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-03

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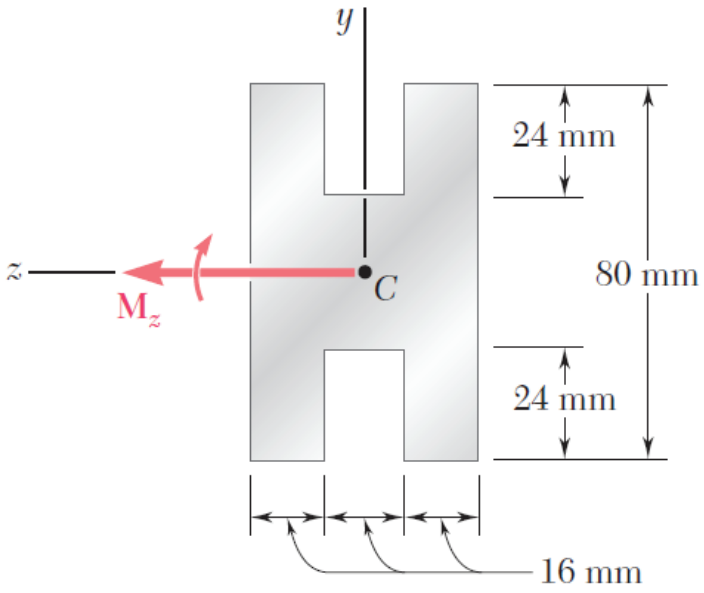
Homework-03

❑ Problem 01

A beam of the cross section shown is extruded from an aluminum alloy. Using a factor of safety of 3.00, determine the largest couple that can be applied to the beam when it is bent about the z axis.

$\sigma_Y = 250Mpa$
$\sigma_U = 450Mpa$



Key Answer: 5.28 kN.m

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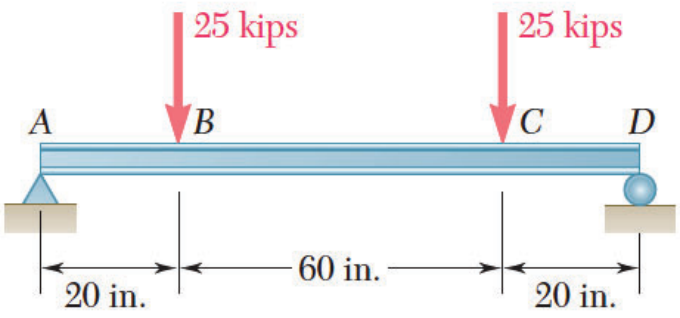
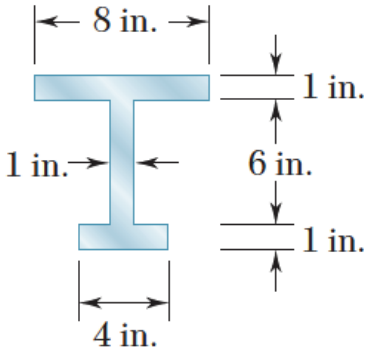
❑ Problem 02

Two vertical forces are applied to a beam of the cross section shown. Determine the maximum tensile and compressive stresses in portion BC of the beam.





Key Answer: 15.40 ksi; -10.38 ksi.

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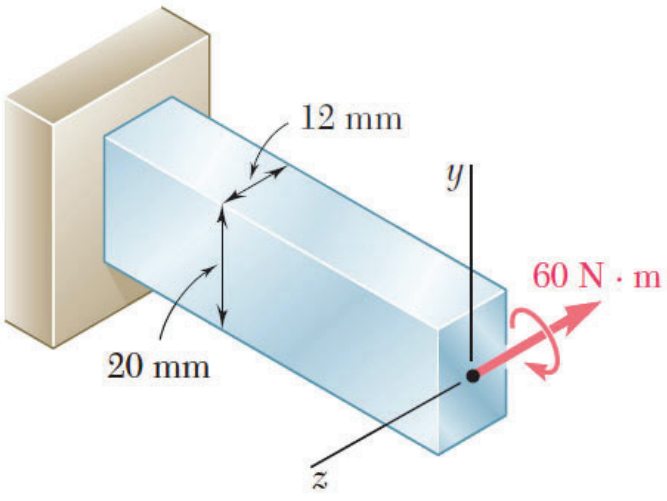
❑ Problem 03

A 60-N . m couple is applied to the steel bar shown. (a) Assuming that the couple is applied about the z axis as shown, determine the maximum stress and the radius of curvature of the bar. (b) Solve part a, assuming that the couple is applied about the y axis. Use E = 200 GPa.



Key Answer: (a) 75.0 MPa; 26.7 m. (b) 125.0 MPa; 9.60 m.

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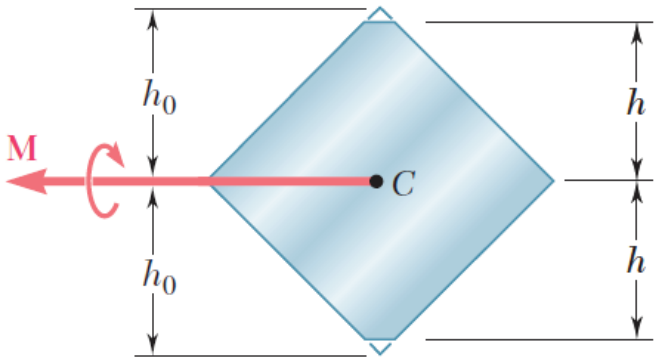
❑ Problem 04

A portion of a square bar is removed by milling, so that its cross section is as shown. The bar is then bent about its horizontal axis by a couple **M**. Considering the case where $h = 0.9h_0$, express the maximum stress in the bar in the form $\sigma_m = k\sigma_0$ where σ_0 is the maximum stress that would have occurred if the original square bar had been bent by the same couple M, and determine the value of k.



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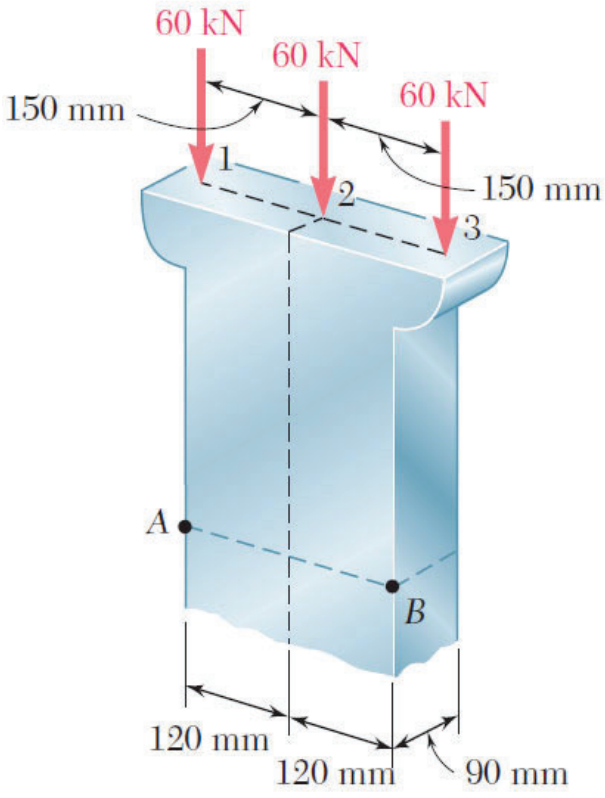
❑ Problem 05

Determine the stress at points A and B, (a) for the loading shown, (b) if the 60-kN loads are applied at points 1 and 2 only.



Key Answer: (a) (A and B) 28.33 MPa. (b) (A) 215.97 MPa; (B) 4.86 MPa.

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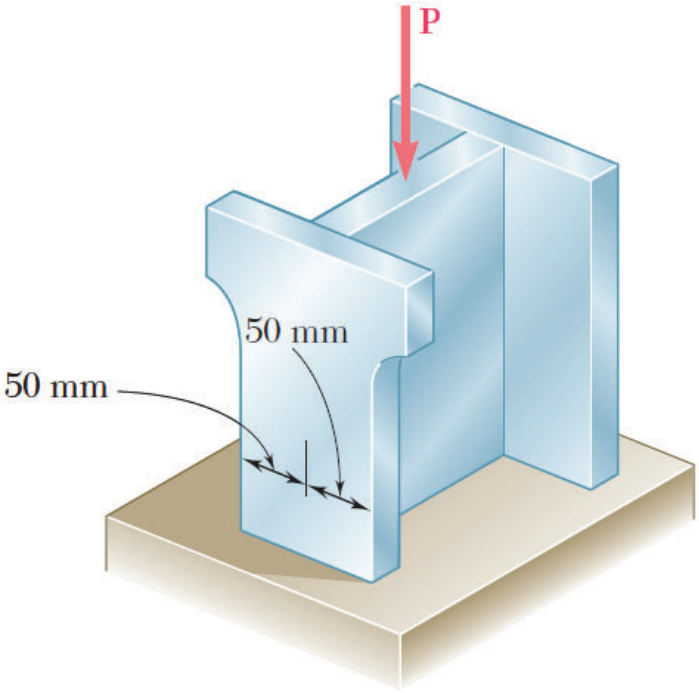
❑ Problem 06

Three steel plates, each of 25 X 150-mm cross section, are welded together to form a short H-shaped column. Later, for architectural reasons, a 25-mm strip is removed from each side of one of the flanges. Knowing that the load remains centric with respect to the original cross section and that the allowable stress is 100 MPa, determine the largest force P (a) that could be applied to the original column, (b) that can be applied to the modified column.



Key Answer: (a) 1125 kN. (b) 817 kN.

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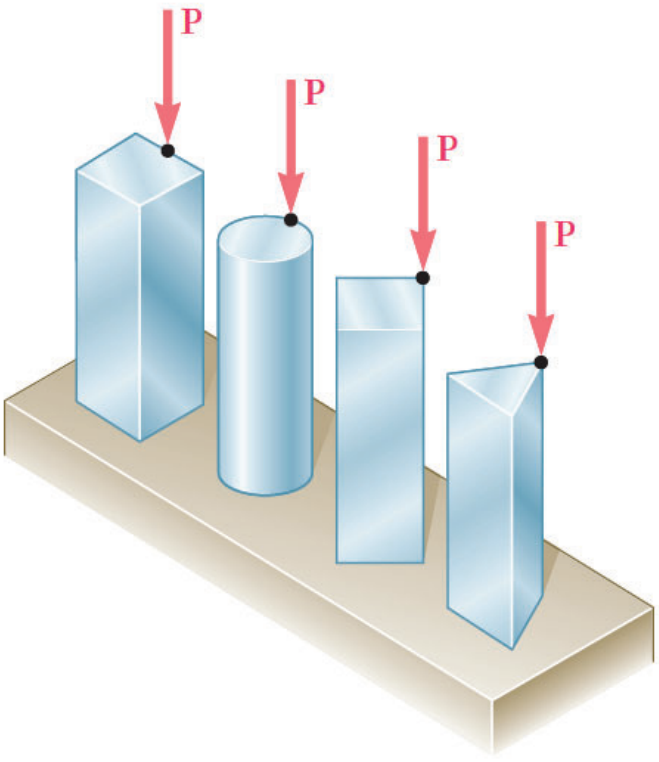
❑ Problem 07

The four bars shown have the same cross-sectional area. For the given loadings, show that (a) the maximum compressive stresses are in the ratio 4:5:7:9, (b) the maximum tensile stresses are in the ratio 2:3:5:3. (Note: the cross section of the triangular bar is an equilateral triangle.)



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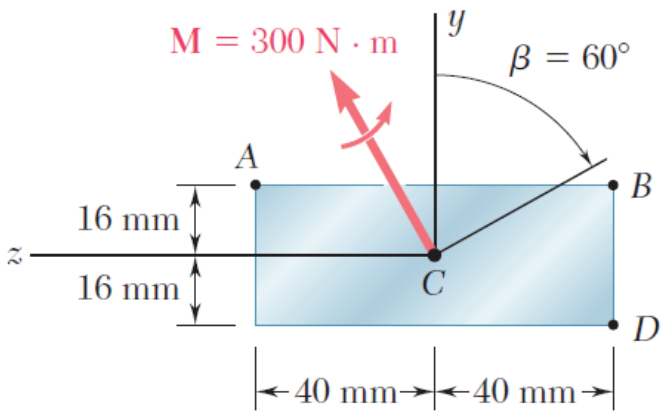
❑ Problem 08

The couple M is applied to a beam of the cross section shown in a plane forming an angle β with the vertical. Determine the stress at (a) point A, (b) point B, (c) point D.



Key Answer: (a) -3.37 MPa. (b) -18.60 MPa. (c) 3.37 MPa.

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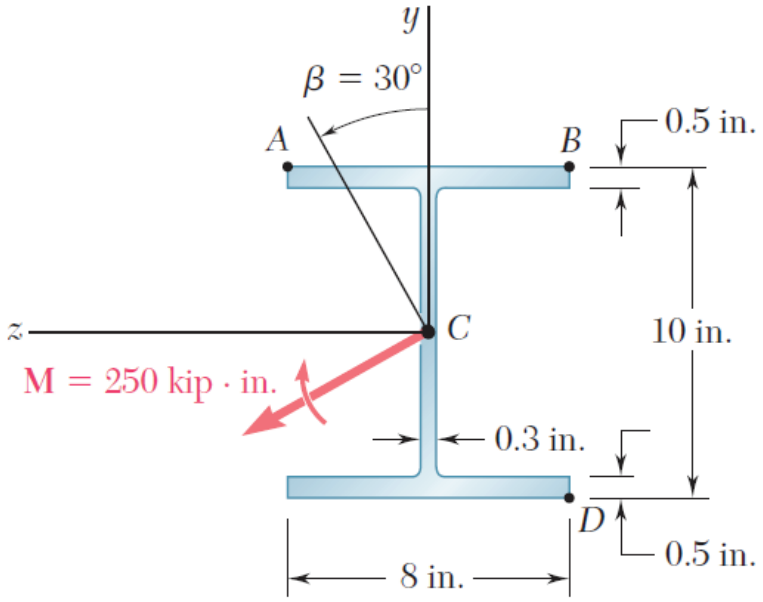
❑ Problem 09

The couple M is applied to a beam of the cross section shown in a plane forming an angle β with the vertical. Determine the stress at (a) point A, (b) point B, (c) point D.



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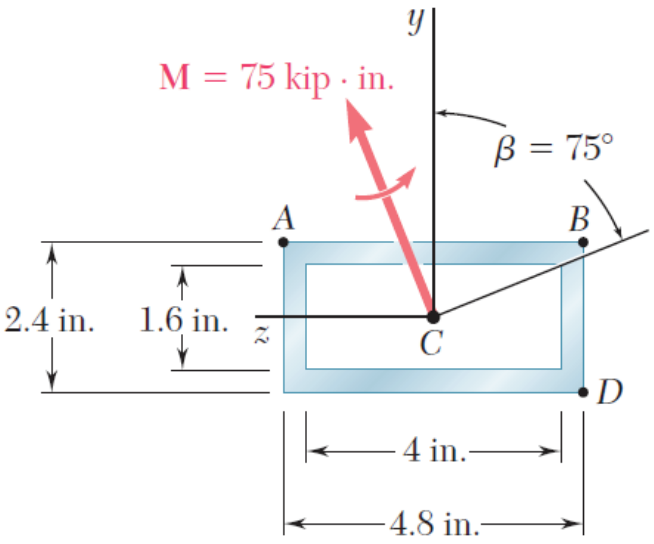
❑ Problem 10

The couple M is applied to a beam of the cross section shown in a plane forming an angle β with the vertical. Determine the stress at (a) point A, (b) point B, (c) point D.



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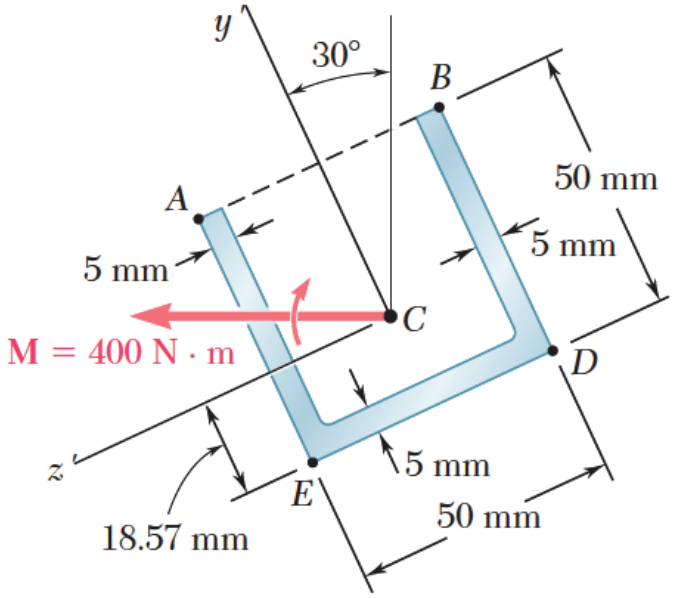
❑ Problem 11

The couple M acts in a vertical plane and is applied to a beam oriented as shown. Determine (a) the angle that the neutral axis forms with the horizontal, (b) the maximum tensile stress in the beam.



$I_{y'} = 281 \times 10^3 \text{ mm}^4$

$I_{z'} = 176.9 \times 10^3 \text{ mm}^4$

Key Answer: (a) 10.03^o. (b) 54.2 MPa.

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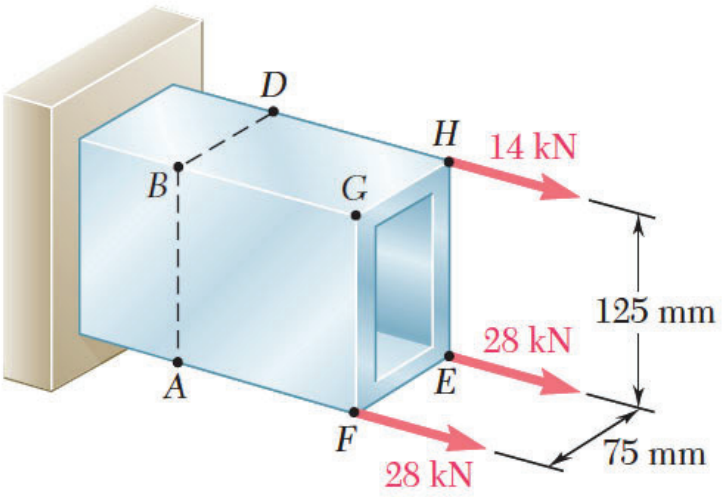
❑ Problem 12

The tube shown has a uniform wall thickness of 12 mm. For the loading given, determine (a) the stress at points A and B, (b) the point where the neutral axis intersects line ABD.



Key Answer: (a) (A) 31.5 MPa; (B) -10.39 MPa.
(b) 94.0 mm above point A.

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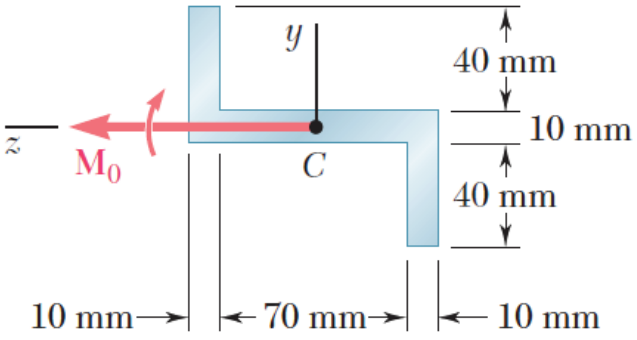
❑ Problem 13

The Z section shown is subjected to a couple M_0 acting in a vertical plane. Determine the largest permissible value of the moment M_0 of the couple if the maximum stress is not to exceed 80 MPa.

Given: $I_{max} = 2.28 \times 10^{-6}$ m^4, $I_{min} = 0.23 \times 10^{-6}$ m^4, principal axes 25.7° ↘ and 64.3° ↗.



Key Answer: 733 N . m