME 304 Quiz #8

A composite beam is composed of three layers as shown. You will need to transform materials A and B to look like material C. Determine



$E_A = 450$ ksi

$E_B = 160$ ksi

$E_C = 800$ ksi

$I_{rec} = \frac{1}{12} b h^3$

$I_{N/A} = I_{c/m} + Ad^2$

$\bar{y} = \frac{\Sigma \bar{y}_i A_i}{\Sigma A_i}$

41. The location of the neutral axis (wrt bottom of beam) a) 1.543 in b) 1.704 in c) 1.936 in d) 2.074 in e) 2.132 in

42. I relative to the neutral axis a) 10.12 in^4 b) 20.25 in^4 c) 30.38 in^4 d) 40.50 in ^4 e) 50.62 in ^4

If the yield stress in Material A is 4 ksi, determine

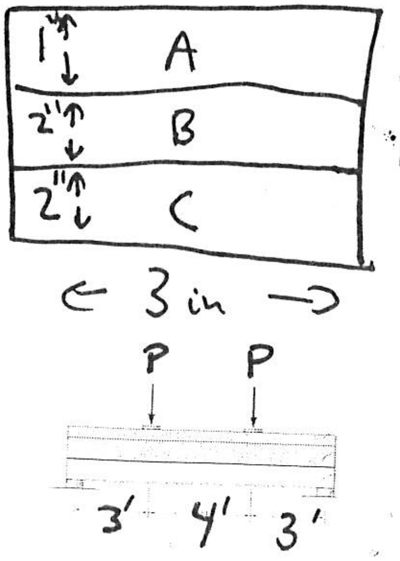
43. The load P required to produce yielding in A a) 500.0 lb b) 652.4 lb c) 750.0 lb d) 978.6 lb e) 1304.9 lb

44. At this load P, what is the maximum stress in C a) 1.53 ksi b) 2.24 ksi c) 3.06 ksi d) 3.37 ksi e) 4.49 ksi

45. At this load P, what is the maximum stress in B a) 1.44 ksi b) 2.16 ksi c) 2.87 ksi d) 4.31 ksi e) 5.74 ksi

ME 304 Quiz #8

A composite beam is composed of three layers as shown. You will need to transform materials A and B to look like material C. Determine



$E_A = 450$ ksi

$E_B = 160$ ksi

$E_C = 800$ ksi

$I_{rec} = \frac{1}{12} b h^3$

$I_{N/A} = I_{cm} + A d^2$

$\bar{y} = \frac{\sum \bar{y}_i A_i}{\sum A_i}$

41. The location of the neutral axis (wrt bottom of beam) a) 1.543 in b) 1.704 in c) 1.936 in d) 2.074 in e) 2.132 in

42. I relative to the neutral axis a) 10.12 in^4 b) 20.25 in^4 c) 30.38 in^4 d) 40.50 in ^4 e) 50.62 in ^4

If the yield stress in Material A is 3 ksi, determine

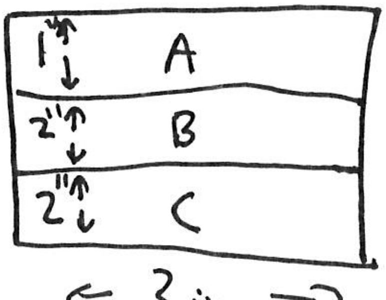
43. The load P required to produce yielding in A a) 500.0 lb b) 652.4 lb c) 750.0 lb d) 978.6 lb e) 1304.9 lb

44. At this load P, what is the maximum stress in C a) 1.53 ksi b) 2.24 ksi c) 3.06 ksi d) 3.37 ksi e) 4.49 ksi

45. At this load P, what is the maximum stress in B a) 1.44 ksi b) 2.16 ksi c) 2.87 ksi d) 4.31 ksi e) 5.74 ksi

ME 304 Quiz #8

A composite beam is composed of three layers as shown. You will need to transform materials A and B to look like material C. Determine



$E_A = 450$ ksi

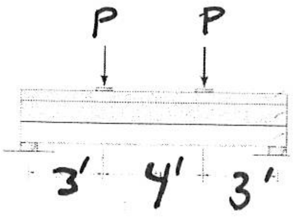
$E_B = 160$ ksi

$E_C = 800$ ksi

$I_{rec} = \frac{1}{12} b h^3$

$I_{N/A} = I_{c/m} + Ad^2$

$\bar{y} = \frac{\Sigma \bar{y}_i A_i}{\Sigma A_i}$



41. The location of the neutral axis (wrt bottom of beam) a) 1.543 in b) 1.704 in c) 1.936 in d) 2.074 in e) 2.132 in

42. I relative to the neutral axis a) 10.12 in^4 b) 20.25 in^4 c) 30.38 in^4 d) 40.50 in ^4 e) 50.62 in ^4

If the yield stress in Material A is 2 ksi, determine

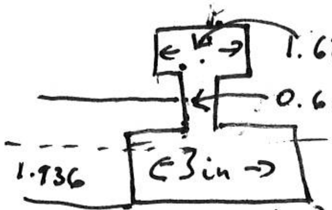
43. The load P required to produce yielding in A a) 500.0 lb b) 652.4 lb c) 750.0 lb d) 978.6 lb e) 1304.9 lb

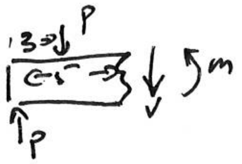
44. At this load P, what is the maximum stress in C a) 1.53 ksi b) 2.24 ksi c) 3.06 ksi d) 3.37 ksi e) 4.49 ksi

45. At this load P, what is the maximum stress in B a) 1.44 ksi b) 2.16 ksi c) 2.87 ksi d) 4.31 ksi e) 5.74 ksi

ME 304 - Quiz 8

Transformed Cross Section





$M = 5P - 2P = 3P$ ft·lb

41. $$\bar{y} = \frac{(2)(3)(1) + 3(.6)2 + (1)(1.6875)4.5}{(3)(2) + (.6)2 + (1.6875)} = 1.936 \text{ in}$$

42. $$I = \frac{1}{12}3(2)^3 + (3)(2)(.936)^2 + \frac{1}{12}(.6)2^3 + (.6)2(1.064)^2 + \frac{1}{12}(1.6875)1^3 + (1.6875)(2.564)^2$$
(2, 5.265, .4, 1.36, .141, 11.093)

$= 20.25 \text{ in}^4$

43. If the ~~allowable~~ Yield stress in material A is ~~20~~ ksi, determine the ~~maximum~~ minimum load P ~~required~~ for yielding in A

$\sigma_a = 2$ ksi | 3 ksi | 4 ksi

$$2 = \frac{450}{800} \cdot \frac{3P(12)\,3.0654}{20.2495}$$
$P = 652.42$ lbs

$$3 = \frac{450}{800}\,\frac{3P(12)3.0654}{20.2495}$$
$P = 978.64$ lbs

$$4 = \frac{450}{800}\,\frac{3P(12)\,3.0654}{20.2495}$$
$P = 1304.85$ lb

44. Max Stress in C (using this P value)

$$\sigma = \frac{3P12\ (1.9346)}{20.2495}$$

$= 2.2439$ ksi $\qquad = 3.3659 \qquad 4487.8$

45. Max Stress in B

$c = 4 - 1.9346 = 2.0654$

$$\sigma = \frac{3P(12)(2.0654)}{20.2495}\,\frac{160}{800}$$

$= $ ~~1.4957 ksi~~ 479.1 $\qquad$ 718.69 $\qquad$ 958.25

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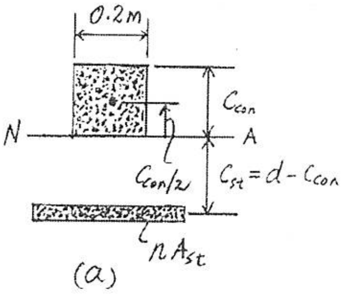
6–138. Continued



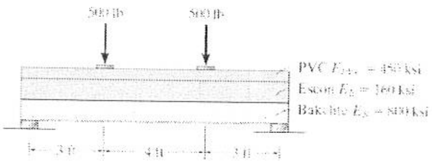
$= 1.3084(10^{-3})\ \text{m}^4$

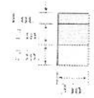
Substituting this result into Eq. (1),

$$M = 12.5(10^6)\left[\frac{1.3084(10^{-3})}{0.1659}\right]$$

$$= 98\,594.98\ \text{N}\cdot\text{m} = 98.6\ \text{kN}\cdot\text{m} \qquad \textbf{Ans.}$$

6–139. The beam is made from three types of plastic that are identified and have the moduli of elasticity shown in the figure. Determine the maximum bending stress in the PVC.





$$(b_{st})_1 = n_1 b_{E_1} = \frac{160}{800}(3) = 0.6\ \text{in.}$$

$$(b_{st})_2 = n_2 b_{PVC} = \frac{450}{800}(3) = 1.6875\ \text{in.}$$

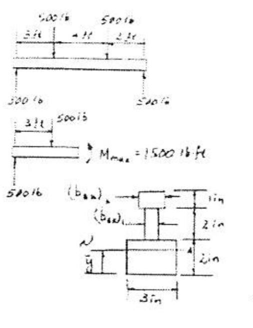
$$\bar{y} = \frac{\Sigma \tilde{y}A}{\Sigma A} = \frac{(1)(3)(2) + 3(0.6)(2) + 4.5(1.6875)(1)}{3(2) + 0.6(2) + 1.6875(1)} = 1.9346\ \text{in.}$$

$$I = \frac{1}{12}(3)(2^3) + 3(2)(0.9346^2) + \frac{1}{12}(0.6)(2^3) + (0.6)(2)(1.0654^2)$$

$$+ \frac{1}{12}(1.6875)(1^3) + 1.6875(1)(2.5654^2) = 20.2495\ \text{in}^4$$

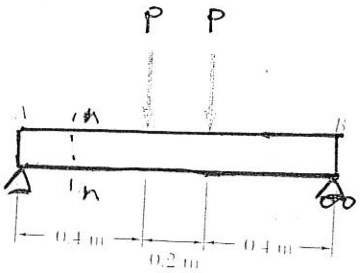
$$(\sigma_{max})_{pvc} = n_2\frac{Mc}{I} = \left(\frac{450}{800}\right)\frac{1500(12)(3.0654)}{20.2495}$$

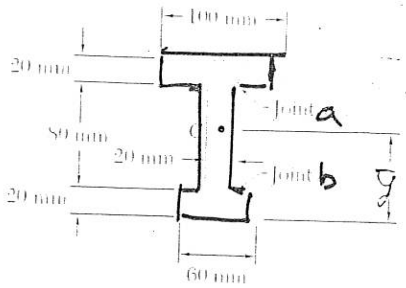
$$= 1.53\ \text{ksi} \qquad \textbf{Ans.}$$



ME 304 Quiz #9

A wood beam is loaded by the point loads shown. Determine for section nn





$P = 1.5\,kN$

$\tau = \frac{VQ}{It}$ $\quad Q = \Sigma \bar{y}_i A_i$ $\quad \bar{y} = \frac{\Sigma \bar{y}_i A_i}{\Sigma A_i}$ $\quad I_{N/A} = I_{cm} + Ad^2$

____________**1. The location of the neutral axis (wrt the bottom of the beam).**

____________**2. The moment of inertia about the neutral axis.**

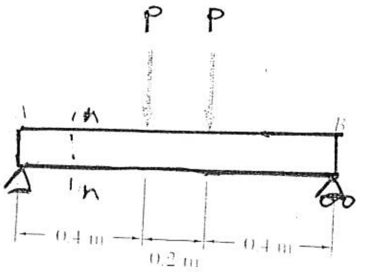
____________**3. The transverse shear in the web at joint a (just below the intersection of the web and flange).**

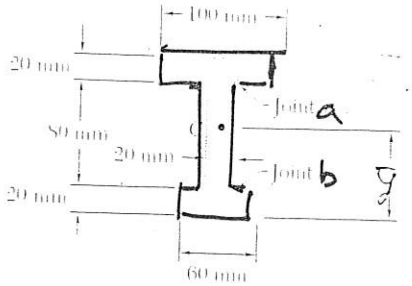
____________**4. The transverse shear in the web at joint b (just above the intersection of the web and flange).**

____________**5. The maximum transverse shear.**

ME 304 Quiz #9

A wood beam is loaded by the point loads shown. Determine for section nn





$P = 3\,kN$

$\tau = \dfrac{VQ}{It}$ $\quad Q = \Sigma \bar{y}_i A_i$ $\quad \bar{y} = \dfrac{\Sigma \bar{y}_i A_i}{\Sigma A_i}$ $\quad I_{N/A} = I_{cm} + Ad^2$

____________**1. The location of the neutral axis (wrt the bottom of the beam).**

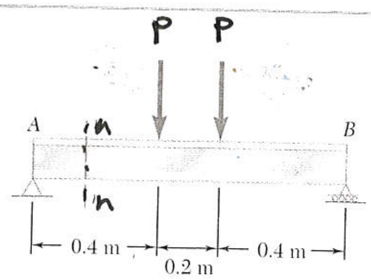
____________**2. The moment of inertia about the neutral axis.**

____________**3. The transverse shear in the web at joint a (just below the intersection of the web and flange).**

____________**4. The transverse shear in the web at joint b (just above the intersection of the web and flange).**

____________**5. The maximum transverse shear.**

Quiz#9



Sample Problem 6.1

Beam AB is made of three plates glued together and is subjected, in its plane of symmetry, to the loading shown. Knowing that the width of each glued joint is 20 mm, determine the average shearing stress in each joint at section n–n of the beam. The location of the centroid of the section is given in Fig. 1 and the centroidal moment of inertia is known to be $I = 8.63 \times 10^{-6}\ \text{m}^4$. $\bar{y} = 68.3\,\text{mm}$

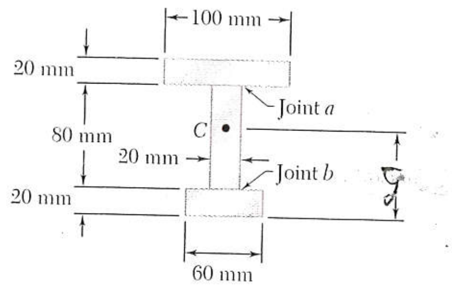


Fig. 1 Cross section dimensions with location of centroid.

STRATEGY: A free-body diagram is first used to determine the shear at the required section. Eq. (6.7) is then used to determine the average shearing stress in each joint.

MODELING:

Vertical Shear at Section *n*–*n*. As shown in the free-body diagram in Fig. 2, the beam and loading are both symmetric with respect to the center of the beam. Thus, we have $\mathbf{A} = \mathbf{B} = 1.5\ \text{kN}\uparrow$.

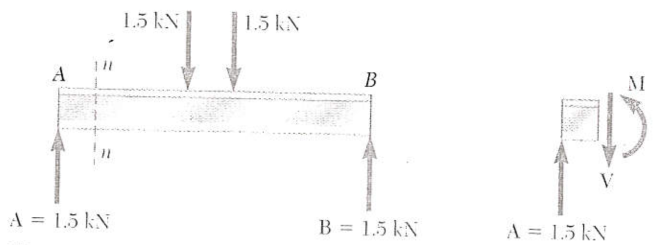
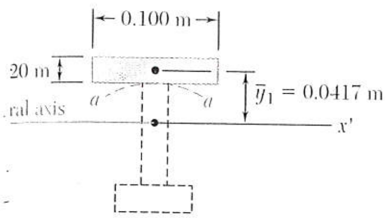


Fig. 2 Free-body diagram of beam and segment of beam to left of section *n*–*n*.

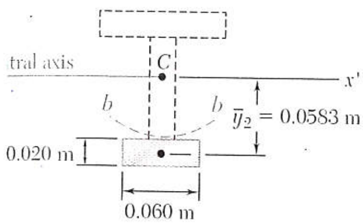
Drawing the free-body diagram of the portion of the beam to the left of section n–n (Fig. 2), we write

$$+\uparrow \Sigma F_y = 0: \qquad 1.5\ \text{kN} - V = 0 \qquad V = 1.5\ \text{kN}$$

(continued)



3 Using area above section a–a to
2.



4 Using area below section b–b to
Q.

ANALYSIS:

Shearing Stress in Joint *a*. Using Fig. 3, pass the section a–a through the glued joint and separate the cross-sectional area into two parts. We choose to determine Q by computing the first moment with respect to the neutral axis of the area above section a–a.

$$Q = A\bar{y}_1 = [(0.100\text{ m})(0.020\text{ m})](0.0417\text{ m}) = 83.4 \times 10^{-6}\text{m}^3$$

Recalling that the width of the glued joint is $t = 0.020$ m, we use Eq. (6.7) to determine the average shearing stress in the joint.

$$\tau_{\text{ave}} = \frac{VQ}{It} = \frac{(1500\text{ N})(83.4 \times 10^{-6}\text{ m}^3)}{(8.63 \times 10^{-6}\text{ m}^4)(0.020\text{ m})} \qquad \tau_{\text{ave}} = 725\text{ kPa}$$

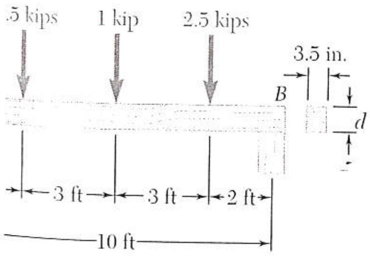
Shearing Stress in Joint *b*. Using Fig. 4, now pass section b–b and compute Q by using the area below the section.

$$Q = A\bar{y}_2 = [(0.060\text{ m})(0.020\text{ m})](0.0583\text{ m}) = 70.0 \times 10^{-6}\text{ m}^3$$

$$\tau_{\text{ave}} = \frac{VQ}{It} = \frac{(1500\text{ N})(70.0 \times 10^{-6}\text{ m}^3)}{(8.63 \times 10^{-6}\text{ m}^4)(0.020\text{ m})} \qquad \tau_{\text{ave}} = 608\text{ kPa}$$

For τ_{max} $Q = A\bar{y}_1 + A_2\bar{y}_2 = (.1)(.02)(.0417) + (.0317)(.02)(.01585)$
$= 93.45 \times 10^{-6}$

$\tau_{max} = \frac{VQ}{It} = \frac{(1500)\,93.45 \times 10^{-6}}{(8.63 \times 10^{-6})(.020)} = 812\text{ kPa}$



Sample Problem 6.2

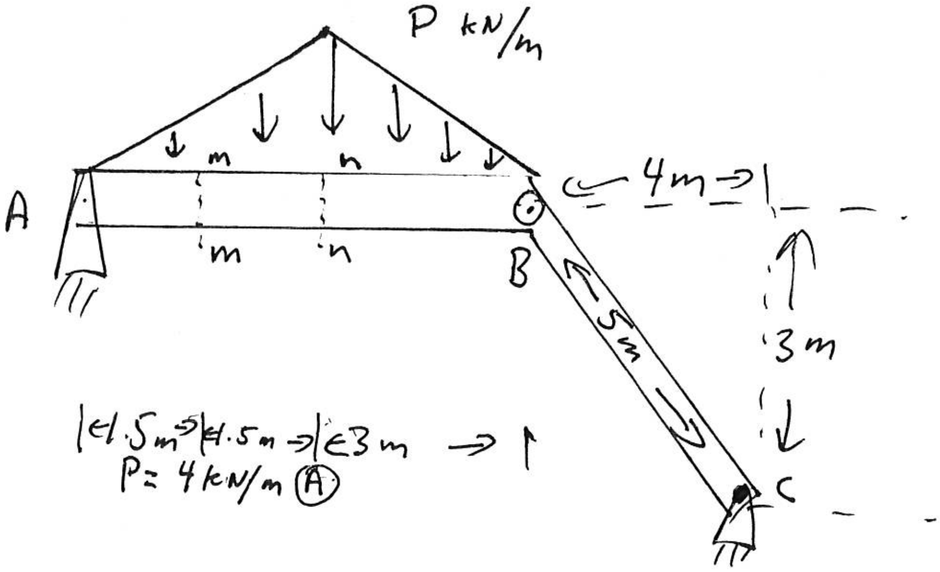
A timber beam AB of span 10 ft and nominal width 4 in. (actual width = 3.5 in.) is to support the three concentrated loads shown. Knowing that for the grade of timber used $\sigma_{\text{all}} = 1800$ psi and $\tau_{\text{all}} = 120$ psi, determine the minimum required depth d of the beam.

STRATEGY: A free-body diagram with the shear and bending-moment diagrams is used to determine the maximum shear and bending moment. The resulting design must satisfy both allowable stresses. Start by assuming that one allowable stress criterion governs, and solve for the required depth d. Then use this depth with the other criterion to determine if it is also satisfied. If this stress is greater than the allowable, revise the design using the second criterion.

(continued)

ME 304 Quiz #10

A structure is loaded as shown. Determine

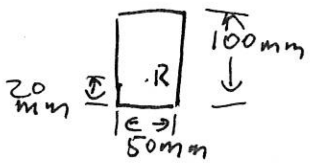


$$\tau = \frac{VQ}{It}$$

$$I = \frac{1}{12} bh^3$$

$$Q = \Sigma \bar{y}_i A_i$$

$$\sigma_x = \frac{-My}{I}$$



51. The magnitude of the reaction at B a) 2.5 kN b) 5 kN c) 10 kN d) 15 kN e) 20 kN

52. The magnitude of the reaction at A in the x direction a) 8 kN b) 4 kN c) 2 kN d) 16 kN e) 12 kN

53. The magnitude of the axial stress at location R for section nn a) 169.6 MPa b) 127.2 MPa c) 42.4 MPa d) 21.2 MPa e) 84.8 MPa

54. The magnitude of the axial stress at location R for section mm a) 28.9 MPa b) 127.2 MPa c) 115.6 MPa d) 57.8 MPa e) 84.8 MPa

55. The magnitude of the transverse shear stress at location R for section nn a) 1.436 MPa b) 1.728 MPa c) 0.864 MPa d) 3.456 MPa e) 0.432 MPa

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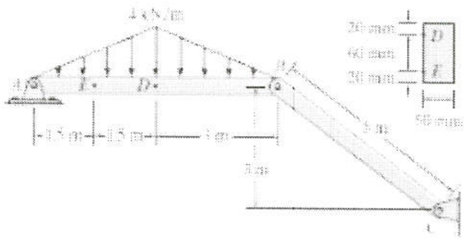
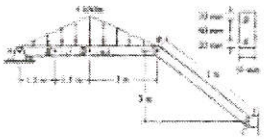
8–30. The frame supports the distributed load shown. Determine the state of stress acting at point E. Show the results on a differential element at this point.

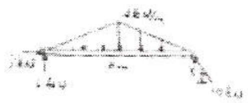


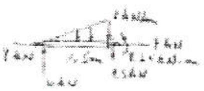
$$\sigma_E = -\frac{P}{A} + \frac{My}{I} = -\frac{8(10^3)}{(0.1)(0.05)} + \frac{8.25(10^3)(0.03)}{\frac{1}{12}(0.05)(0.1)^3} = 57.8\text{ MPa} \qquad \textbf{Ans.}$$

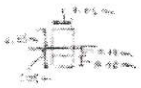
$$\tau_E = \frac{VQ}{It} = \frac{4.5(10^3)(0.04)(0.02)(0.05)}{\frac{1}{12}(0.05)(0.1)^3(0.05)} = 864\text{ kPa} \qquad \textbf{Ans.}$$

$\boxed{2 / 4 / 6\ W_{max}}$









Ans:
$\sigma_E = 57.8$ MPa, $\tau_E = 864$ kPa

Avr 68%
5 - 42
4 - 44
3 - 41
2 - 25
1 - 31

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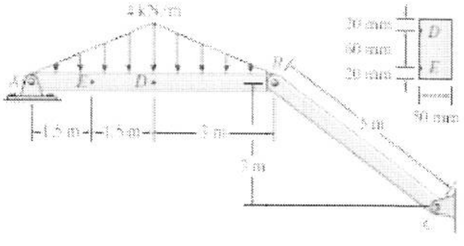
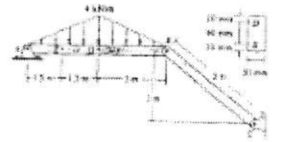
8–38. The frame supports the distributed load shown. Determine the state of stress acting at point D. Show the results on a differential element at this point.

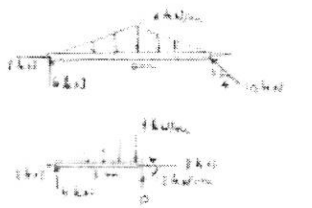


$$\sigma_D = -\frac{P}{A} - \frac{My}{I} = -\frac{8(10^3)}{(0.1)(0.05)} - \frac{12(10^3)(0.03)}{\frac{1}{12}(0.05)(0.1)^3}$$

$\sigma_D = -88.0$ MPa **Ans.**

$\tau_D = 0$ **Ans.**

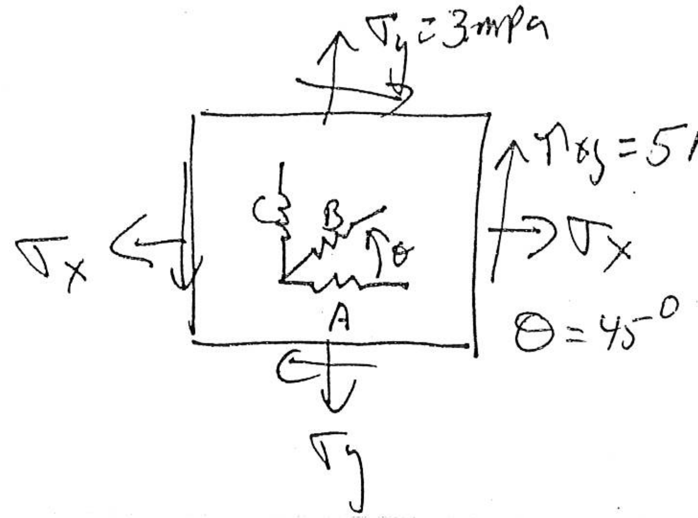




Ans:
$\sigma_D = -88.0$ MPa, $\tau_D = 0$

ME 304 Quiz # 11

For the plane STRESS problem shown, compute the magnitudes of



$E = 1$ GPa
$\nu = .3$
$\epsilon_C = 0.001$

_____ 71. $\sigma_x = ?$
_____ 72. $\epsilon_x = ?$
_____ 73. $\epsilon_z = ?$
_____ 74. $\gamma_{xy} = ?$
_____ 75. $\epsilon_B = ?$

Stiffness

$$\varepsilon_x = \frac{1}{E}\left[\sigma_x - \nu(\sigma_y + \sigma_z)\right], \qquad \gamma_{xy} = \frac{\tau_{xy}}{G}$$

$$\varepsilon_y = \frac{1}{E}\left[\sigma_y - \nu(\sigma_x + \sigma_z)\right], \qquad \gamma_{yz} = \frac{\tau_{yz}}{G}$$

$$\varepsilon_z = \frac{1}{E}\left[\sigma_z - \nu(\sigma_x + \sigma_y)\right], \qquad \gamma_{xz} = \frac{\tau_{xz}}{G}$$

$$G = \frac{E}{2(1+\nu)}$$

Compliance

$$\sigma_x = 2G\varepsilon_x + \lambda e, \qquad \tau_{xy} = G\gamma_{xy}$$

$$\sigma_y = 2G\varepsilon_y + \lambda e, \qquad \tau_{yz} = G\gamma_{yz}$$

$$\sigma_z = 2G\varepsilon_z + \lambda e, \qquad \tau_{xz} = G\gamma_{xz}$$

$$e = \varepsilon_x + \varepsilon_y + \varepsilon_z = \frac{1-2\nu}{E}(\sigma_x + \sigma_y + \sigma_z)$$

$$\lambda = \frac{\nu E}{(1+\nu)(1-2\nu)}$$

$$\epsilon_\theta = \epsilon_x \cos^2\theta + \epsilon_y \sin^2\theta + \sin\theta\cos\theta\,\gamma_{xy}$$

6) $$\epsilon_y = \frac{-.3}{1GPa}\sigma_x + \frac{3MPa}{1GPa} = .001$$

$$-.3\sigma_x + 3MPa = 1MPa$$

$$+.3\sigma_x = +2\ MPa$$

$$\sigma_x = 6.666\ MPa$$

7) $$\epsilon_x = \frac{\sigma_x}{E} - \frac{\nu\sigma_y}{E}$$

$$= \frac{6.66\ MPa}{1GPa} - \frac{.3(3MPa)}{1GPa} = 5.766\times10^{-3}$$

8) $$\epsilon_z = \frac{-\nu}{E}\sigma_x - \frac{\nu}{E}\sigma_y = \frac{-.3}{1GPa}(9.666\ MPa)$$

$$= -2.899\times10^{-3}$$

9) $$\gamma_{xy} = \frac{\tau}{G} = \frac{5MPa}{.3846GPa} = 13\times10^{-3}$$

$$G = \frac{1GPa}{2.6} = .3846\ GPa$$

10) $$\epsilon_B = \epsilon_x \cos^2 45 + \epsilon_y \sin^2 45 + 2\sin 45\cos 45\ \gamma_{xy}$$

$$= (5.76)\frac{1}{2} + 1(1/2) + \cancel{2}\left(\frac{1}{2}\right)13 = \cancel{16.88\times10^{-3}}$$

$$= 9.88\times10^{-3}$$

Version ~~B~~