Mechanics of Materials

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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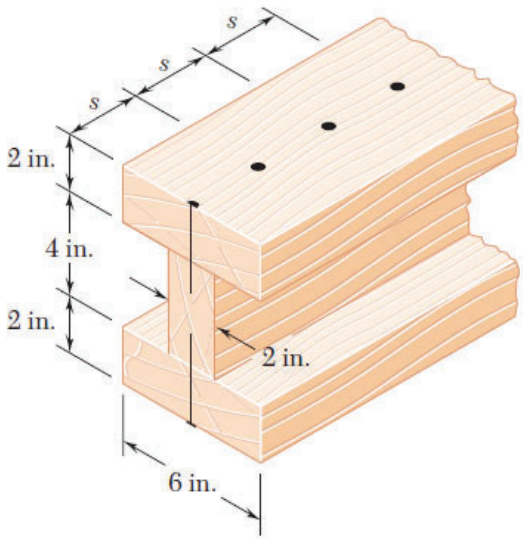
Homework-04

❑ 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.

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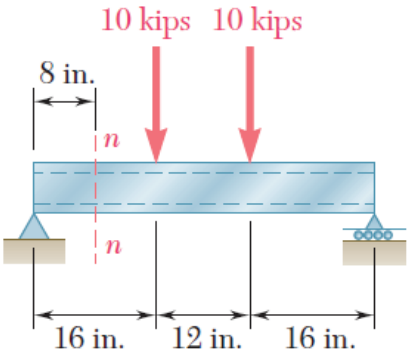
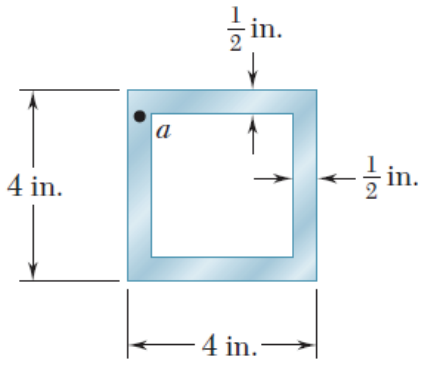
❑ Problem 02

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.

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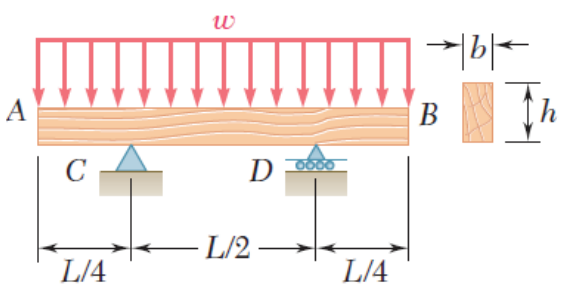
❑ Problem 03

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, τ_m = 1.08 MPa, and σ_m = 12 MPa.



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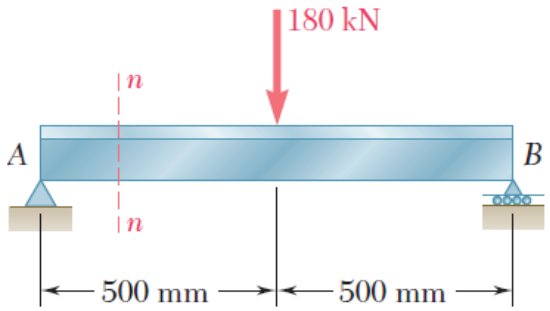
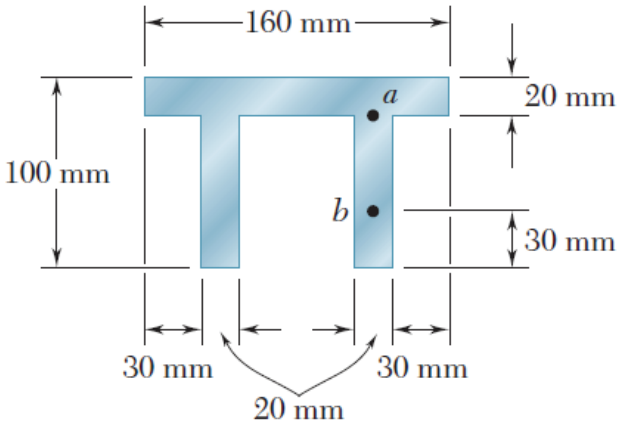
❑ Problem 04

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.

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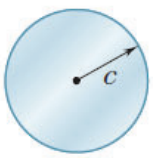
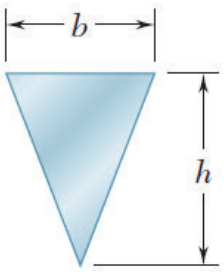
❑ Problem 05

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

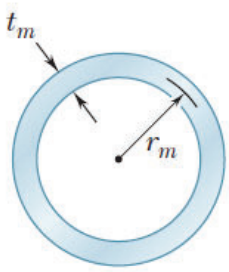
$$\tau_{\max} = k\frac{V}{A}$$ where A is the cross-sectional area of the beam.



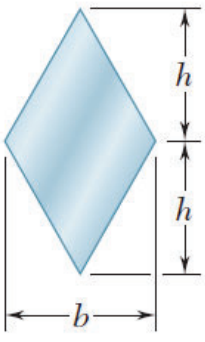
(*I*)



(*II*)



(*III*)



(*IV*)

Key Answer:
(II): (a) Line at mid-height. (b) 1.500.
(IV): (a) hy4 from neutral axis. (b) 1.125.

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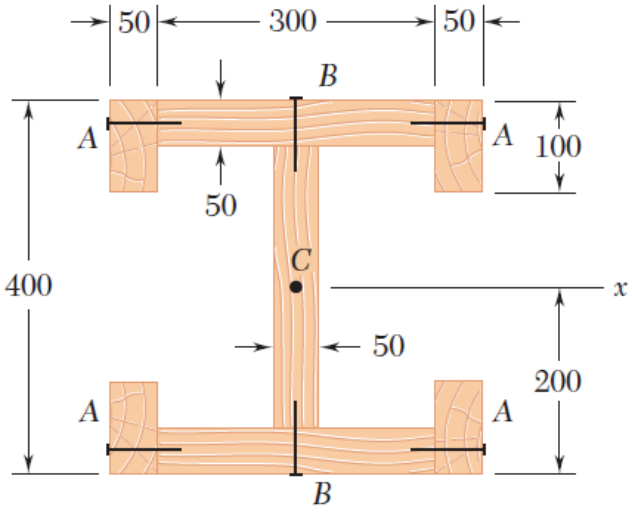
❑ Problem 06

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.

$I_x = 1.504 \times 10^9 \ mm^4$



Dimensions in mm

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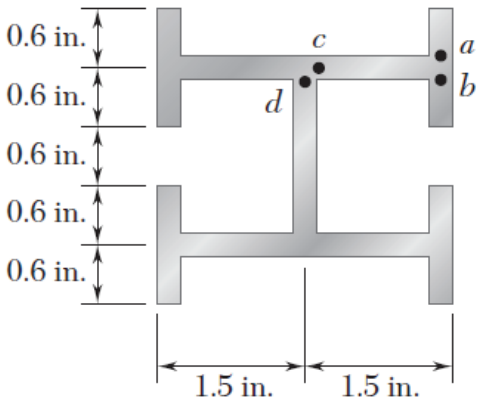
❑ Problem 07

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.

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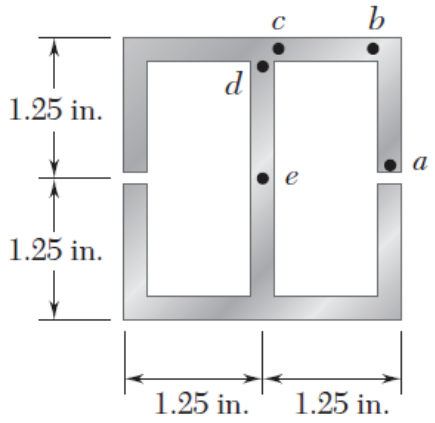
❑ Problem 08

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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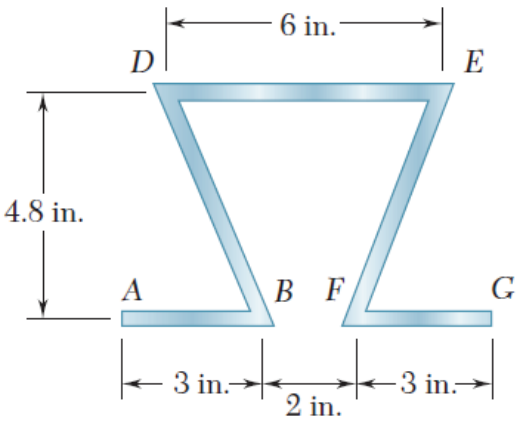
❑ Problem 09

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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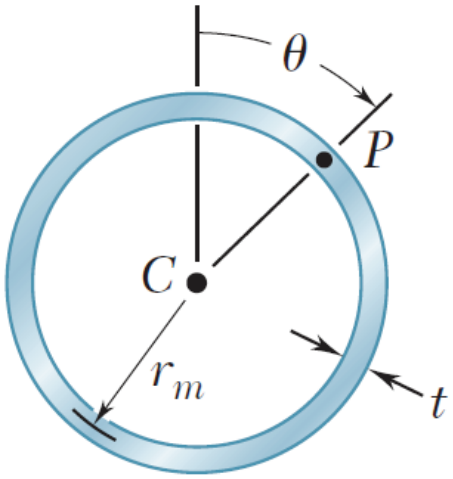
❑ Problem 10

(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 $\theta = 90^o$ and is equal to 2V/A, where A is the cross-sectional area of the pipe.



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

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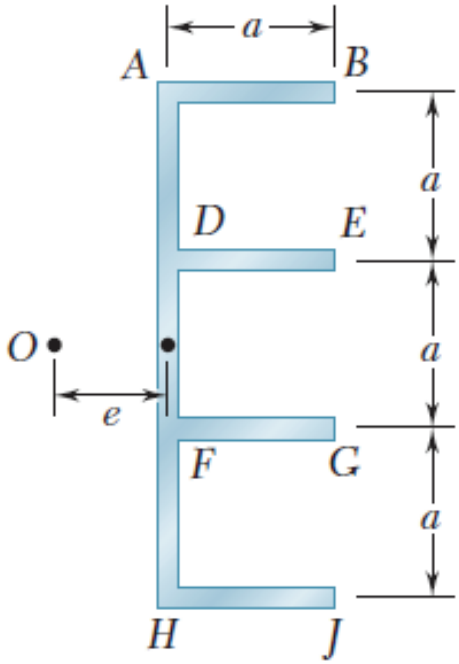
❑ Problem 11

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.

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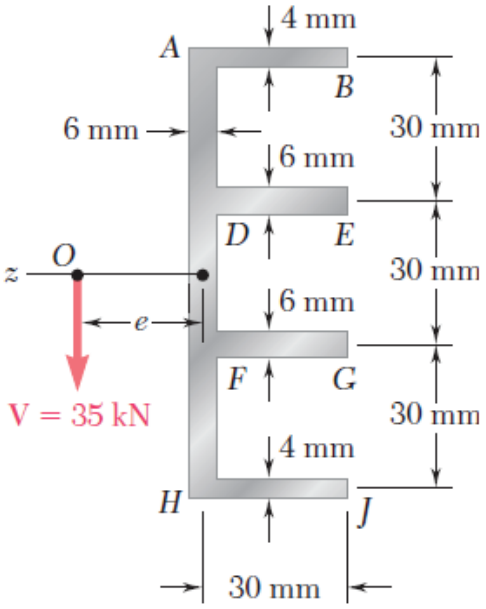
❑ Problem 12

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.



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

Key Answer:
(a) e = 9.12 mm. (b) At B, E, G, and J: τ = 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.

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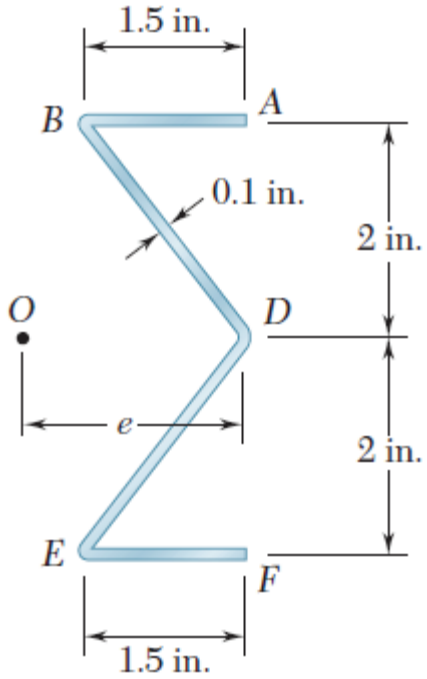
❑ Problem 13

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.

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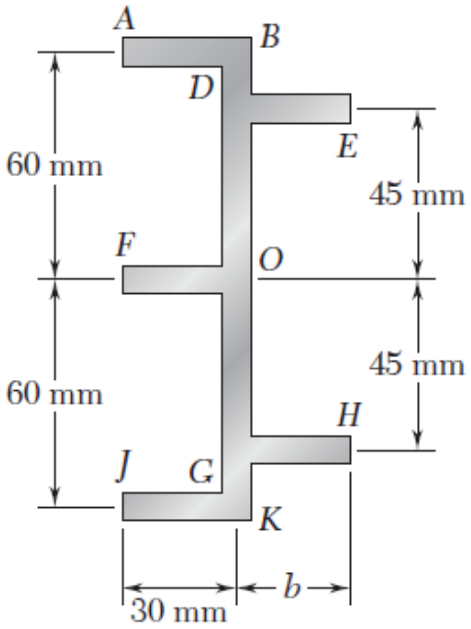
❑ Problem 14

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.