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"

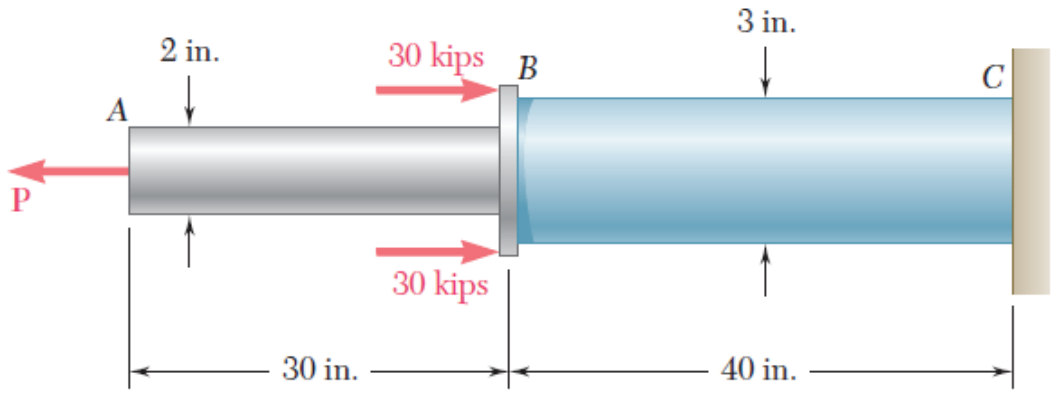
Homework-01

By: Kaveh Karami
Associate Prof. of Structural Engineering
https://prof.uok.ac.ir/Ka.Karami

Homework-01

❑ Problem 01

Two solid cylindrical rods AB and BC are welded together at B and loaded as shown. Determine the magnitude of the force P for which the tensile stress in rod AB has the same magnitude as the compressive stress in rod BC.



Key Answer: 28.2 kips.

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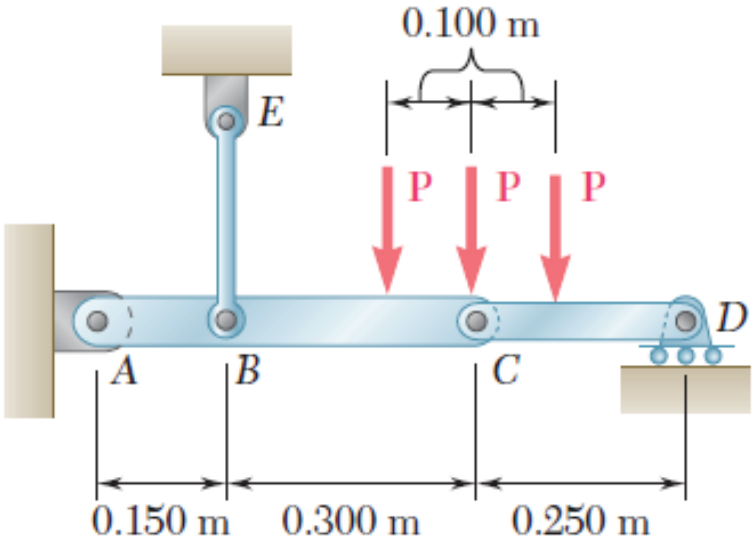
❑ Problem 02

Three forces, each of magnitude P=4 kN, are applied to the mechanism shown. Determine the cross-sectional area of the uniform portion of rod BE for which the normal stress in that portion is +100 MPa.



Key Answer: 285 mm^2

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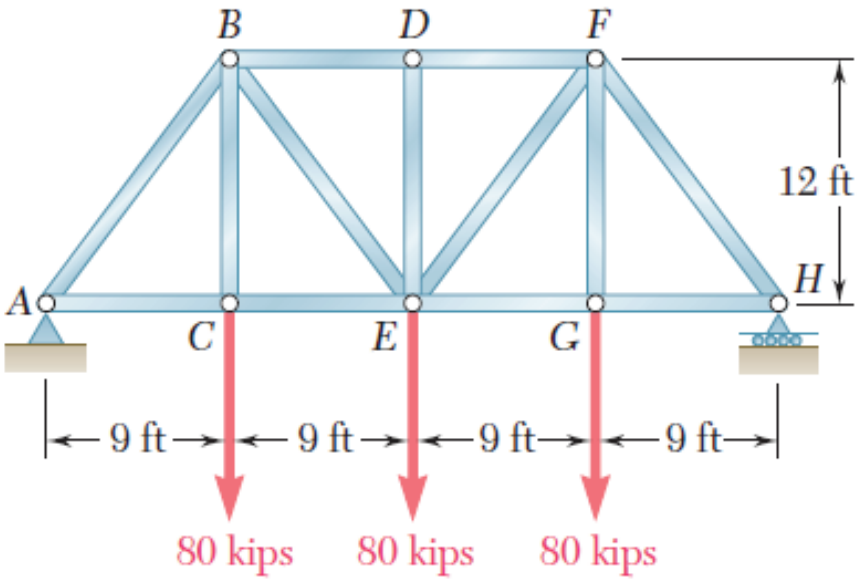
❑ Problem 03

For the Pratt bridge truss and loading shown, determine the average normal stress in member BE, knowing that the cross-sectional area of that member is 5.87 in^2.



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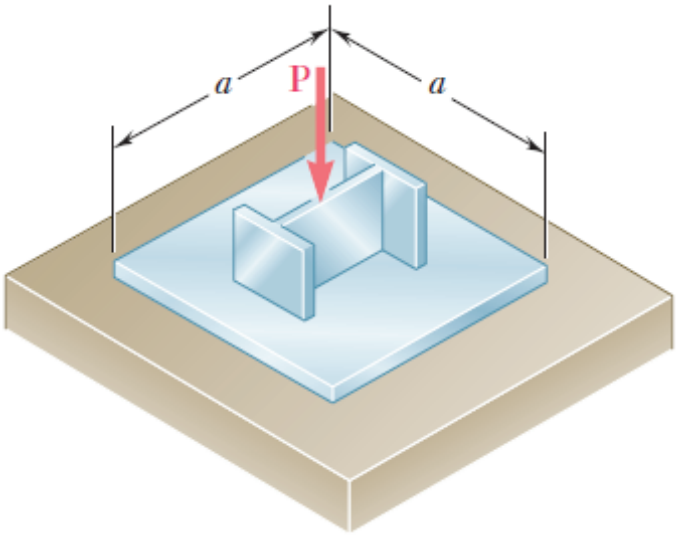
❑ Problem 04

An axial load P is supported by a short W8X40 column of cross-sectional area A = 11.7 in^2 and is distributed to a concrete foundation by a square plate as shown. Knowing that the average normal stress in the column must not exceed 30 ksi and that the bearing stress on the concrete foundation must not exceed 3.0 ksi, determine the side a of the plate that will provide the most economical and safe design.



Key Answer: 10.82 in.

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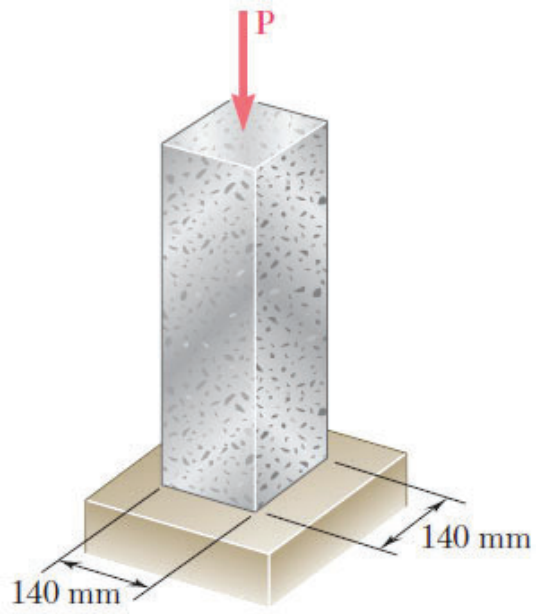
❑ Problem 05

A 1060-kN load P is applied to the granite block shown. Determine the resulting maximum value of (a) the normal stress, (b) the shearing stress. Specify the orientation of that plane on which each of these maximum values occurs.



Key Answer: (a) 0 (tension) at $\theta = 90^o$;
54.1 MPa (compression) at $\theta = 0^o$.
(b) 27.0 MPa at $\theta = 45^o$.

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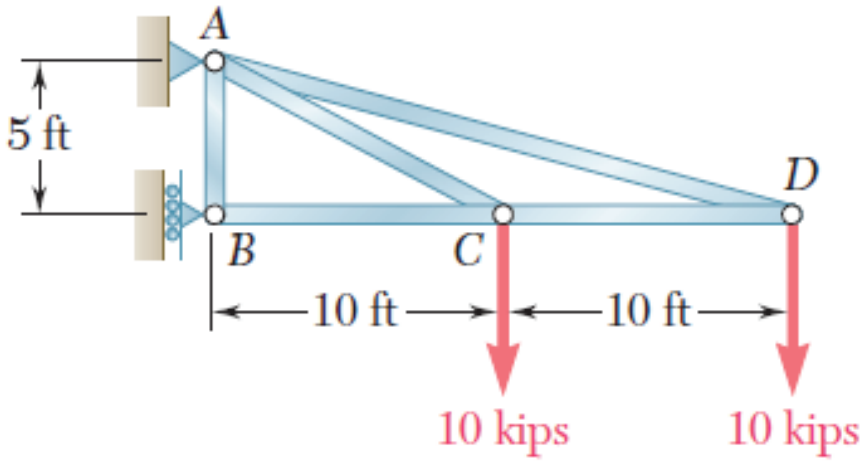
❑ Problem 06

A $\frac{3}{4}$ in. diameter rod made of the same material as rods AC and AD in the truss shown was tested to failure and an ultimate load of 29 kips was recorded. Using a factor of safety of 3.0, determine the required diameter (a) of rod AC, (b) of rod AD.



Key Answer: (a) 1.141 in. (b) 1.549 in.

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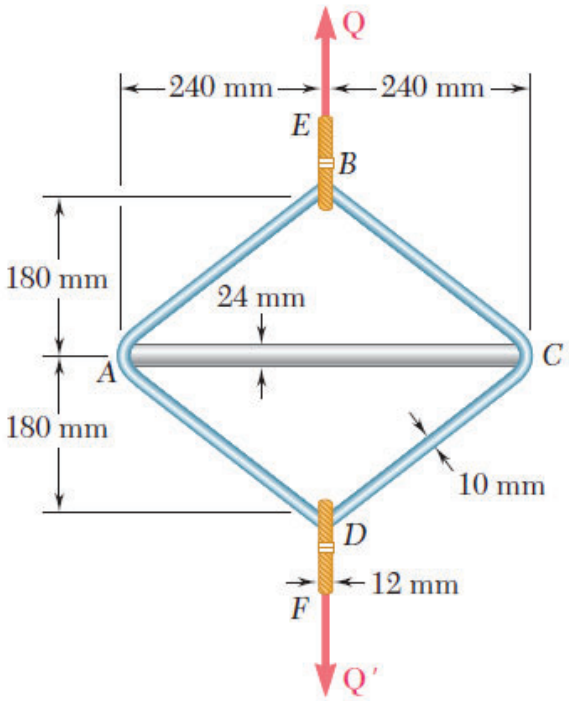
❑ Problem 07

A steel loop ABCD of length 1.2 m and of 10-mm diameter is placed as shown around a 24-mm-diameter aluminum rod AC. Cables BE and DF, each of 12-mm diameter, are used to apply the load Q. Knowing that the ultimate strength of the steel used for the loop and the cables is 480 MPa and that the ultimate strength of the aluminum used for the rod is 260 MPa, determine the largest load Q that can be applied if an overall factor of safety of 3 is desired.



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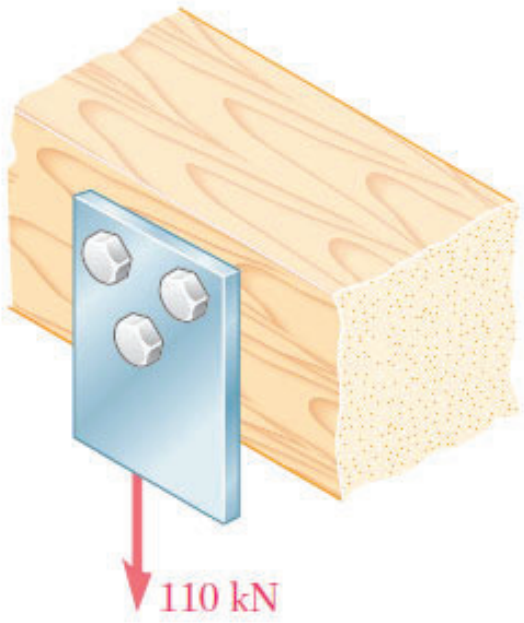
❑ Problem 08

Three steel bolts are to be used to attach the steel plate shown to a wooden beam. Knowing that the plate will support a 110-kN load, that the ultimate shearing stress for the steel used is 360 MPa, and that a factor of safety of 3.35 is desired, determine the required diameter of the bolts.



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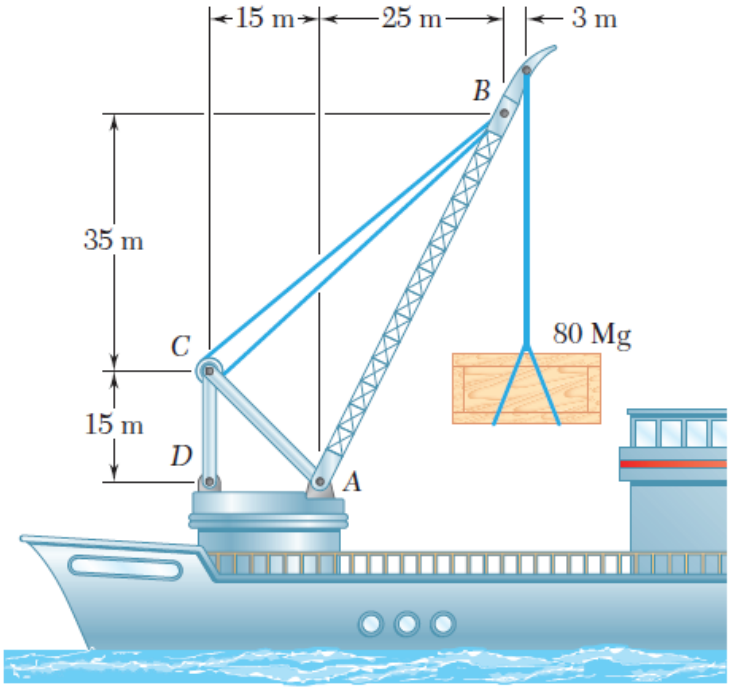
❑ Problem 09

In the marine crane shown, link CD is known to have a uniform cross section of 50X150 mm. For the loading shown, determine the normal stress in the central portion of that link.



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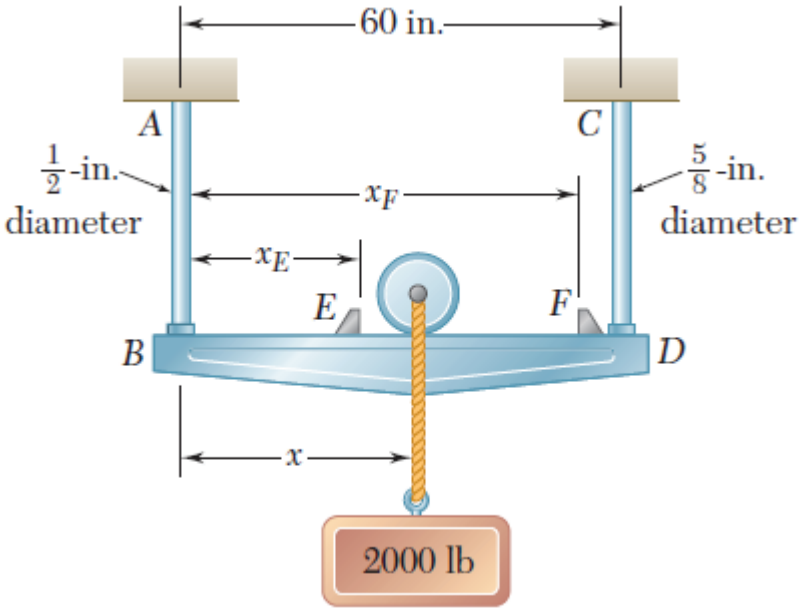
❑ Problem 10

The 2000-lb load may be moved along the beam BD to any position between stops at E and F. Knowing that $\sigma_{all} = 6$ ksi for the steel used in rods AB and CD, determine where the stops should be placed if the permitted motion of the load is to be as large as possible.



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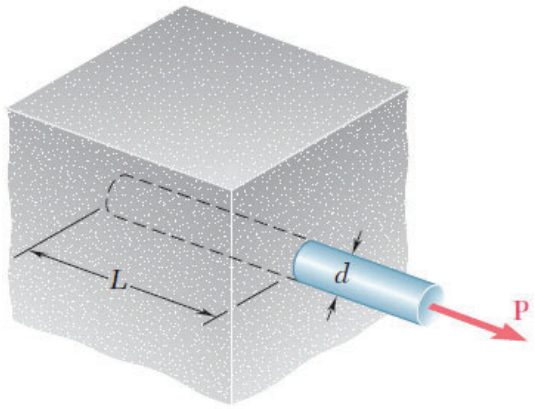
❑ Problem 11

A force P is applied as shown to a steel reinforcing bar that has been embedded in a block of concrete. Determine the smallest length L for which the full allowable normal stress in the bar can be developed. Express the result in terms of the diameter d of the bar, the allowable normal stress σ_{all} in the steel, and the average allowable bond stress τ_{all} between the concrete and the cylindrical surface of the bar. (Neglect the normal stresses between the concrete and the end of the bar.)



Key Answer: $\dfrac{\sigma_{all} \cdot d}{4\tau_{all}}$