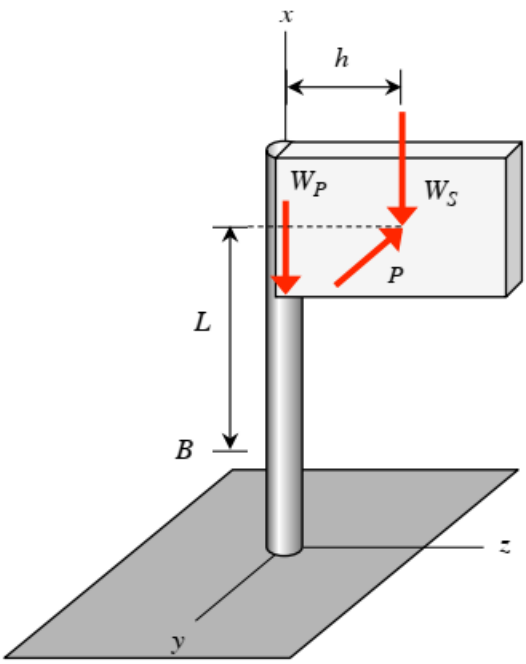
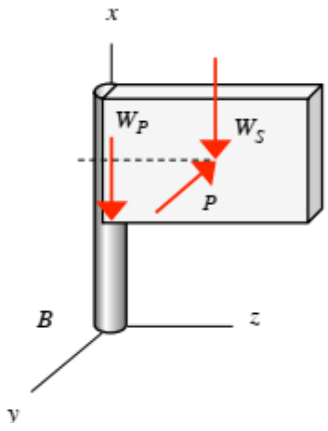
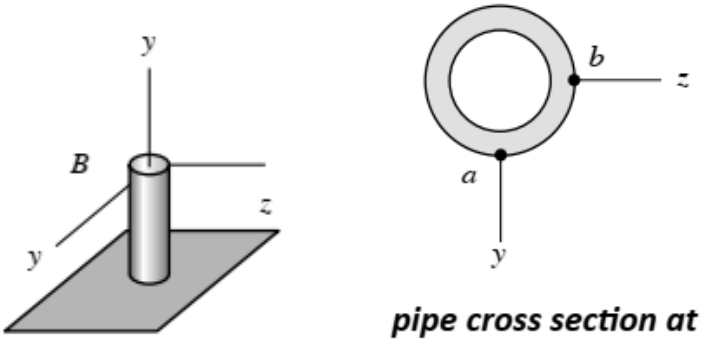
Example 14.12

Wind blowing on a sign produces a resultant force P in the –y direction at the point indicated. The support pole for the sign weights W_P and the sign weighs W_S. The pole is a pipe with outer and inner diameters of d and d_i, respectively. Determine the principal stresses at points a and b on the outer surface of the pole at location B along the pole's length.







pipe cross section at B

A. Determine the state of stress on the stress elements located at points a and b. (**Ch14: combined loading**)

B. Draw the Mohr's circle and determine the principal stresses and angle of principal stress. Which point has a larger absolute maximum shear stress? (**Ch13: stress transformations**)

C. The pole is made of a polymer with a yield strength of 9500 psi. Have the material elements failed at either point "a" or point "b"? (**Ch15: Failure methods**)

$W_P = 160\ lb$

$W_S = 125\ lb$

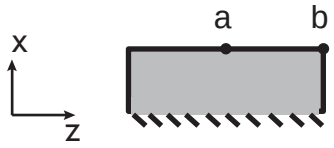
$\mathrm{P} = 75\ lb$

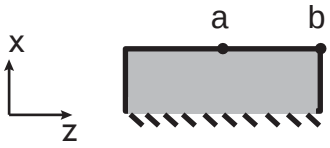
$h = 40\ in$

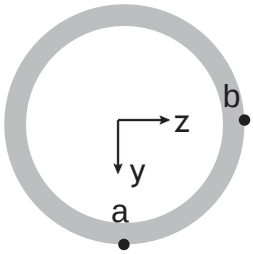
$\mathrm{L} = 220\ in$

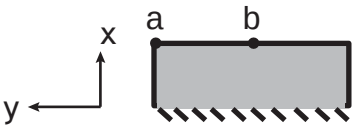
$\mathrm{d}_o = 3.5\ in$

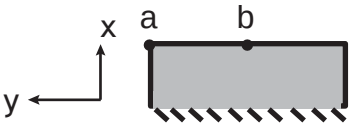
$\mathrm{d}_i = 3.068\ in$





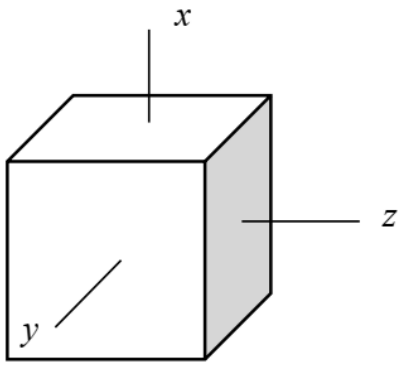




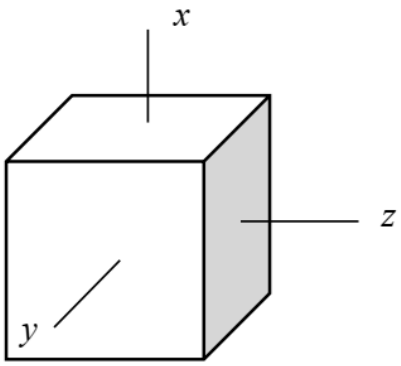


Force	a	b

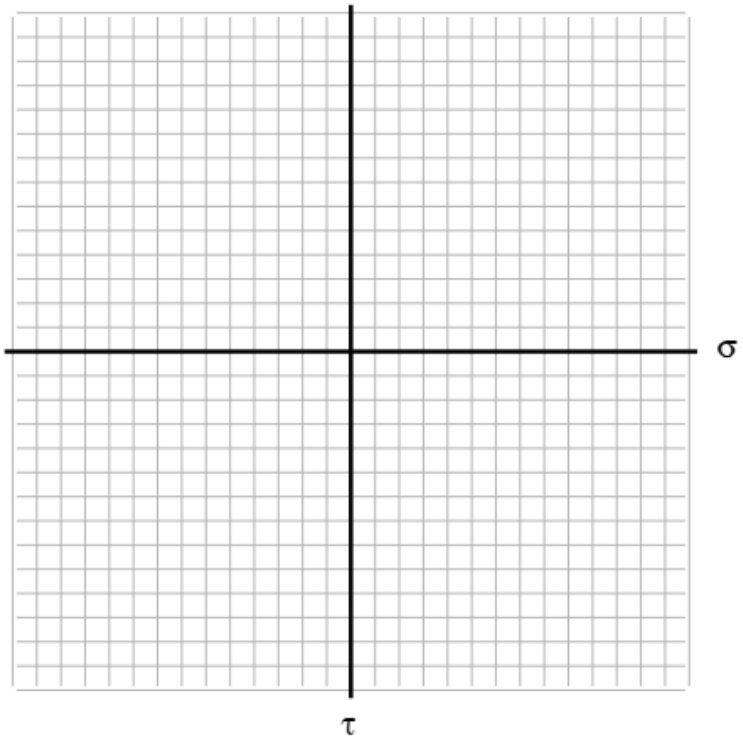
stress element at "a"



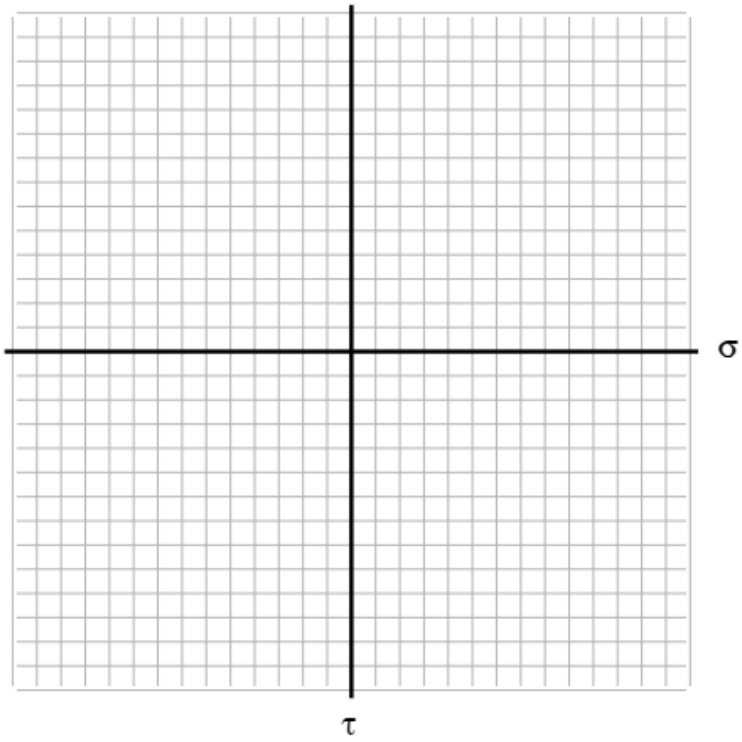
stress element at "b"

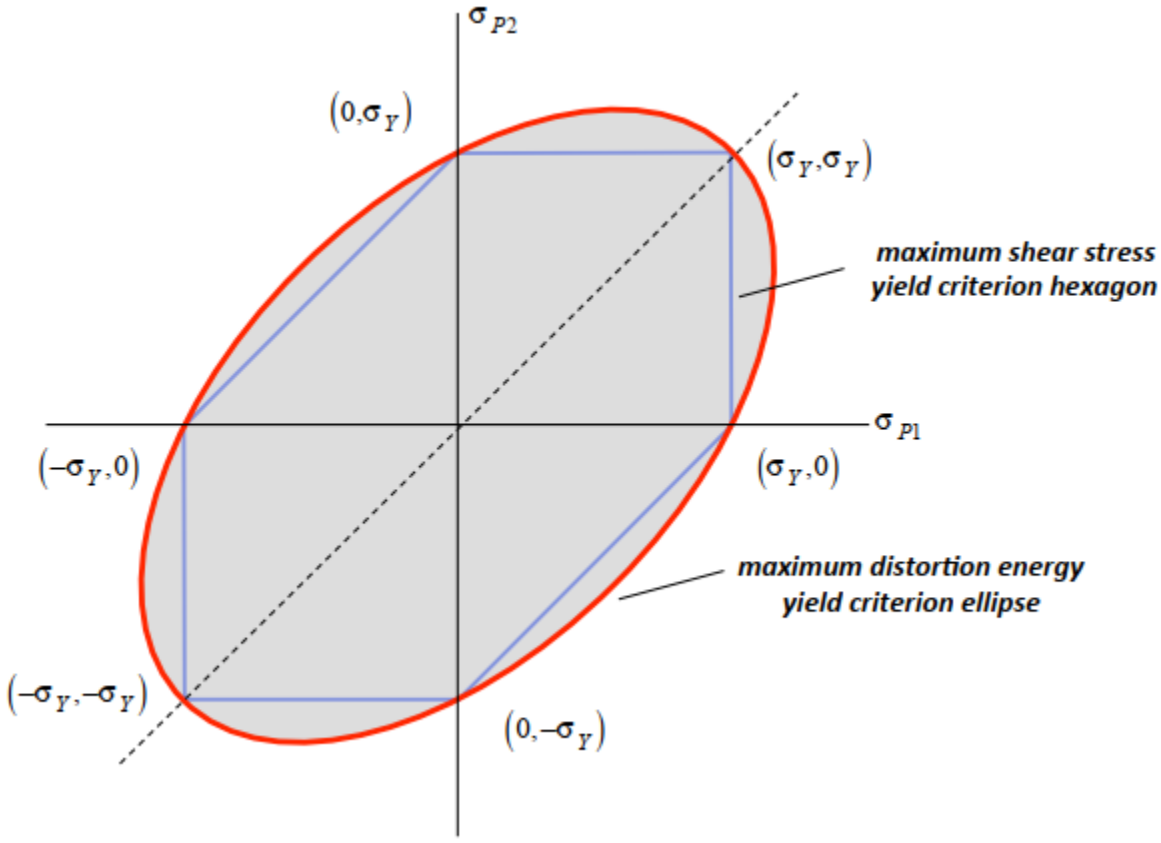


Mohr's circle at "a"



Mohr's circle at "b"

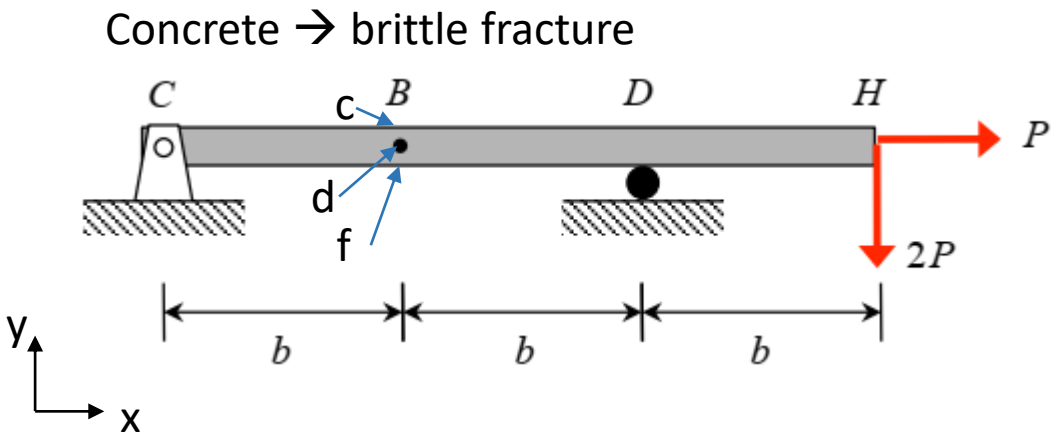


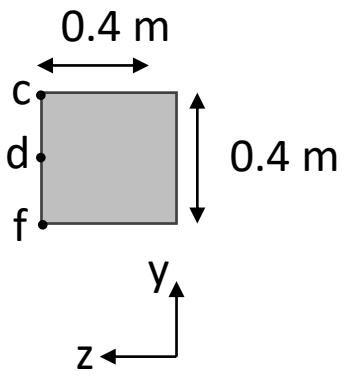

σ_{P2}
$(0,\sigma_Y)$
(σ_Y,σ_Y)
maximum shear stress
yield criterion hexagon
σ_{P1}
$(-\sigma_Y,0)$
$(\sigma_Y,0)$
maximum distortion energy
yield criterion ellipse
$(-\sigma_Y,-\sigma_Y)$
$(0,-\sigma_Y)$

Example 14.5

An with a second area moent of I is subjected to axial and transverse loads at its right end. Determine the principal stresses in the beam at B.

Concrete → brittle fracture





b = 5 m

$\sigma_{UC} = 20\ MPa$

$\sigma_{UT} = 3\ MPa$

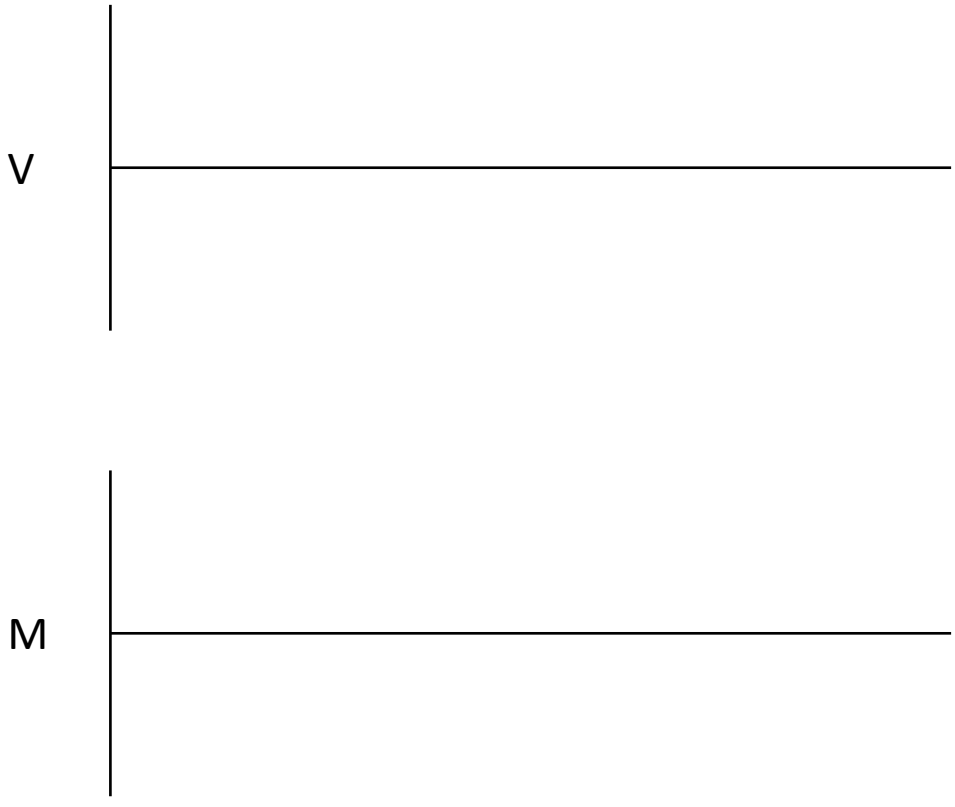
(A) Draw the shear force and bending moment diagrams that result from the transverse load 2P.

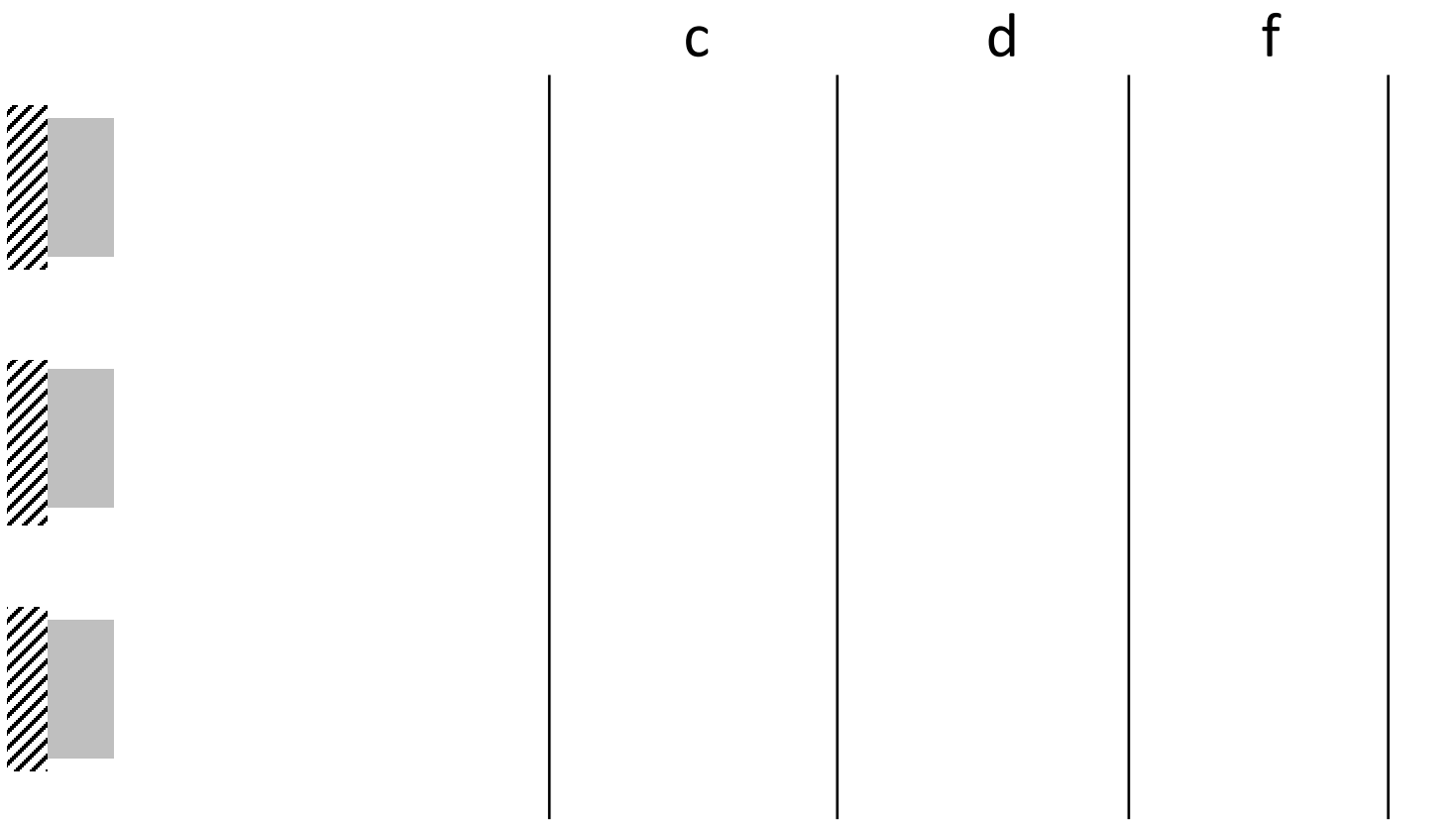
(B) Determine the reactions at B.

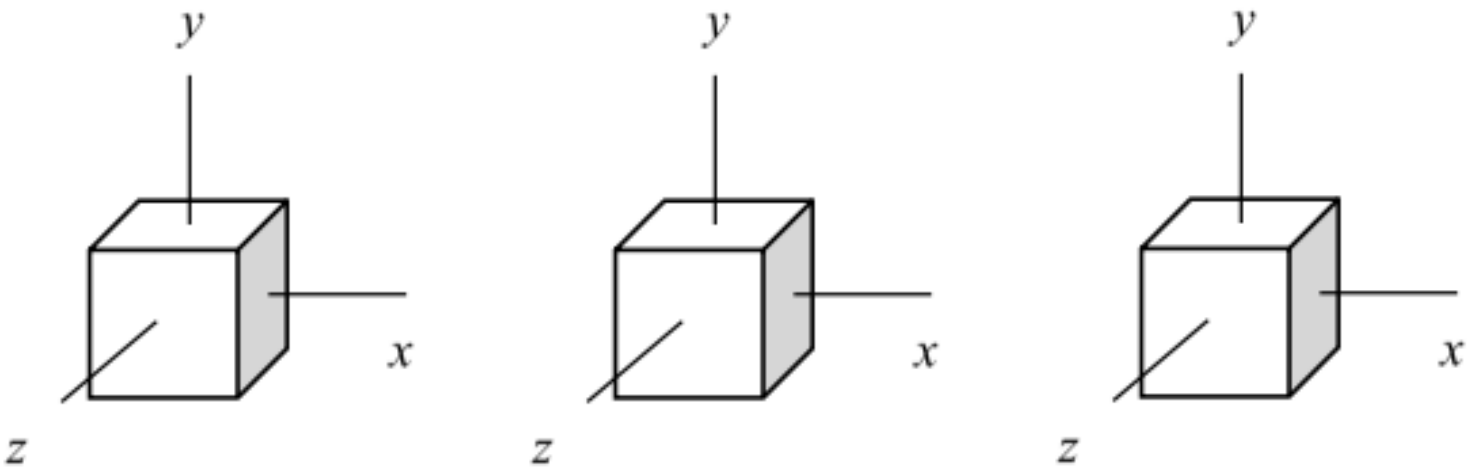
(C) Draw the stress elements at points c, d, and f.

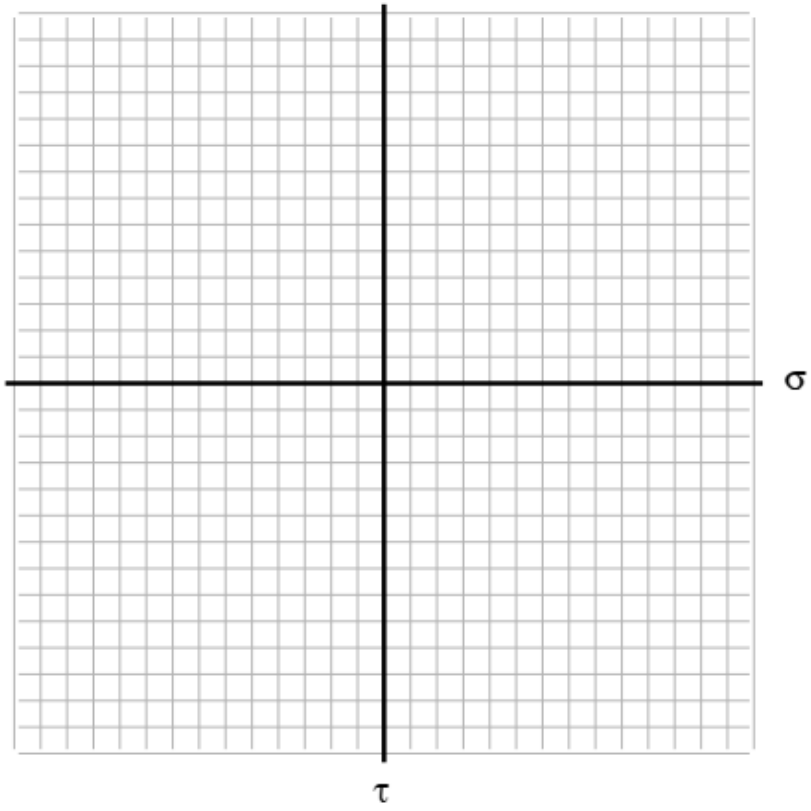
(D) Will the materials at points c, d, or f fail when P = 6.4 kN?

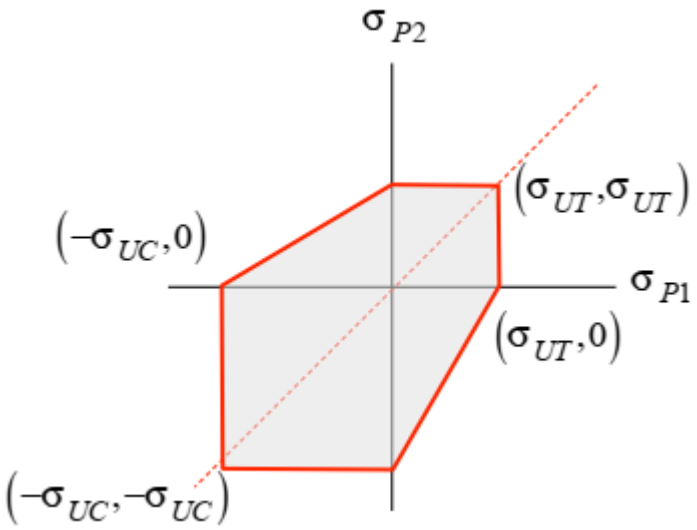
(E) If the direction of axial force P is reversed (becomes compressive), will failure occur?


V
M


c
d
f


y
x
z
y
x
z
y
x
z


σ
τ


σ P2
(σ UT,σ UT)
(−σ UC,0)
σ P1
(σ UT,0)
(−σ UC,−σ UC)

Quiet Week Example No. 1

The propped-cantilevered beam shown has a circular cross-section (of radius r), and is made of a ductile material having a Young's modulus of E and yield strength of σ_Y. The beam has a transverse load P and an axial torque T applied at the free end D, where $T = Pr$. Here we are asked to determine the factor of safety against yielding on either the top or lower surfaces of the beam. In this solution, anticipate the following steps:

i. Equilibrium analysis
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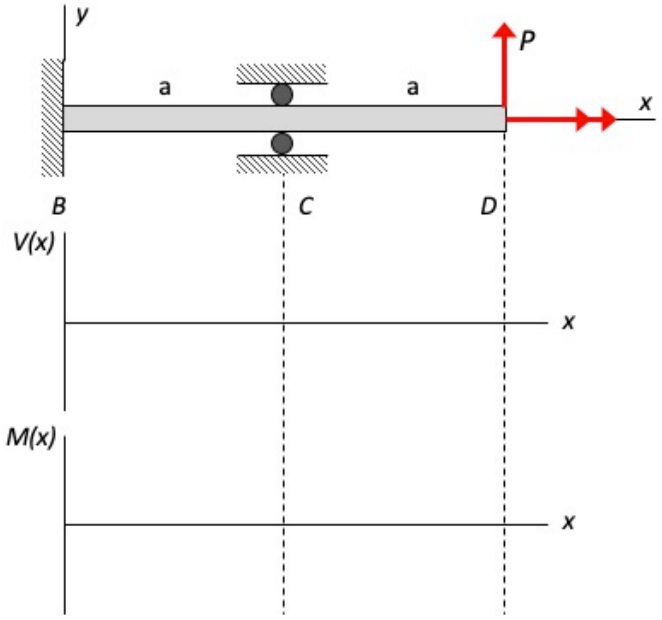
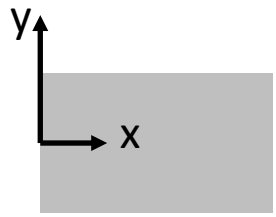
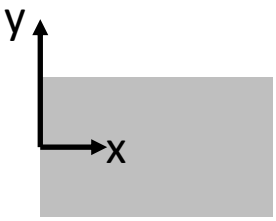
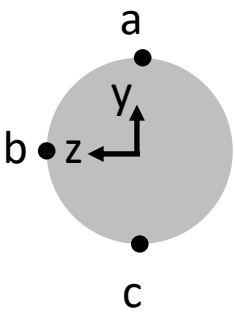
v. Mohr's circle for the critical state of stress
vi. Failure analysis

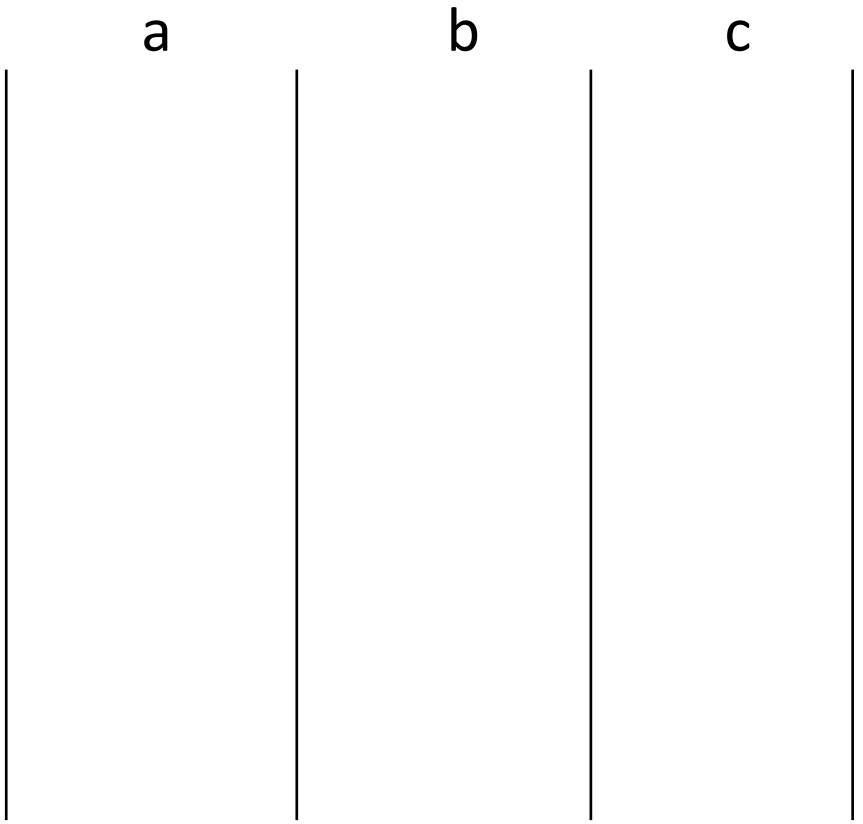
SOLUTION

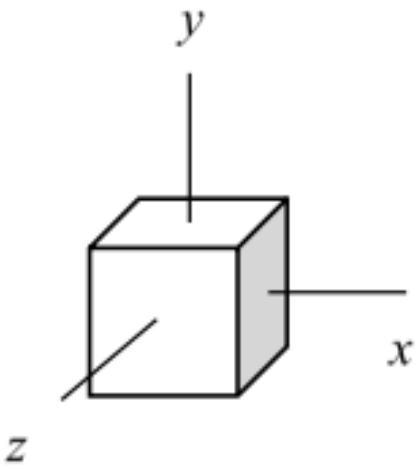


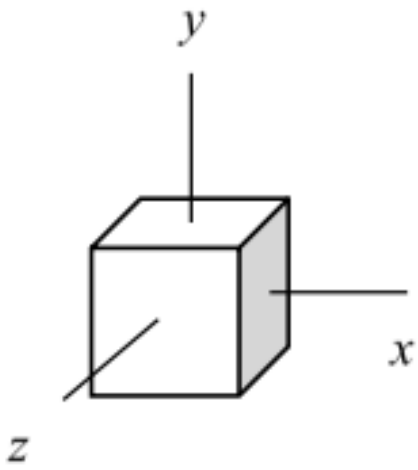

y
x

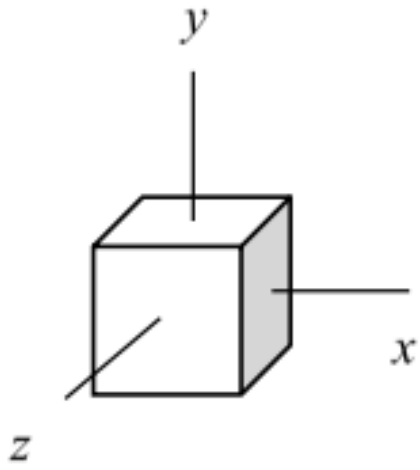

y
x

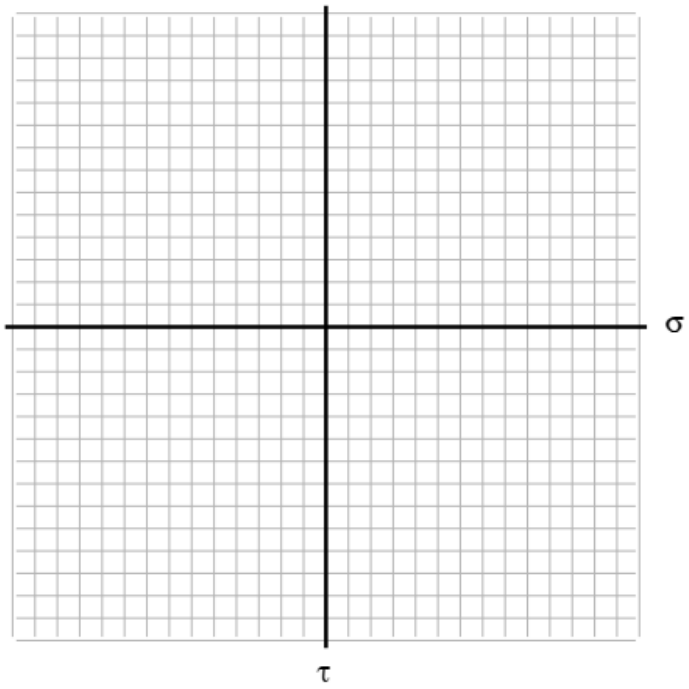

a
y
b
z
c

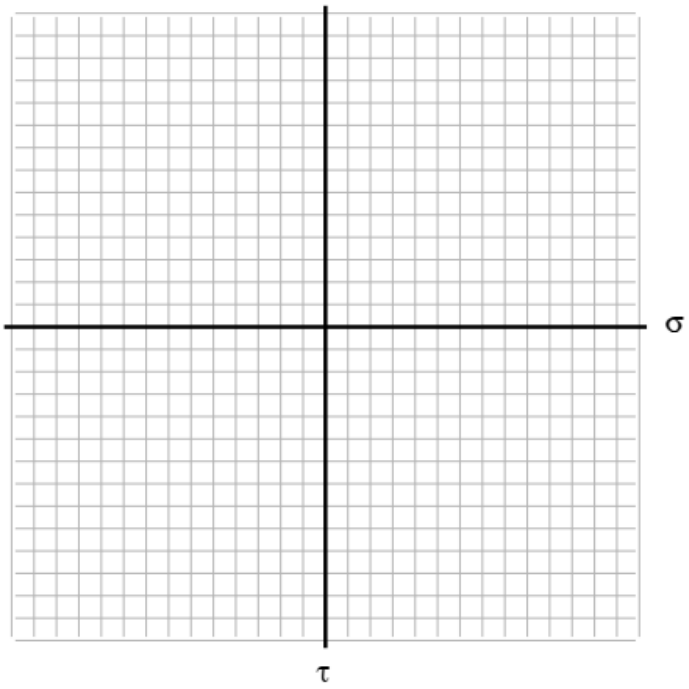

a
b
c


y
x
z


y
x
z


y
x
z


σ
τ


σ
τ

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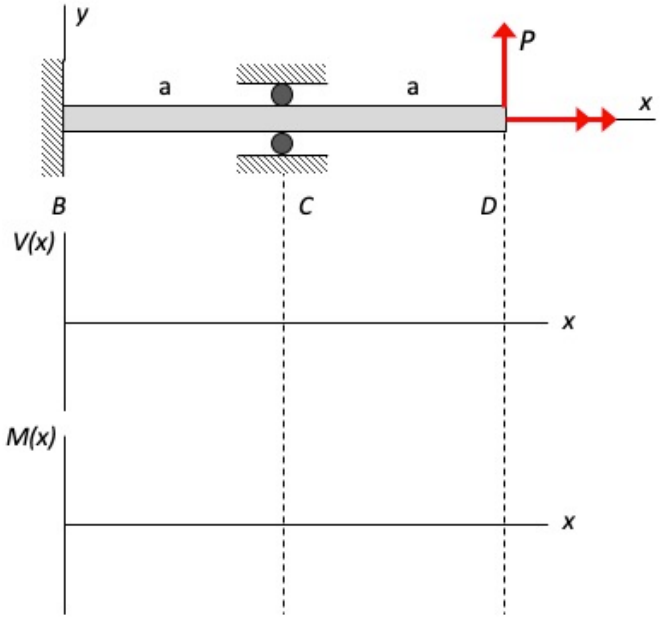
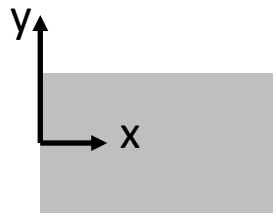
SOLUTION

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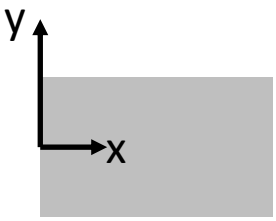
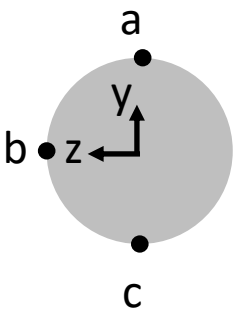
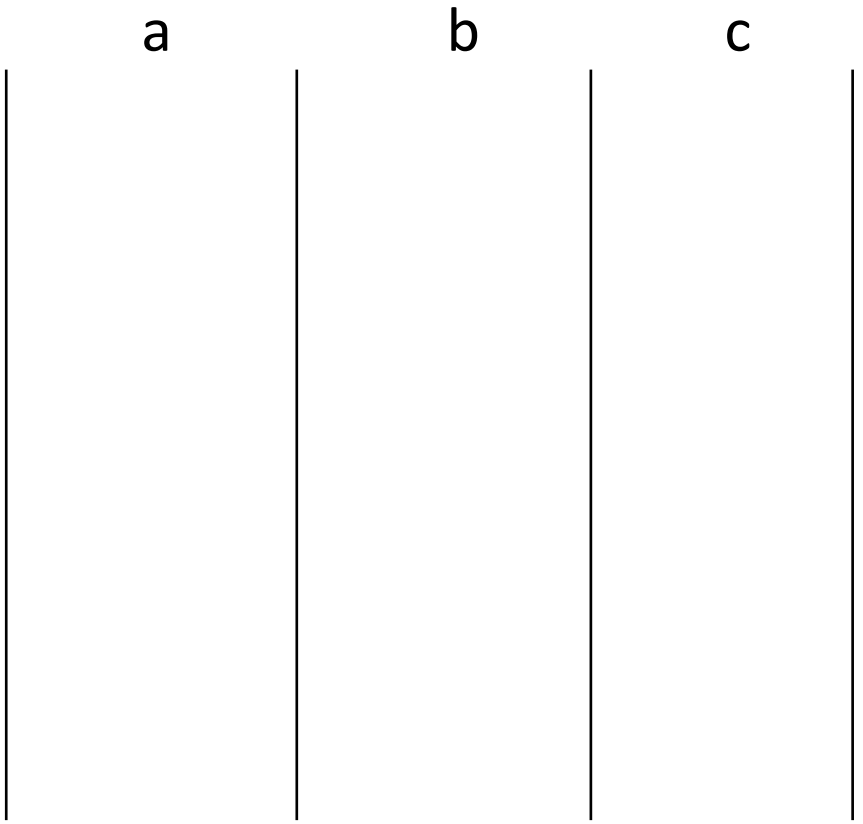
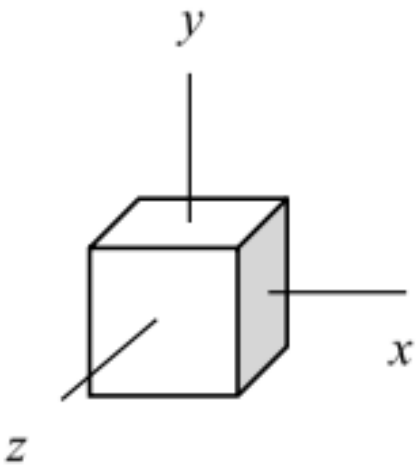
x


y
x


a
y
b
z
c


a
b
c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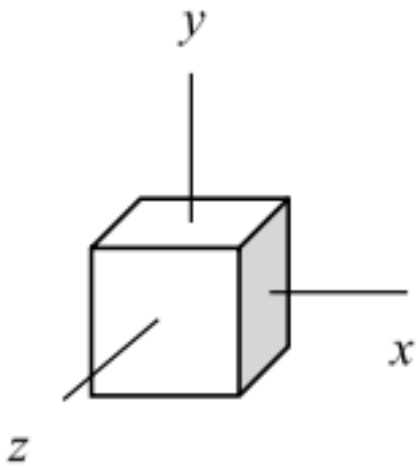
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x
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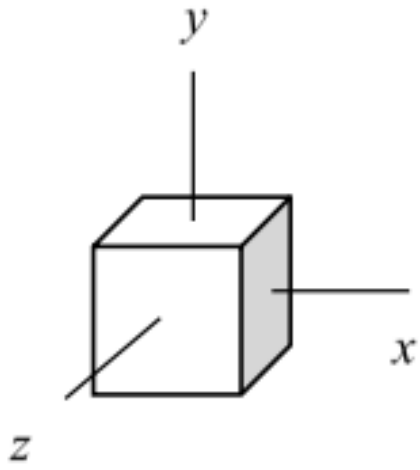
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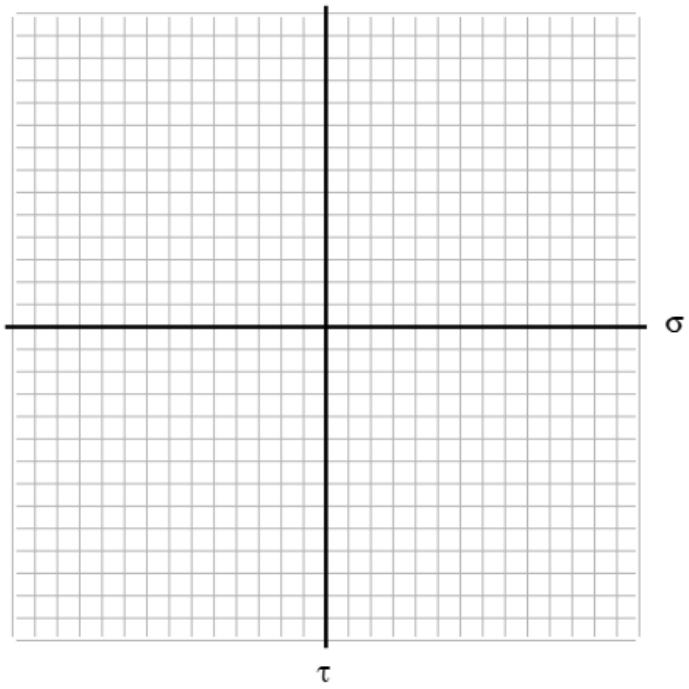
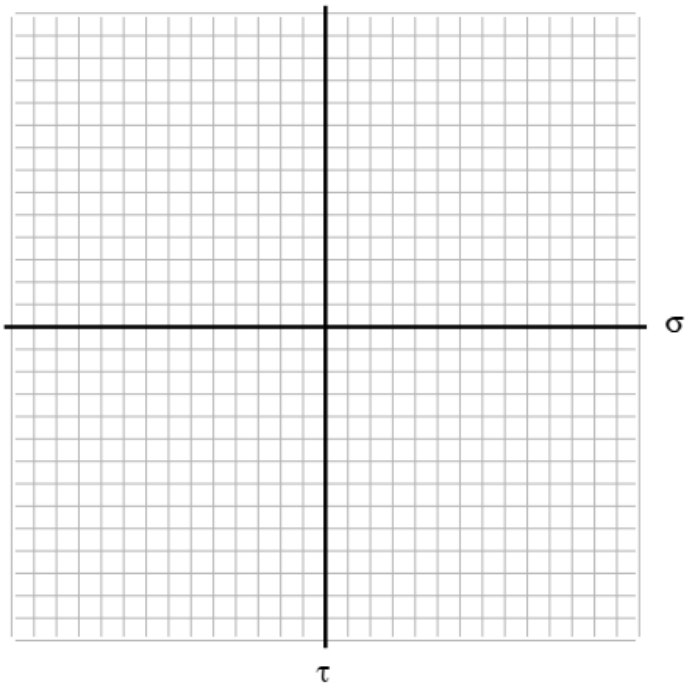

σ
τ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