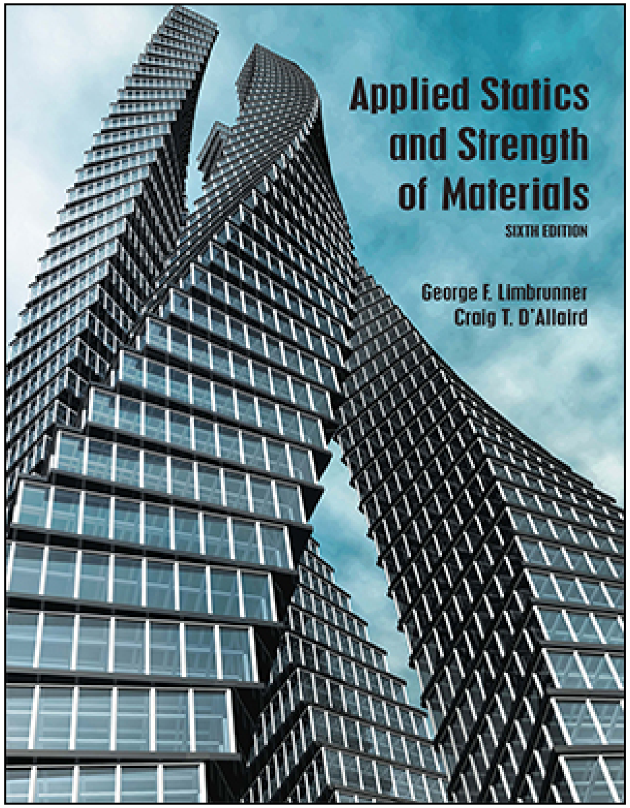
Applied Statics and Strength of Materials



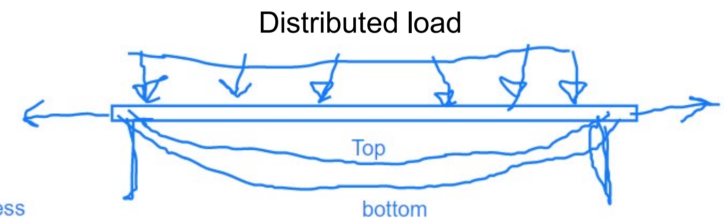
CHAPTER 17

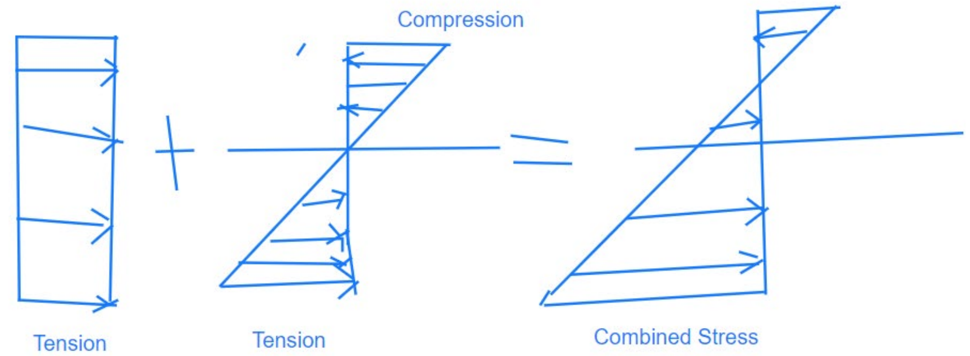
Combined Stresses

Combined Stress

Type 1- Combined axial and Bending

Type 2- Combined Normal and Shear Stress



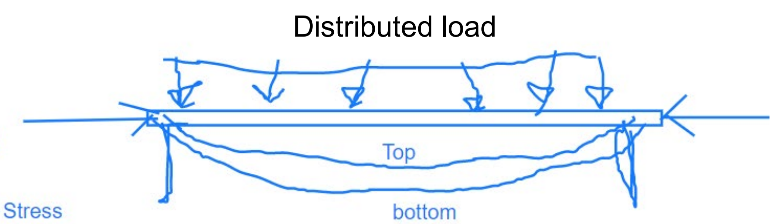


Type 1

Combined Stress

Type 1- Combined axial and Bending

Type 2- Combined Normal and Shear Stress



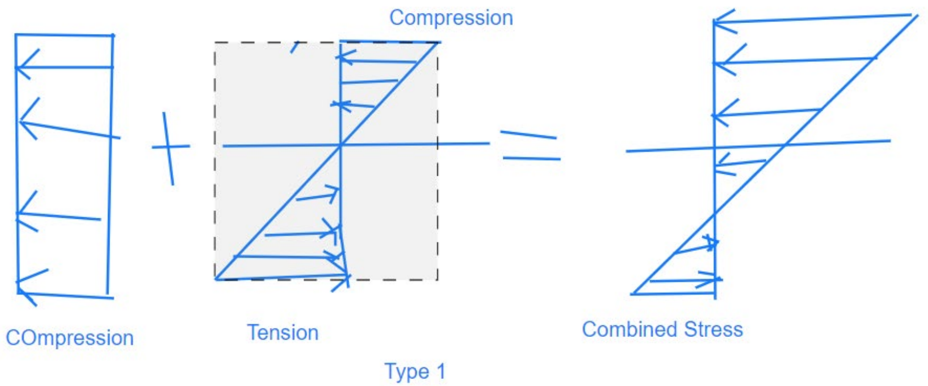


Figure 17.4 Combined axial and bending stresses.

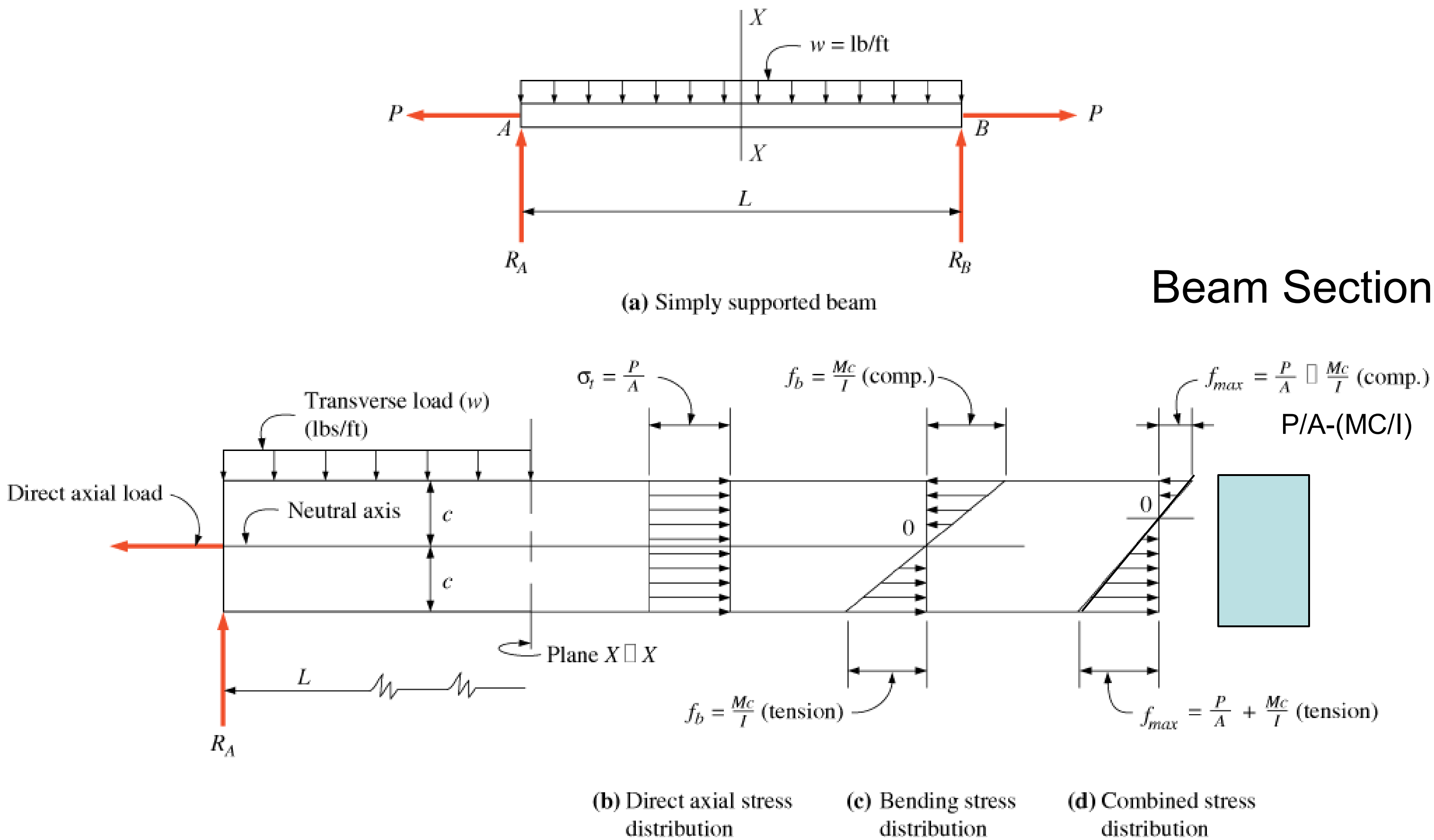
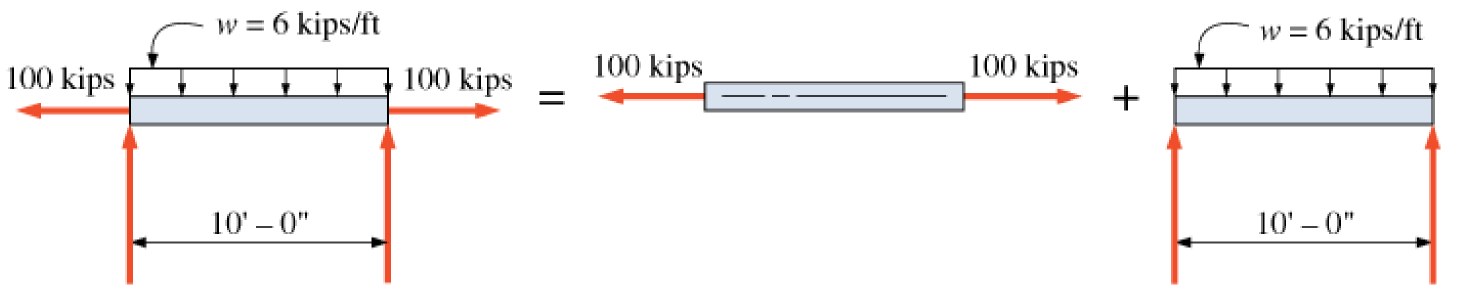


Figure 17.6 Method of superposition.

Example W 14x61 beam

Compute Maximum combined tensile and compressive stress



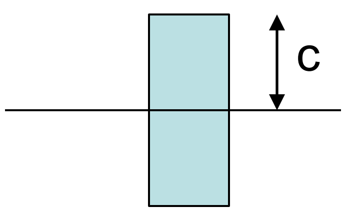
(a) Loaded beam **(b)** Axially loaded beam **(c)** Transversely loaded beam

Normal Stress = P/A

Bending stress= MC/I

M=wL^2/8=6*100/8=75 kip-ft

P=100 kips



$M = wL^2/8$

I from table= 640 in^4

C from Table, =13.9/2=6.95 in

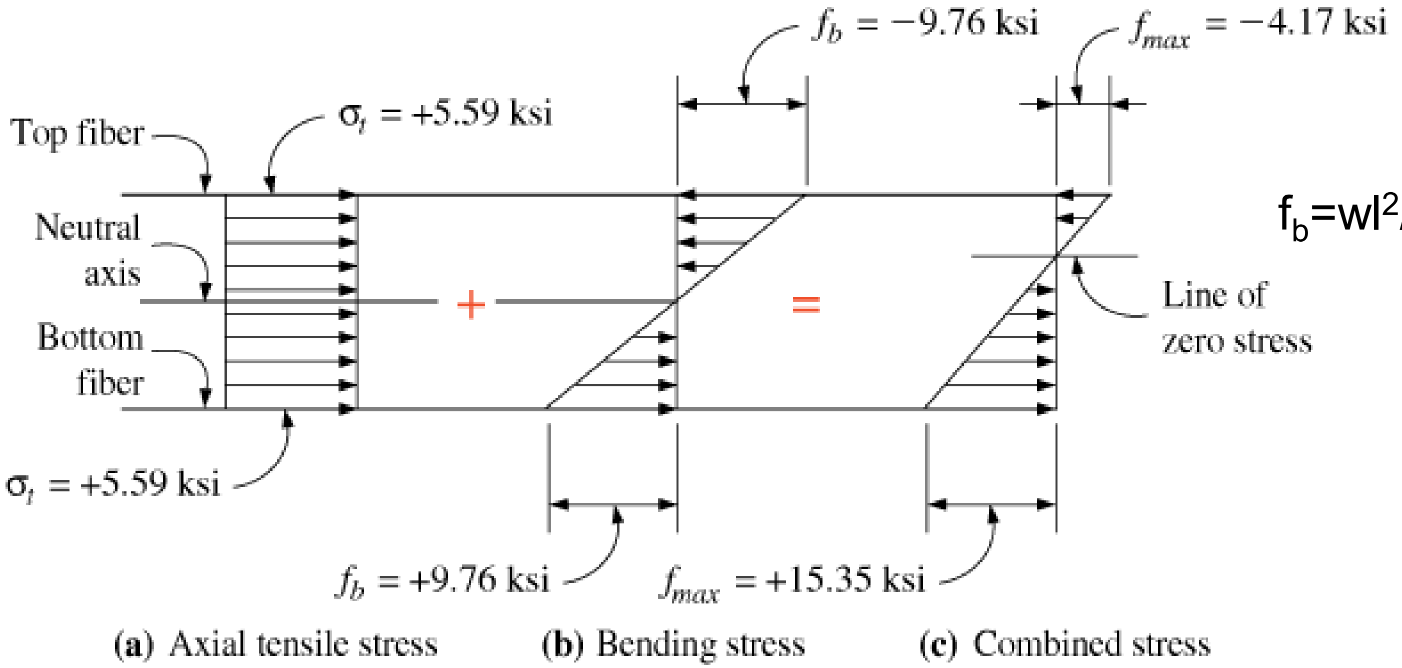
A=17.9 in^2

Bending Stress=75*12*6.95/640 =9.77 ksi

Normal =100/17.9=5.6 ksi

Figure 17.7 Stress distributions at midspan.

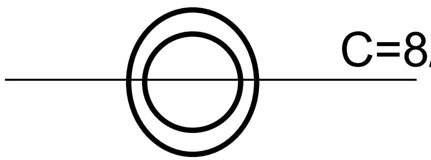
$F_{top,}$ max= Normal-Bending stress
F_{bottom}, max= Normal+Bending stress



$f_b = wl^2/8$

Figure 17.8 Load diagram.

Steel pipe



C=8/2=4 in

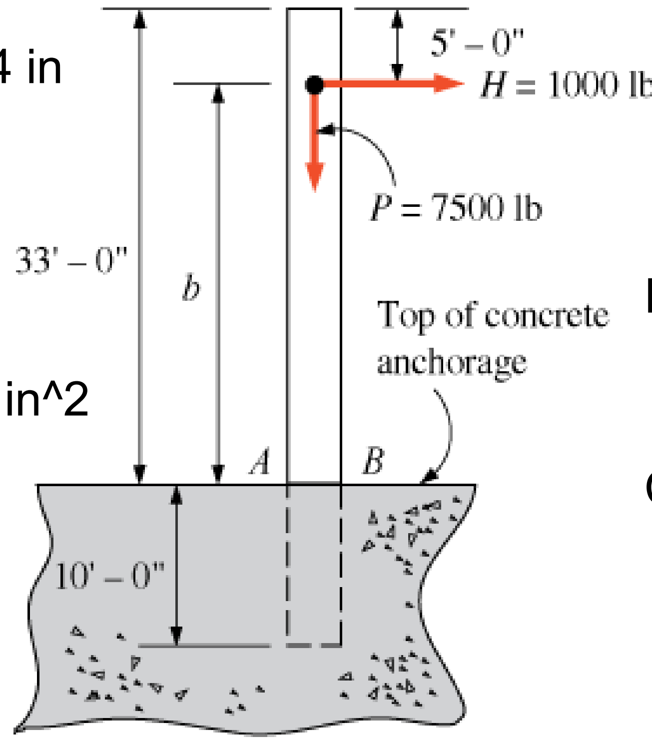
8 in dia, section
Thickness, 0.25 in

A=pi()*(8^2-7.5^2)/4=6.08 in^2

Annular Area

$I=pi()*(D_o\text{^}4-D_i\text{^}4)/64$

=pi()*(8^4-7.5^4)/64



Steel Pipe

Find Max Combined Stress

Compressive stress= P/A

b=28 ft
Moment=b*H

Solution in Excel

	A	B	C	D	E
	I	45.74638	In^4		
	Area	6.086836	in^2		
	Compressive stress	-1232.17	psi		
	Moment	28000	ft.lb		
	Bending stress	29379.38	psi		
	Stress at Point A	28147.21	Psi, Combined Tensile		
	Stress at Point B	-30611.5	Psi, Combined Compressive		
	If Fy=60 ksi, then find safety factor at Point A and B				
	FS can not be less than 1.				
	FS= Fy/Applied stress	2.13165	at point A		
		1.960045	at point B		
		Which point is more critical? Ans is B			

Figure 17.9 Stress distributions in plane A–B.

fc=P/A
=7500/6=

M=H*b

fb=MC/I

Stress at A= -fc+fb

Stress at B= -fc-fb

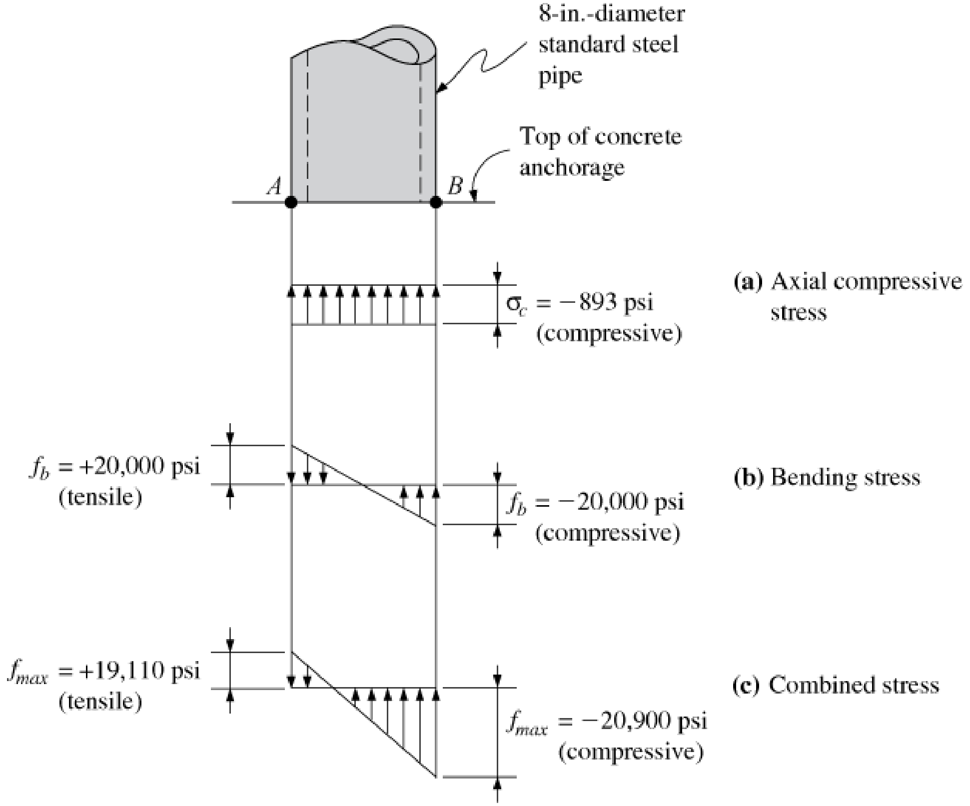


Figure 17.10 Combined stresses caused by eccentric load.

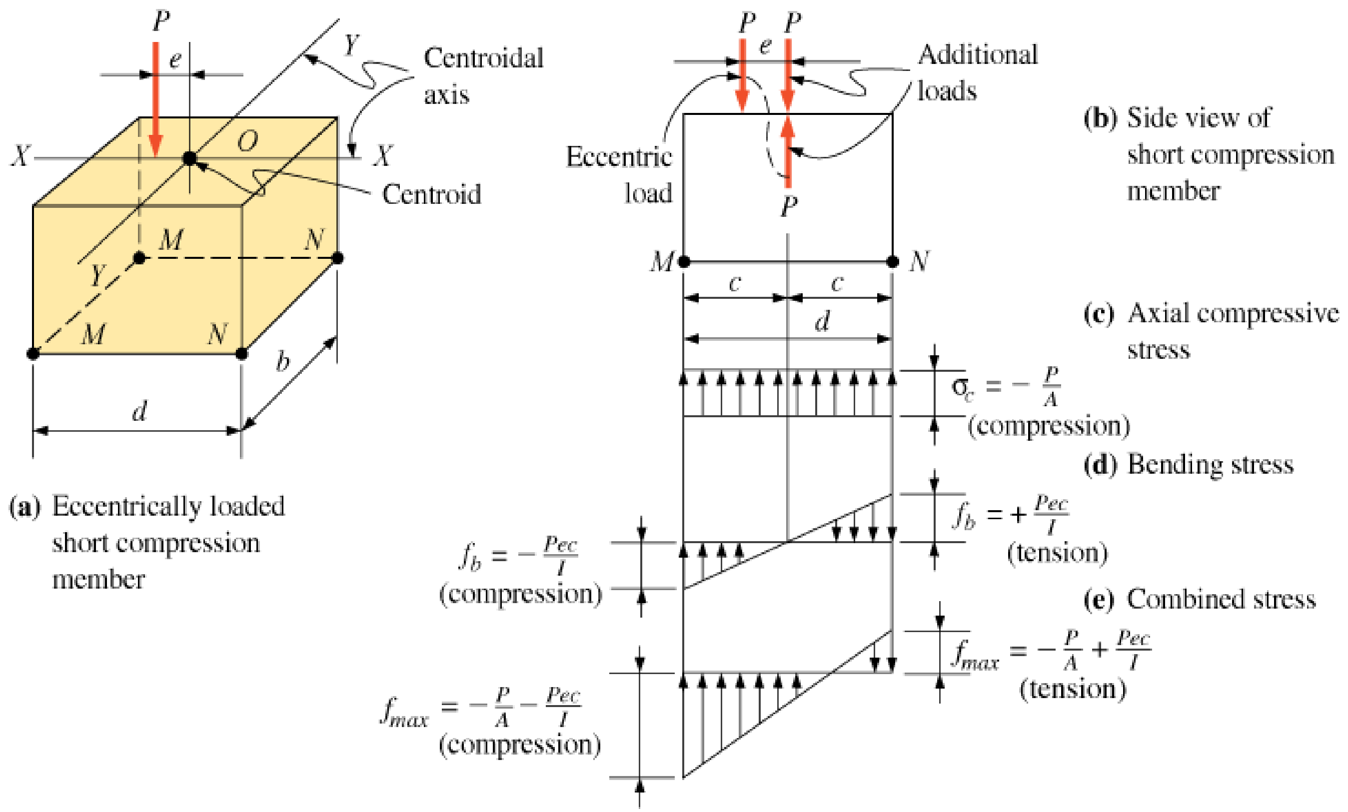


Figure 17.28 Axially loaded member and Mohr's circle.

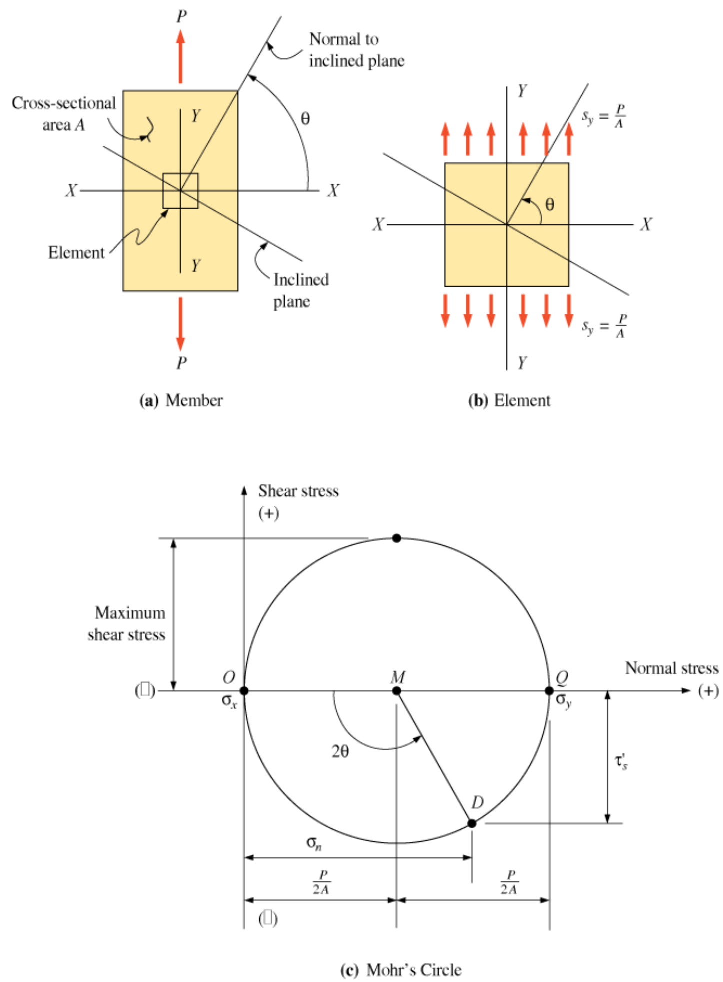
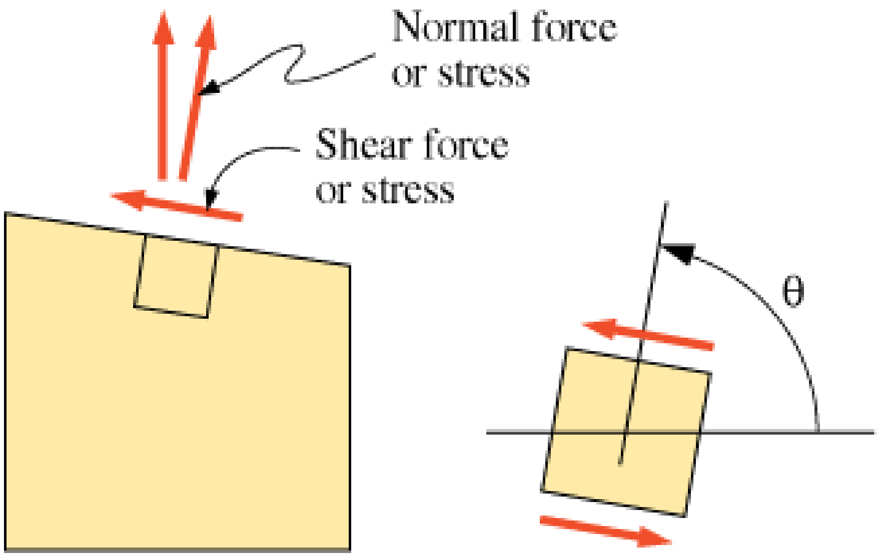
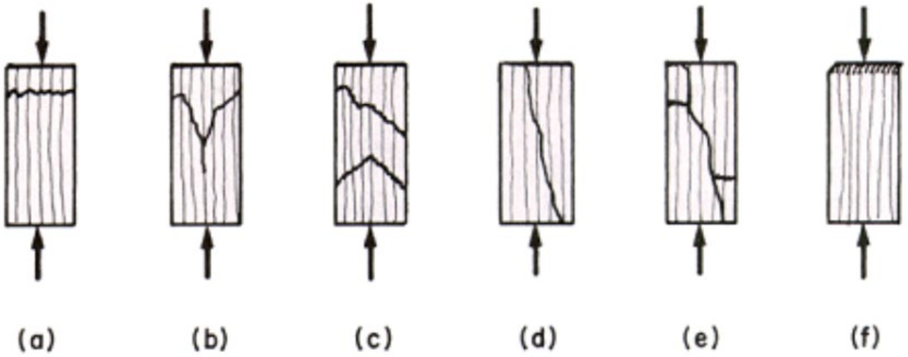


Figure 17.29 Shear stress direction on inclined plane.

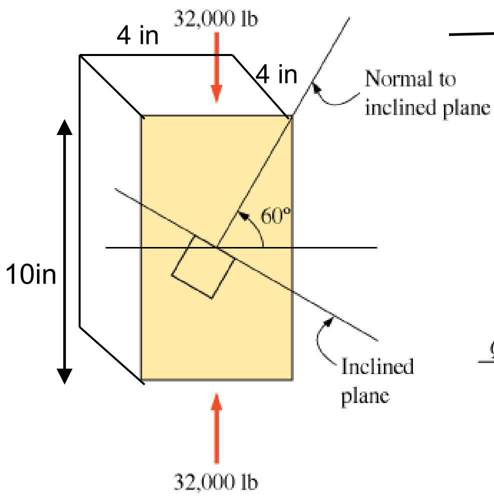


Typical Lumber failure and the failure planes under compression

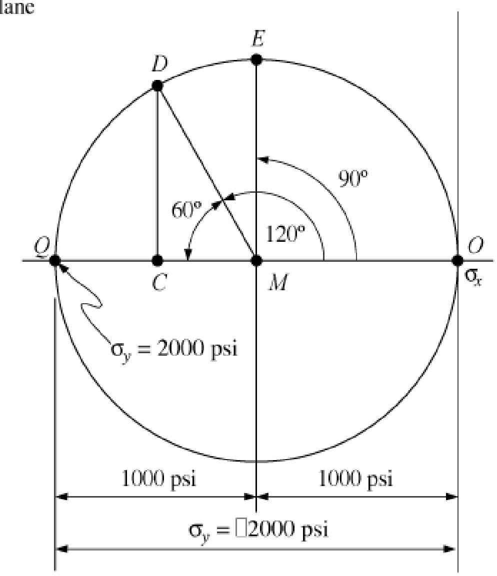


Failure types of nonbuckling clear wood in compression parallel to grain: (a) crushing, (b) wedge splitting, (c) shearing, (d) splitting, (e) crushing and splitting, (f) brooming or end rolling.

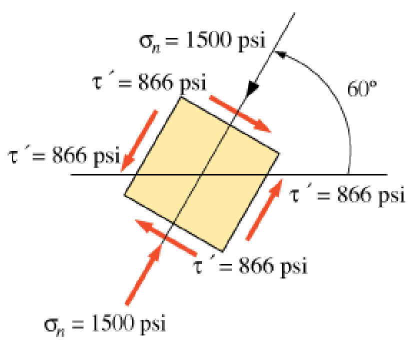
Figure 17.30 Mohr's circle: uniaxial stress.



(a) Member



(b) Mohr's circle



(c) Rotated element

10-inch-long metal blok 4 in by 4 in cross section, subjected to compressive load 32,000 lb. Using Mohr's circle determine normal and shear stress on a plane that has a normal inclined 60 deg counterclockwise.

Determine the Magnitude of Max shear stress and locate the plane where it exists.

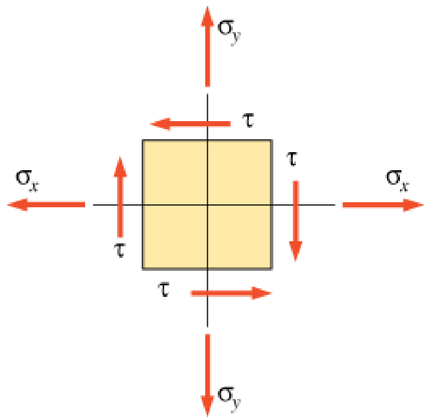
Use Mohr's circle to represent stresses at any plane

Max compressive stress
Sigma Y=-P/A=32000/16 =-2000 psi

Normal stress at 60 deg plane-
OC=1000+1000 Cos 60=1500 psi
Shear stress at 60 deg plane-
DC= 1000 Sin 60 =866 psi

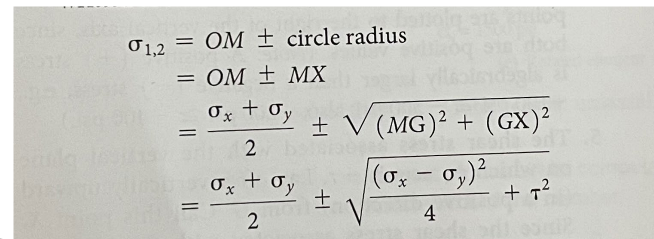
Max shear stress occur on a plane 45 Deg with the plane perpendicular to longitudinal axis. By Inspection ME for Max shear, +1000 psi

Figure 17.31 Mohr's circle example.

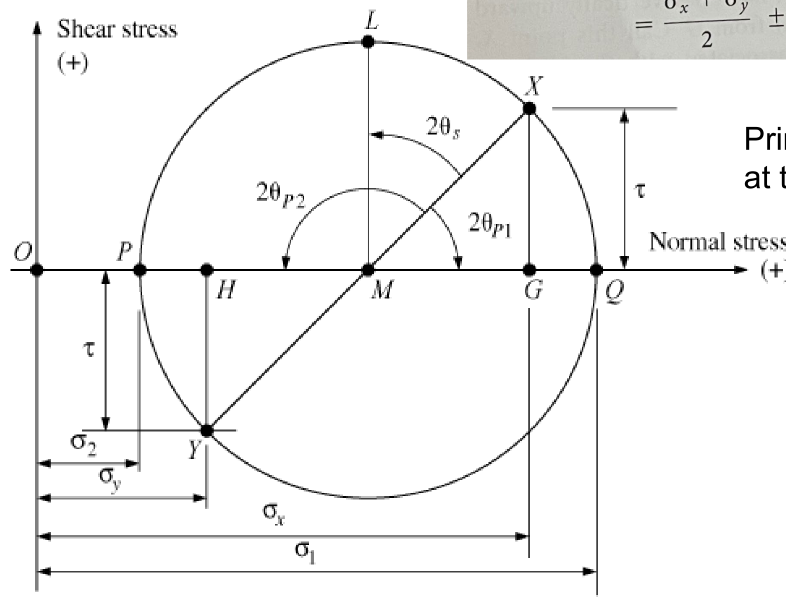


(a) Original stressed element

General State of Stress



$$\sigma_{1,2} = OM \pm \text{circle radius}$$
$$= OM \pm MX$$
$$= \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{(MG)^2 + (GX)^2}$$
$$= \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\frac{(\sigma_x - \sigma_y)^2}{4} + \tau^2}$$



(b) Mohr's circle

Principal stress, the normal s
at the plane of interest.

Sigma 1,2= OM±Circle Radius
=(sigma_x+sigma_y)/2±sqrt((MG^2)+(GX^2))
=(sigma_x+sigma_y)/2±sqrt ((sigma_x-Sigma-y)^2/4+Tau^2)

Figure 17.32 Stressed element.

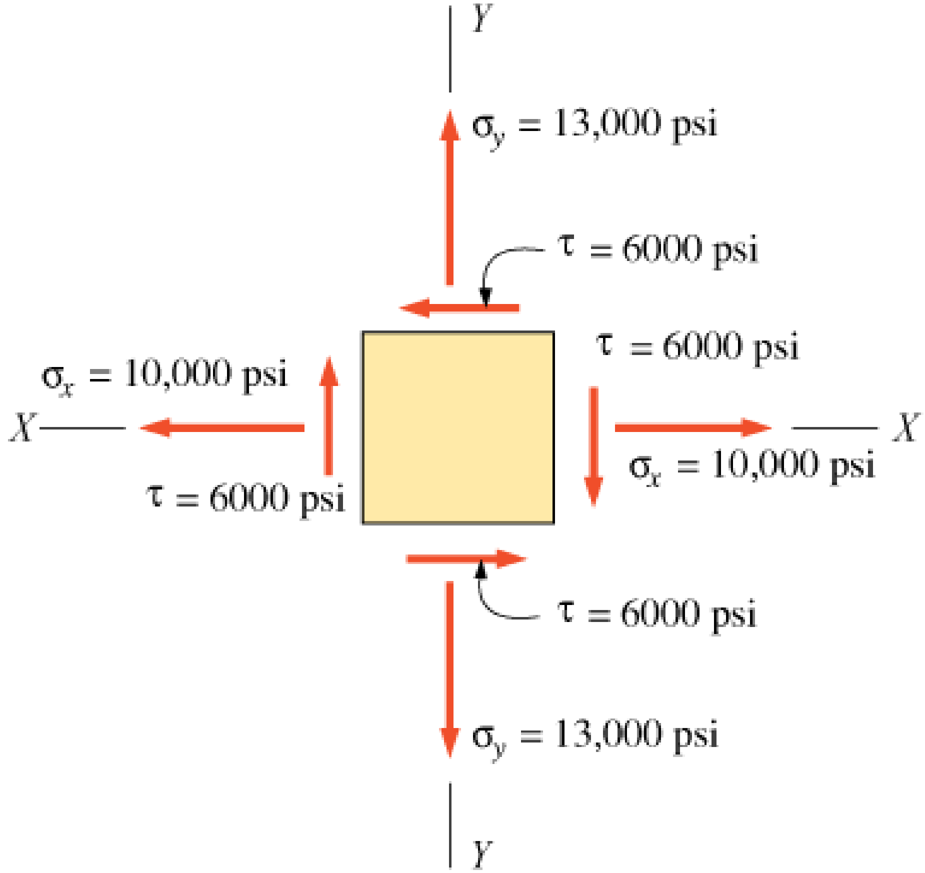


Figure 17.33 Mohr's circle.

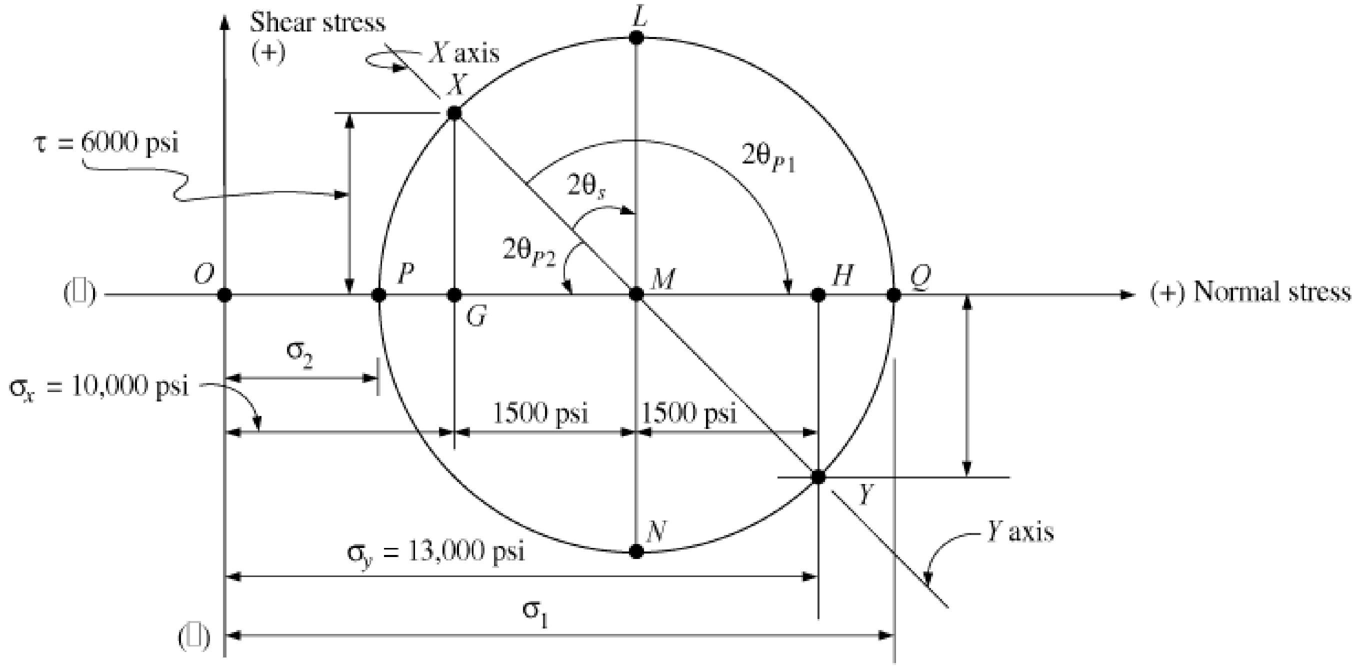
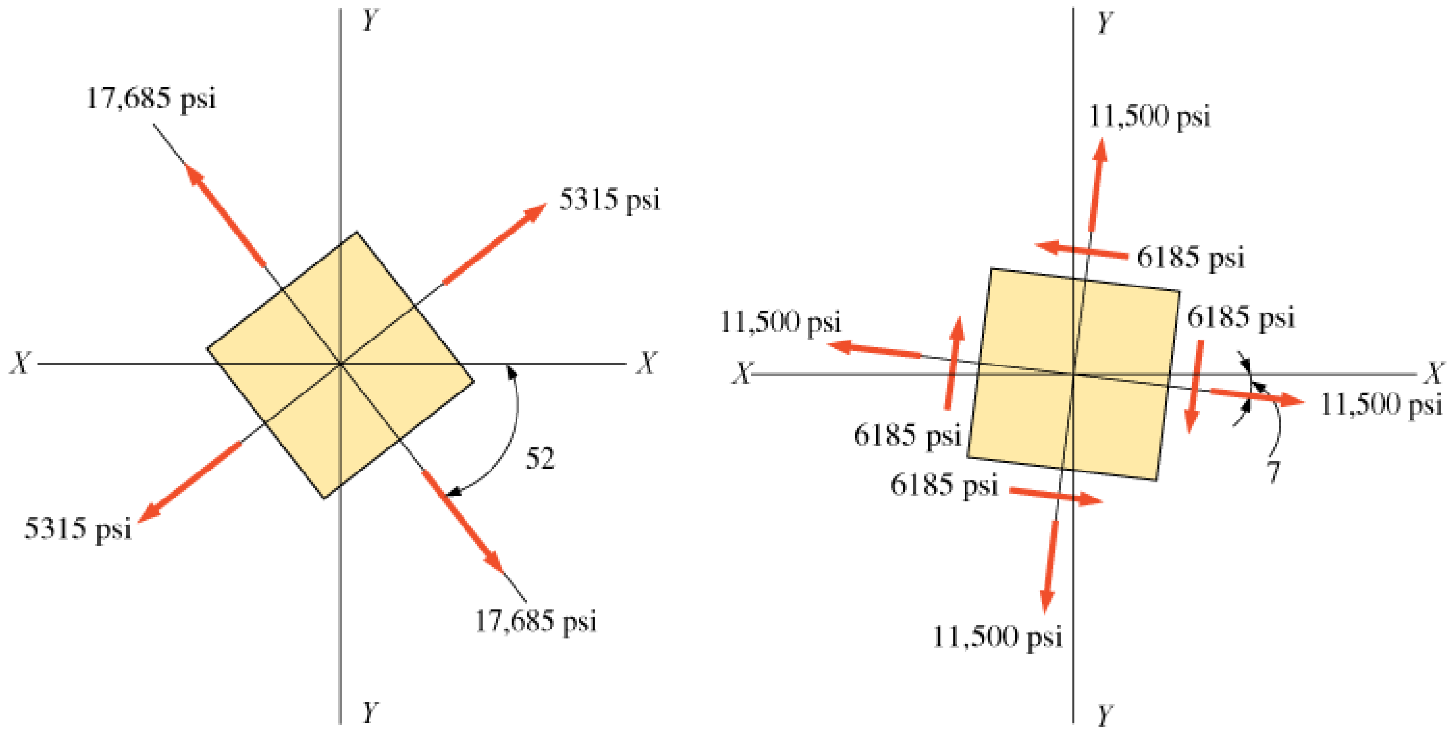
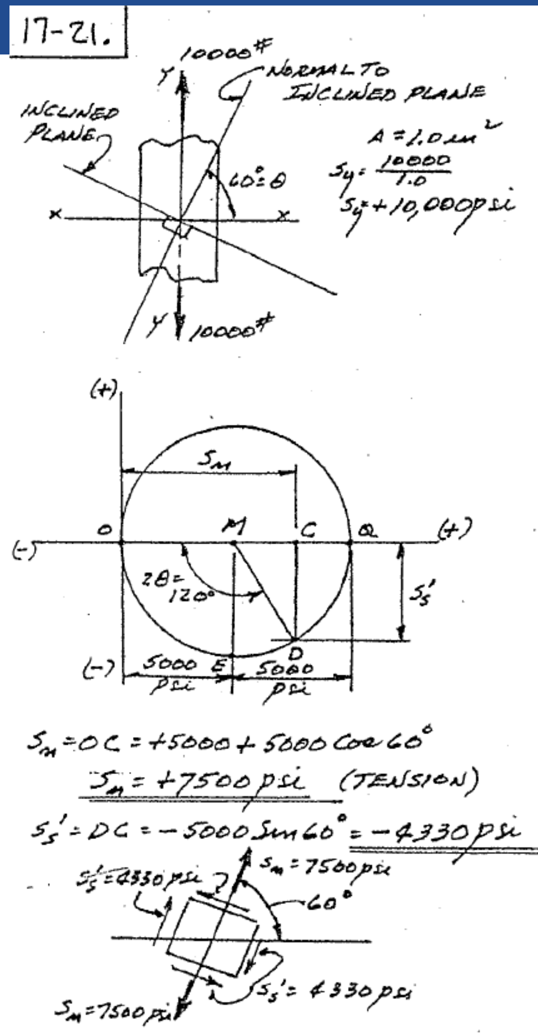


Figure 17.34 Results for Example 17.10.



(a) Principal stress element **(b)** Maximum shear stress element



Steel bar , axial tensile load 10000 lb

Calculate Shear and normal stress at the plane shown

Type 1 - Combined Stress

Type 2 combined stress

asrahman@citytech.cuny.edu

I will post problems in Black board

How is this combined stress , relevant to the project?

Dont forget discussion board

Example - Roof Mount winch motor system

Analyse factor of safety based on top and bottom fiber of the shaft

Find design codes, where the factor of safety of a winch motor system is specified, then utilise this into your design

USe this codes as a reference