

Mechanics of Materials



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Ferdinand P.Beer, E.Russel Johnston, Jr., John T.Dewolf

Other Reference:

J.Wat Oler “Lectures notes on Mechanics od Materials”

Ibrahim A.Assakkaf “Lectures notes on Mechanics od Materials”

Homework-04

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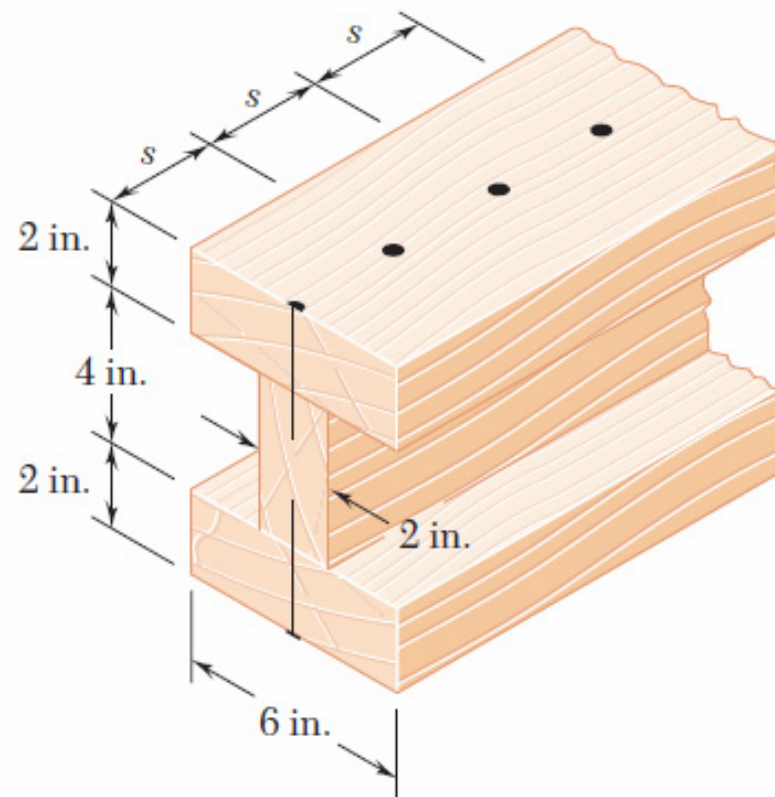
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Homework-04

□ Problem 01

Three boards, each 2 in. thick, are nailed together to form a beam that is subjected to a vertical shear. Knowing that the allowable shearing force in each nail is 150 lb, determine the allowable shear if the spacing s between the nails is 3 in.

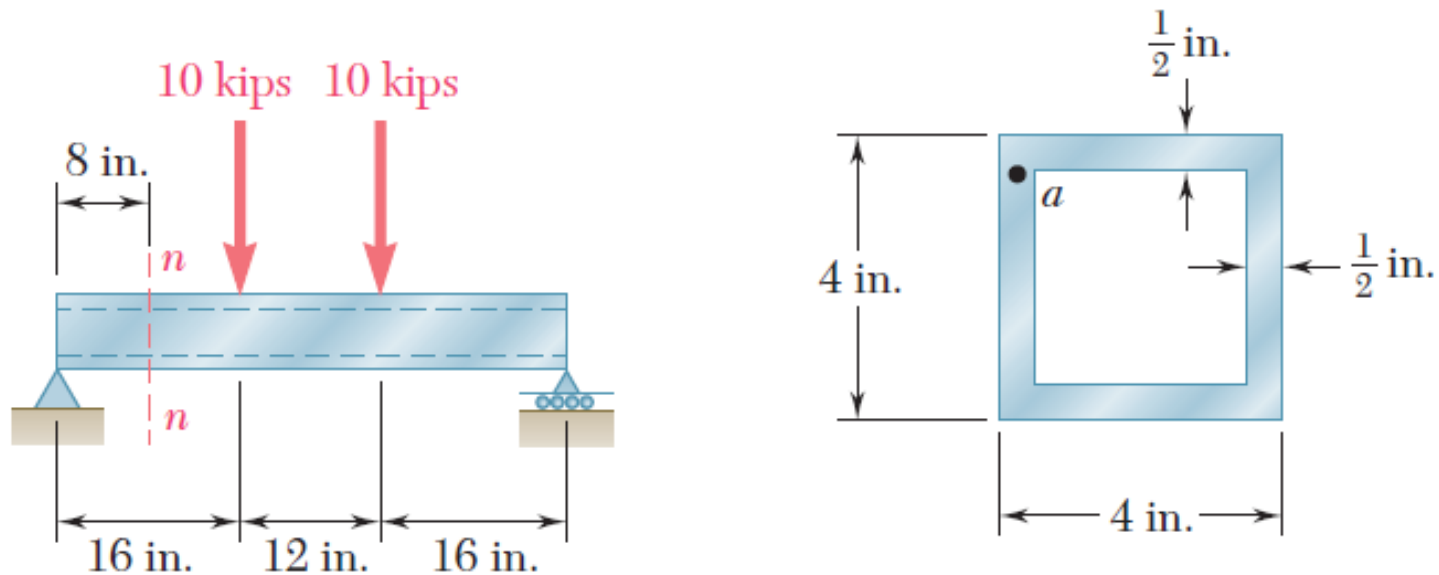


Key Answer: 326 lb.

Homework-04

□ Problem 02

For the beam and loading shown, consider section n-n and determine (a) the largest shearing stress in that section, (b) the shearing stress at point a.

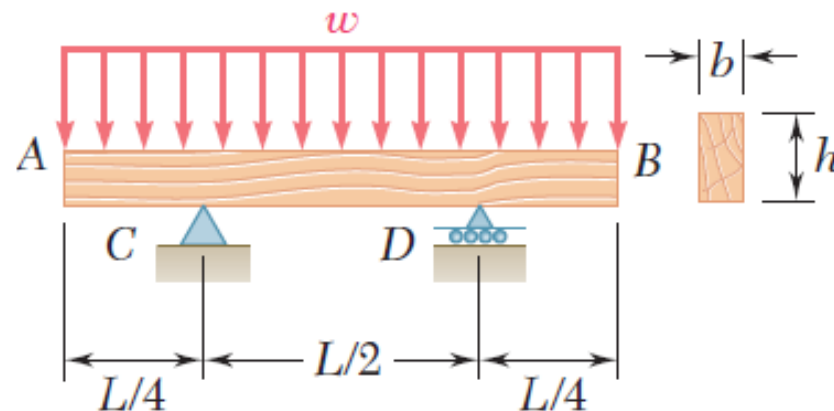


Key Answer: (a) 3.17 ksi. (a) 2.40 ksi.

Homework-04

□ Problem 03

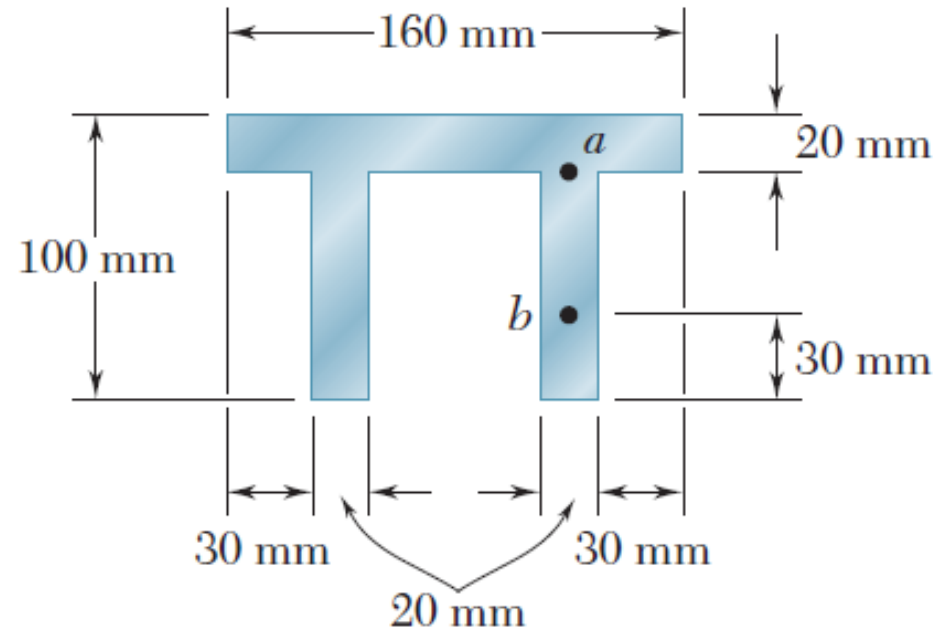
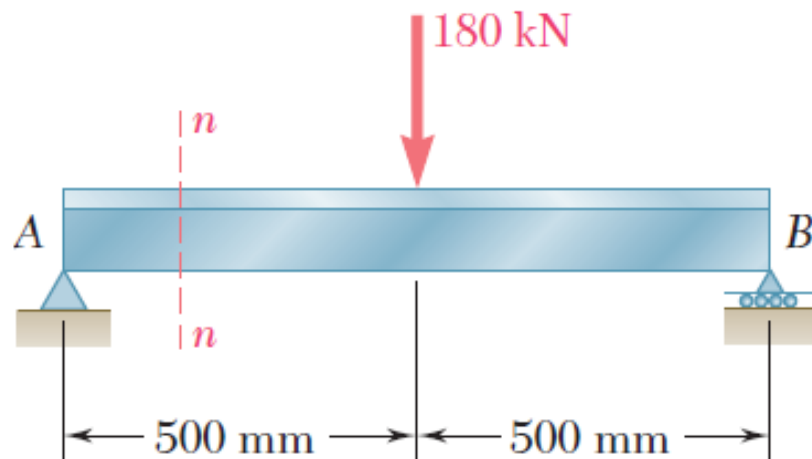
A timber beam AB of length L and rectangular cross section carries a uniformly distributed load w and is supported as shown. (a) Show that the ratio τ_m / σ_m of the maximum values of the shearing and normal stresses in the beam is equal to $2h/L$, where h and L are, respectively, the depth and the length of the beam. (b) Determine the depth h and the width b of the beam, knowing that $L=5$ m, $w=8$ kN/m, $\tau_m = 1.08$ MPa, and $\sigma_m = 12$ MPa.



Homework-04

□ Problem 04

For the beam and loading shown, consider section n-n and determine the shearing stress at (a) point a, (b) point b.



Key Answer: (a) 31.0 MPa. (b) 23.2 MPa.

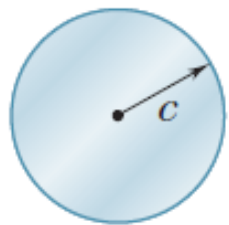
Homework-04

□ Problem 05

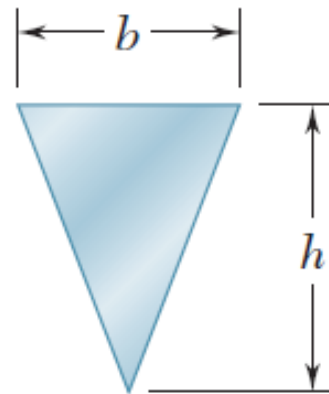
A beam having the cross section shown is subjected to a vertical shear V . Determine (a) the horizontal line along which the shearing stress is maximum, (b) the constant k in the following expression for the maximum shearing stress

$$\tau_{\max} = k \frac{V}{A}$$

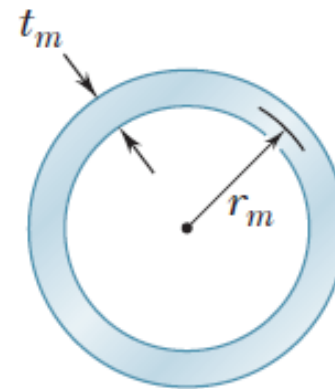
where A is the cross-sectional area of the beam.



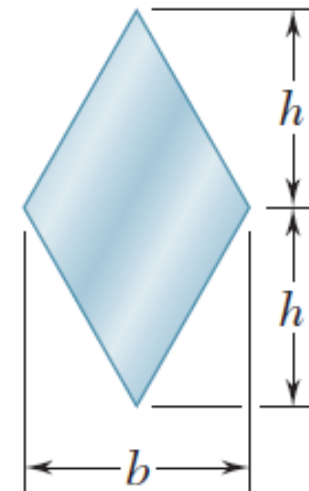
(I)



(II)



(III)



(IV)

Key Answer:

(II): (a) Line at mid-height. (b) 1.500.

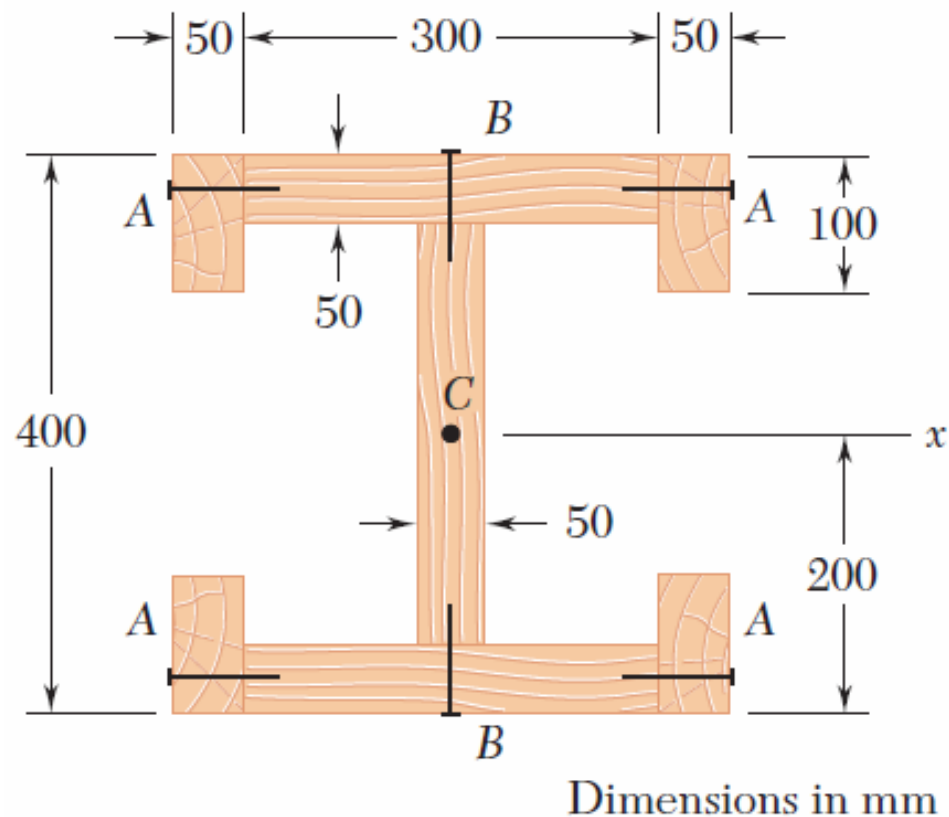
(IV): (a) $hy/4$ from neutral axis. (b) 1.125.

Homework-04

□ Problem 06

The built-up wooden beam shown is subjected to a vertical shear of 8 kN. Knowing that the nails are spaced longitudinally every 60 mm at A and every 25 mm at B, determine the shearing force in the nails (a) at A, (b) at B.

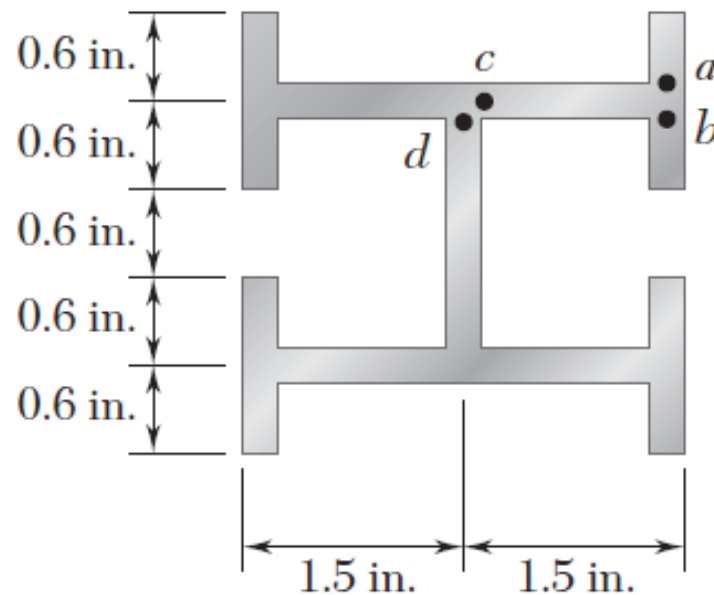
$$I_x = 1.504 \times 10^9 \text{ mm}^4$$



Homework-04

□ Problem 07

An extruded beam has the cross section shown and a uniform wall thickness of 0.20 in. Knowing that a given vertical shear V causes a maximum shearing stress $\tau = 9$ ksi, determine the shearing stress at the four points indicated.

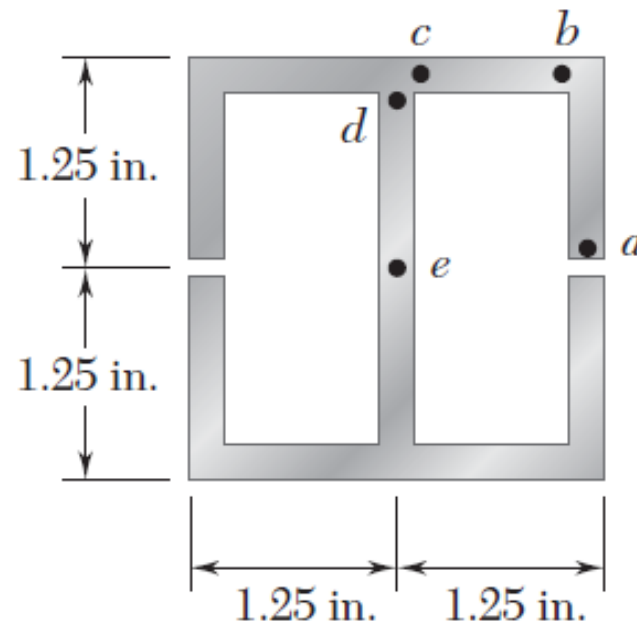


Key Answer: (a) 1.167 ksi. (b) 0.513 ksi. (c) 4.03 ksi. (d) 8.40 ksi.

Homework-04

□ Problem 08

The extruded aluminum beam has a uniform wall thickness of $\frac{1}{8}$ in. Knowing that the vertical shear in the beam is 2 kips, determine the corresponding shearing stress at each of the five points indicated.

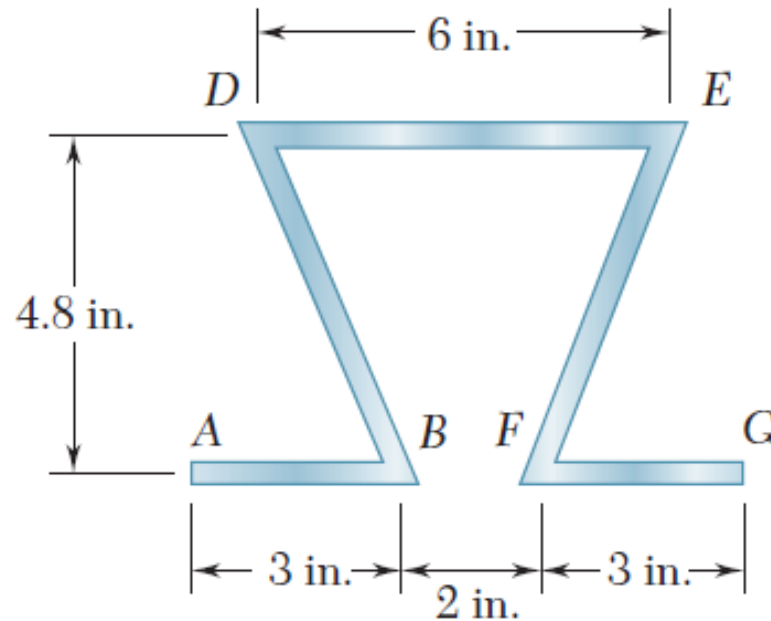


Key Answer: (a) 0. (b) 1.26 ksi. (c) 3.30 ksi. (d) 6.84 ksi. (e) 7.86 ksi.

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□ Problem 09

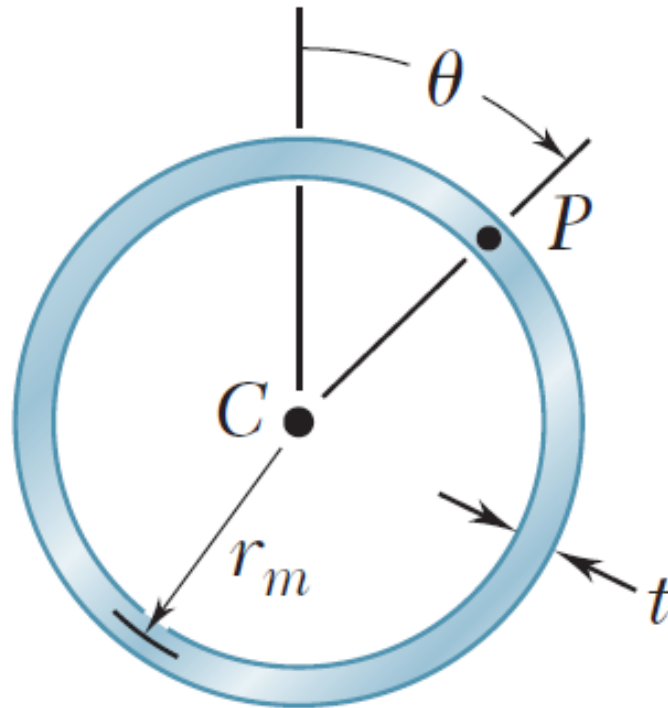
A plate of thickness t is bent as shown and then used as a beam. For a vertical shear of 600 lb, determine (a) the thickness t for which the maximum shearing stress is 300 psi, (b) the corresponding shearing stress at point E. Also sketch the shear flow in the cross section.



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□ Problem 10

(a) Determine the shearing stress at point P of a thin-walled pipe of the cross section shown caused by a vertical shear V. (b) Show that the maximum shearing stress occurs for $\theta = 90^\circ$ and is equal to $2V/A$, where A is the cross-sectional area of the pipe.

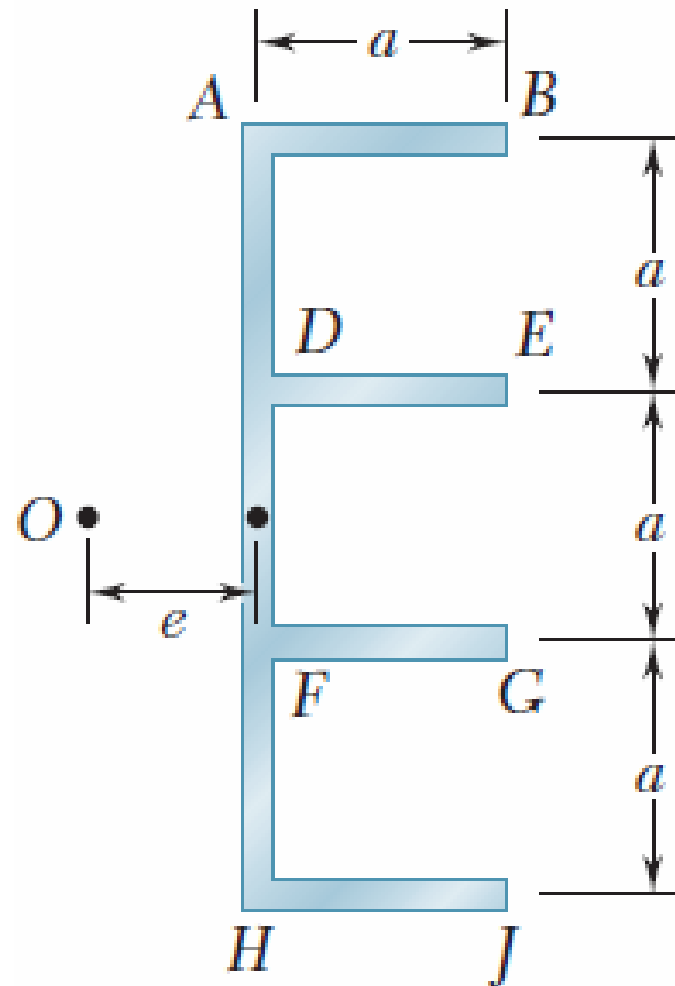


Key Answer: (a) $V \sin\left(\frac{\theta}{\pi r_m t}\right)$

Homework-04

□ Problem 11

Determine the location of the shear center O of a thin walled beam of uniform thickness having the cross section shown.



Key Answer: $e = 0.345a$.

Homework-04

□ Problem 12

An extruded beam has the cross section shown. Determine (a) the location of the shear center O , (b) the distribution of the shearing stresses caused by the vertical shearing force V shown applied at O .

Key Answer:

(a) $e = 9.12$ mm. (b) At B, E, G, and J: $\tau = 0$;

Just to the right of A or H: 50.6 MPa;

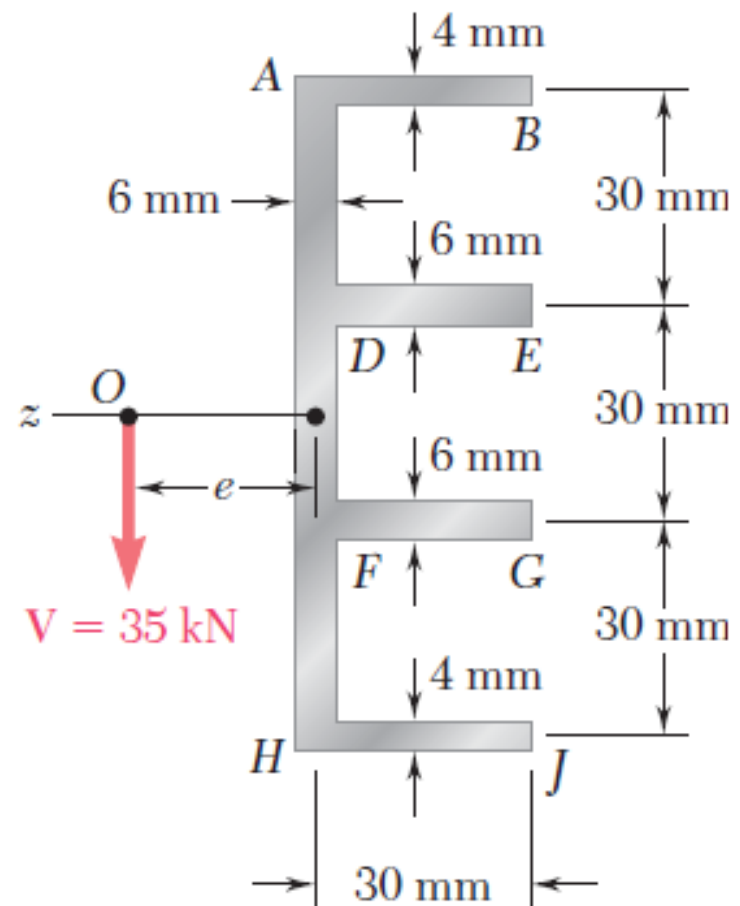
Just below A and just above H: 33.8 MPa;

Just above D and just below F: 67.5 MPa;

Just to the right of D or E: 16.88 MPa;

Just below D and just above F: 84.4 MPa;

At K: 88.6 MPa.

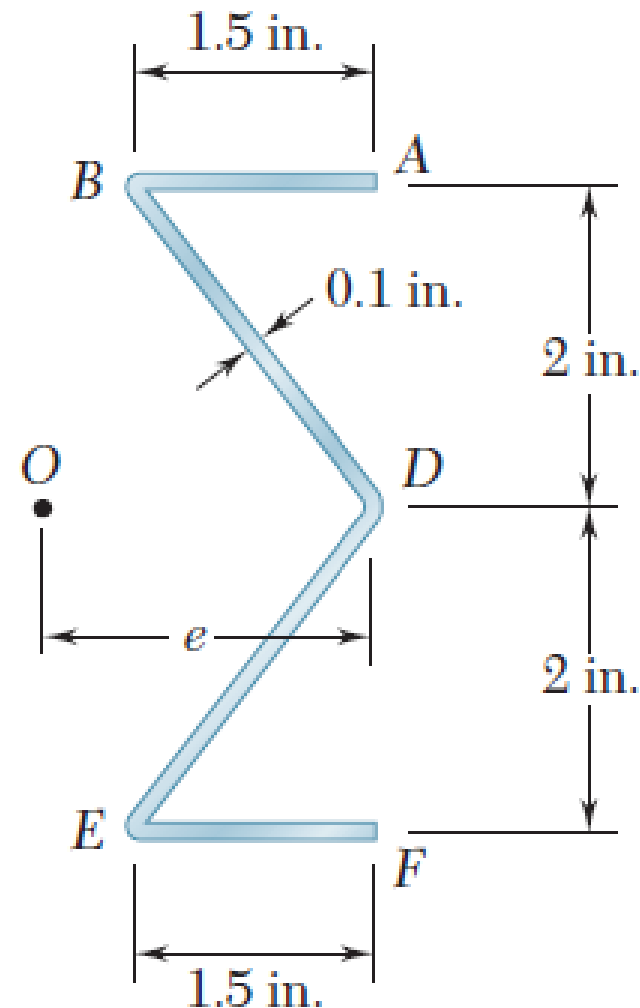


$$I_z = 0.933 \times 10^6 \text{ mm}^4$$

Homework-04

□ Problem 13

Determine the location of the shear center O of a thin-walled beam of uniform thickness having the cross section shown.

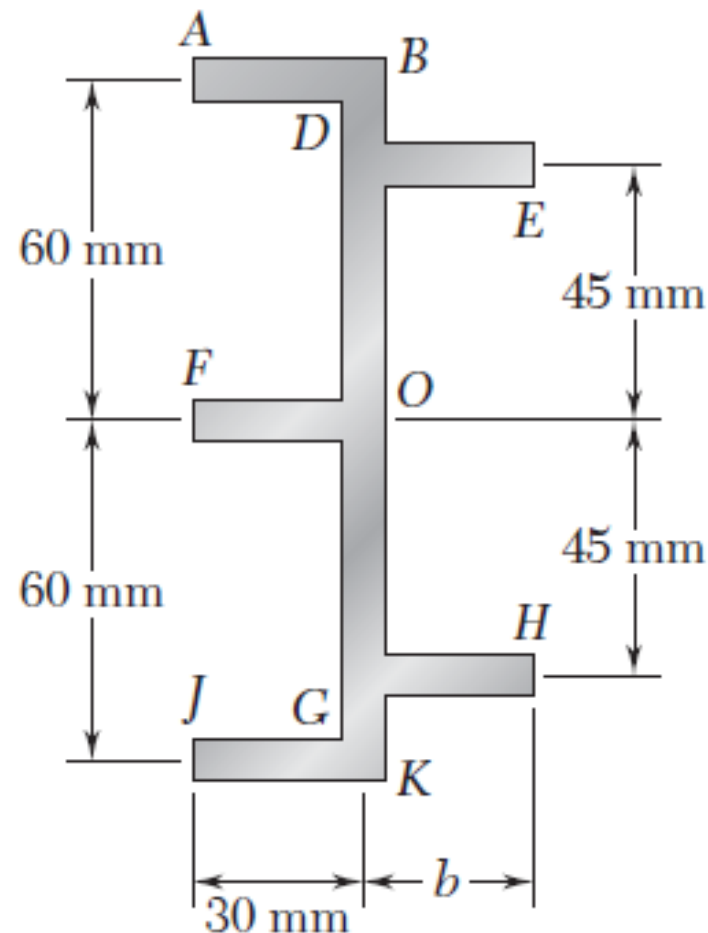


Key Answer: $e = 0.482$ in.

Homework-04

□ Problem 14

A thin-walled beam of uniform thickness has the cross section shown. Determine the dimension b for which the shear center O of the cross section is located at the point indicated.



Key Answer: 40.0 mm.