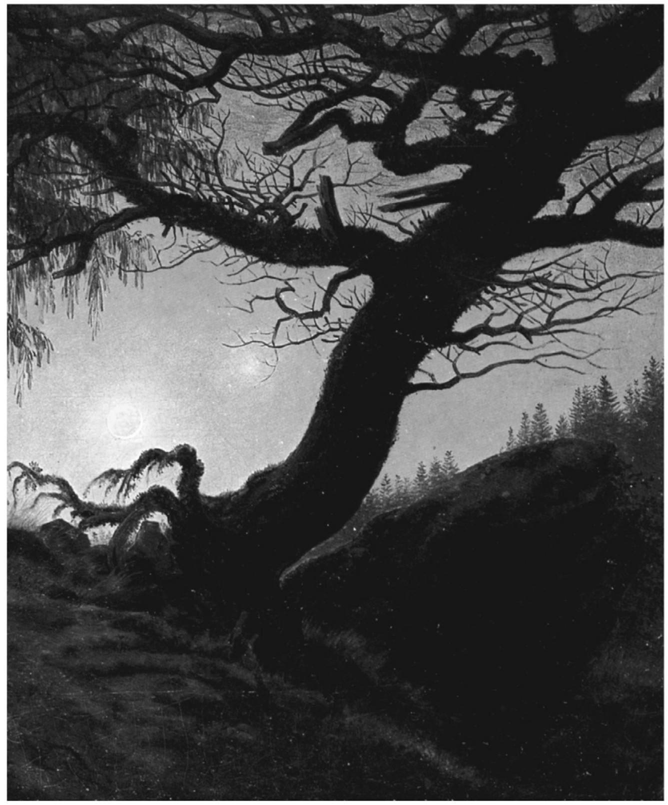
Architecture 324
Structures II

# Combined Stress

- Axial vs. Eccentric Load
- Combined Stress
- Interaction Formulas

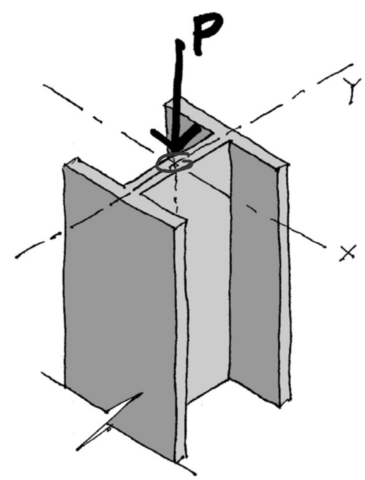


from "Man und Frau den Mond betrachtend"
1830-35 by Caspar David Friedrich
Alte Nationalgalerie, Berlin



# Axial Stress

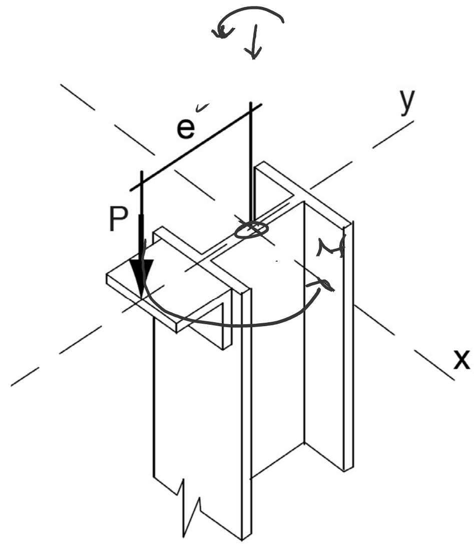
- Loads pass through the centroid of the section , i.e. axially loaded
- Member is straight
- Load less than buckling load




Then:

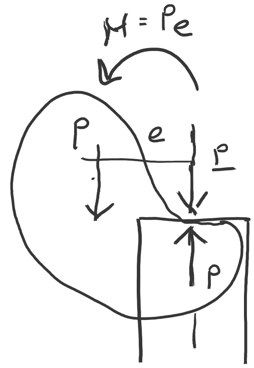
$$f_a = \frac{P}{A}$$

# Eccentric Loads




- Load is offset from centroid
- Bending Moment = P e
- Total load = P + M

Interaction formula




$$f = \frac{P}{A} \pm \frac{Mc}{I}$$

AXIAL BEND

%AXIAL %BEND

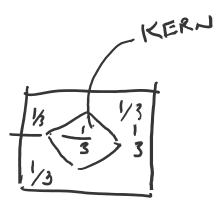
$$\frac{f_a}{F_a} \pm \frac{f_b}{F_b} \leq 1.0$$

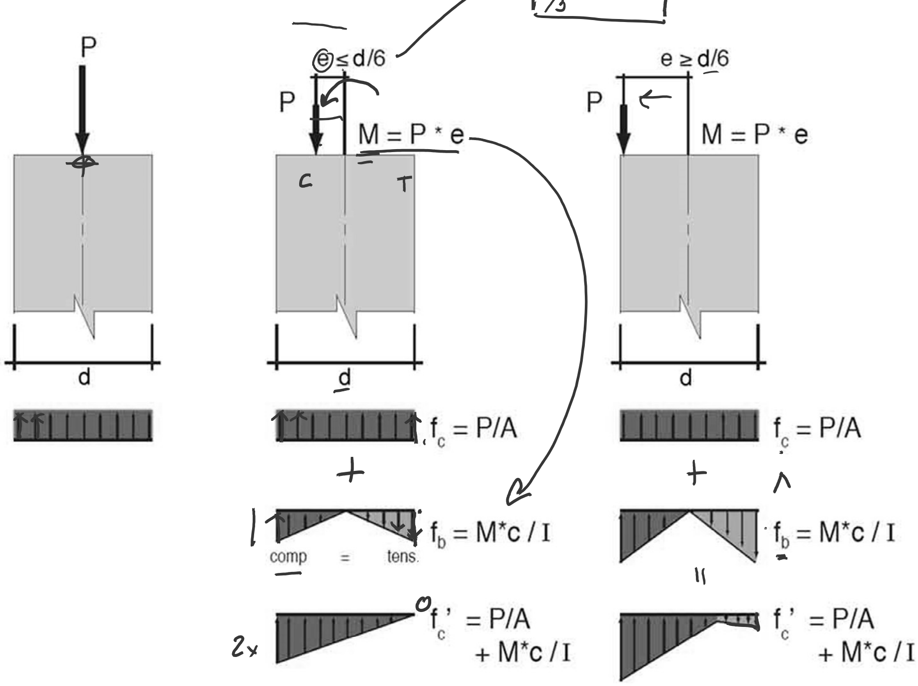
100%



# Combined Stress

- Stresses combine by superposition
- Values add or subtract by sign




*axial loaded - uniform compressive stress.*

*small eccentricity - linearly varying stress.*

*large eccentricity - tensile stress on part of cross section.*

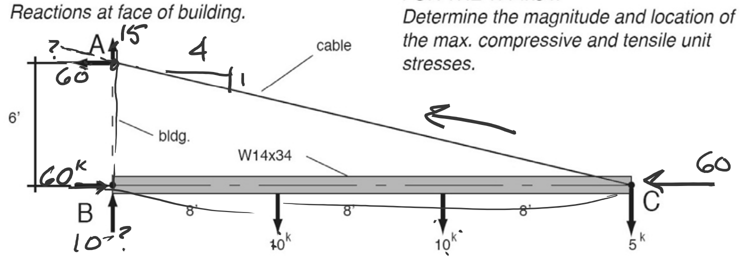
# Example

*CANOPY CONSTRUCTION PROJECTING FROM FACE OF BUILDING.*
*The supporting cable is pin-connected on the centroidal axis of the steel beam.*

*Reactions at face of building.*

*FOR THE W14x34:*
*Determine the magnitude and location of the max. compressive and tensile unit stresses.*

$\frac{60}{15} \quad \frac{4}{1}$




1. Determine external reactions

$\Sigma M_A = 0 = -B_H 6' + 10^K(8') + 10^K(16') + 5^K(24')$

$\underline{B_H = 60^K}$

$\Sigma M_B = 0 = -A_H(6') + 10^K(8') + 10^K(16') + 5^K(24')$

$\underline{A_H = 60^K}$

CHECK $\Sigma F_H = 0 = 60^K - 60^K$ ✓

FBD @ A

$A_V$, 4, 1, $60^K$, $60^K$

$\frac{60}{4} : \frac{A_V}{1}$

$\underline{A_V = 15^K}$

$\Sigma F_V = 0 = 15^K - 10^K - 10^K - 5^K + B_V$

$\underline{B_V = 10^K}$

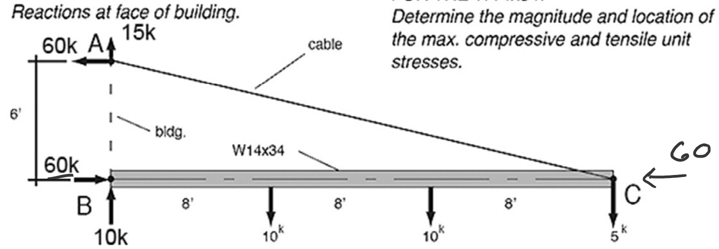


# Example

*CANOPY CONSTRUCTION PROJECTING FROM FACE OF BUILDING.*
*The supporting cable is pin-connected on the centroidal axis of the steel beam.*

*Reactions at face of building.*

*FOR THE W14x34:*
*Determine the magnitude and location of the max. compressive and tensile unit stresses.*




2. Determine internal member **forces**: Axial and Flexural

3. Determine axial and flexural **stresses**

W14x34 $\quad A = 10.0 \text{ in}^2$
$\qquad\qquad S_x = 48.6 \text{ in}^3$

FORCE:

AXIAL $= 60^K$

FLEXURAL $= M = PL/3 = 10^K(8') = \underline{80^{'-K}}$

STRESS:

AXIAL $= f_a = \frac{P}{A} = 60^K / 10 \text{ in}^2 = \underline{6.0 \text{ KSI}}$

FLEXURAL $: f_b = M/S = 80^{'-K} (12''/') / 48.6 \text{ in}^3 = \underline{19.75 \text{ KSI}}$

# Example

2. Use interaction formula to determine combined stresses at key locations (e.g. extreme fibers)

COMBINED STRESS

TOP SIDE:

$$\overset{c}{f_a} \pm \overset{c}{f_b} = 6.0 + 19.75 = \underline{25.75} \text{ KSI (COMP)}$$

BOTTOM SIDE:

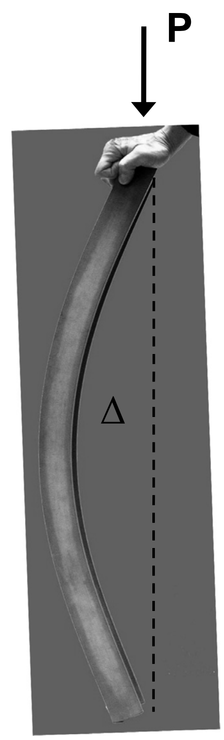
$$\underset{c}{f_a} - \underset{T}{f_b} = 6.0 - 19.75 = -\underline{13.75} \text{ KSI (TENS)}$$



# Second Order Stress
# "P Delta Effect"

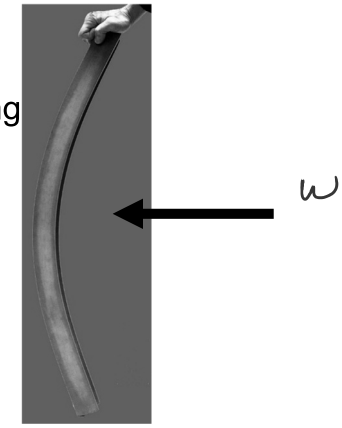
With larger deflections this can become significant.

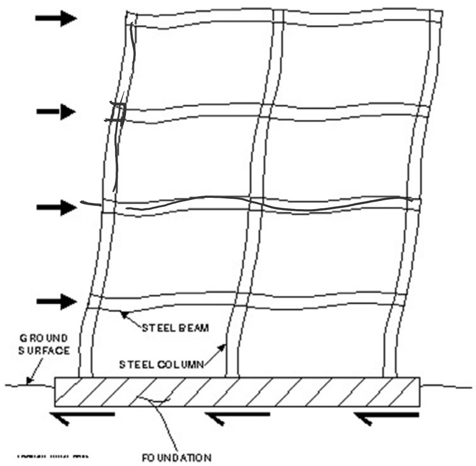
1. Eccentric load causes bending moment
2. Bending moment causes deflection, Δ
3. P x Δ causes additional moment
   M



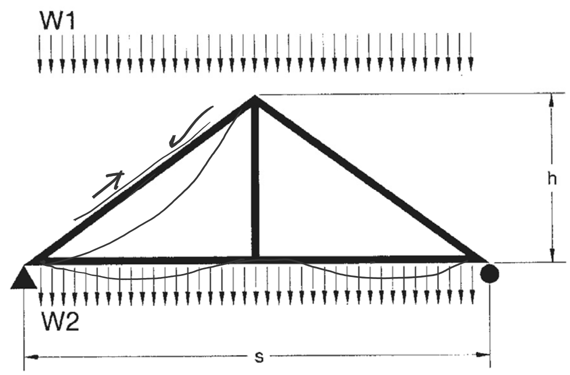
# Other Examples of Combined Stress

Columns with side loading



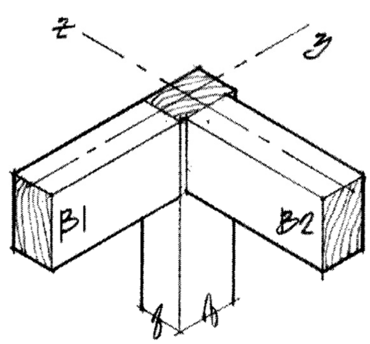

Moment frames

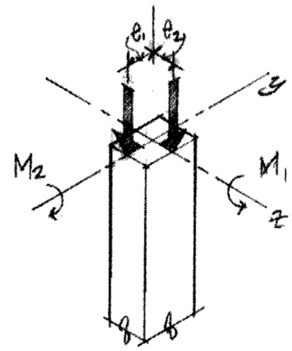



Trusses loaded on members



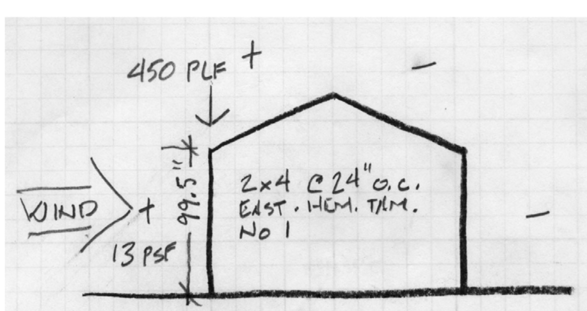
# Other Examples of Combined Stress




$M_1 = P_1 \times e_1$ (ABOUT THE x-AXIS)
$M_2 = P_2 \times e_2$ (ABOUT THE y-AXIS)

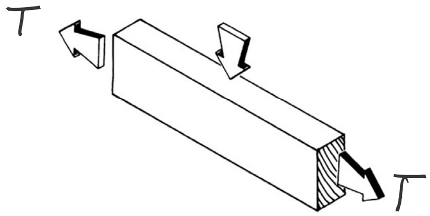
Eccentrically loaded columns




Wind load on walls

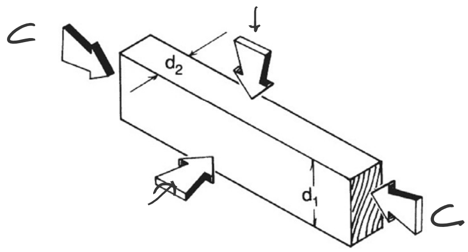
# Combined Stress in NDS

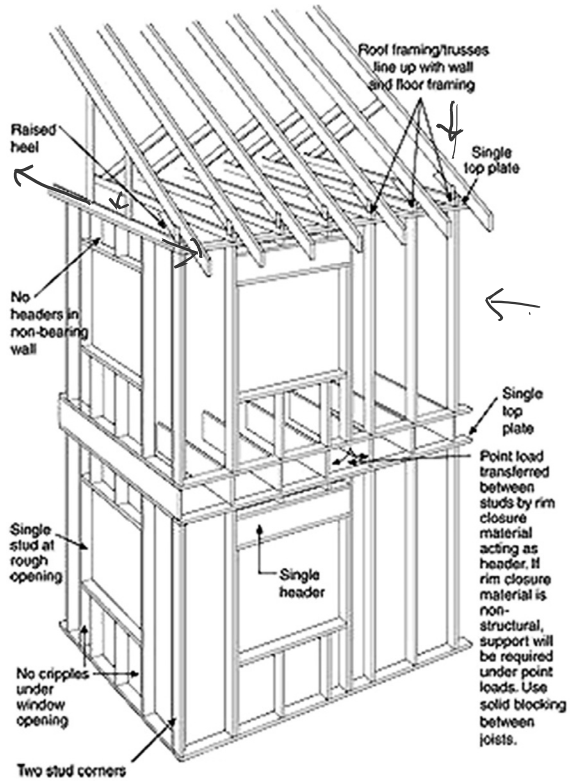
**Figure 3G** **Combined Bending and Axial Tension**




**3.9.2 Bending and Axial Compression**

**Figure 3H** **Combined Bending and Axial Compression**






# Tension + Flexure

**NDS Equations**

CASE 1. Tension is critical. Eq. 3.9-1

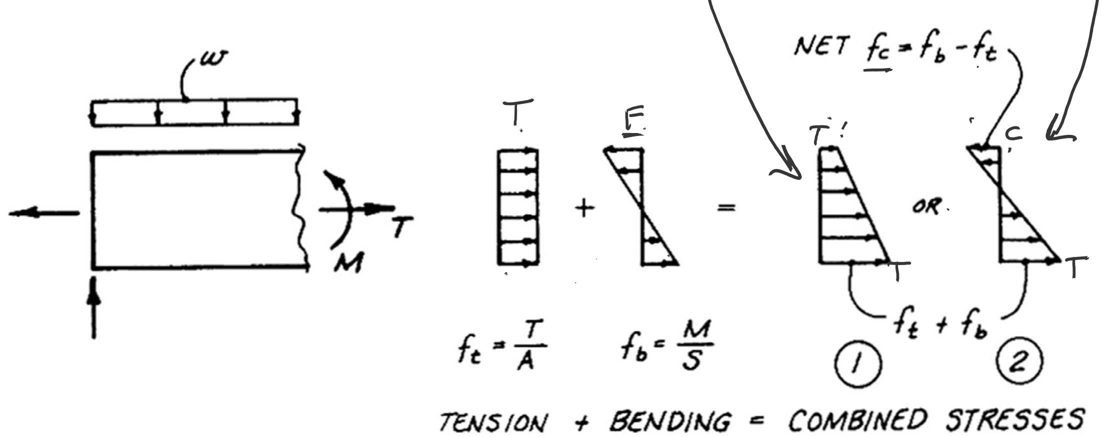
* no $C_L$

$$\frac{f_t}{F_{t'}} + \frac{f_b}{F_b *} \leq 1.0$$

CASE 2. Flexure is critical. Eq. 3.9-2

** no $C_V$

$$\frac{f_b - f_t}{F_b **} \leq 1.0$$



# Tension + Flexure NDS

## 3.9.1 Bending and Axial Tension

Members subjected to a combination of bending and axial tension (see Figure 3G) shall be so proportioned that:

$$\frac{f_t}{F_t'} + \frac{f_b}{F_b^*} \leq 1.0 \qquad \text{TENSION CRIT.} \qquad (3.9\text{-}1)$$

**and**

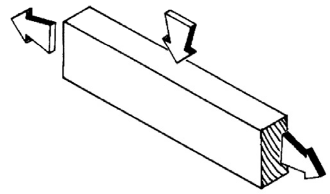
$$\frac{f_b - f_t}{F_b^{**}} \leq 1.0 \qquad \text{FLEXURE CRIT.} \qquad (3.9\text{-}2)$$

**where:**

$F_b^*$ = reference bending design value multiplied by all applicable adjustment factors except $C_L$

$F_b^{**}$ = reference bending design value multiplied by all applicable adjustment factors except $C_V$

**Figure 3G Combined Bending and Axial Tension**





# Example Problem

Given: Queen Post truss

Hem-Fir No.1 & Better

$F_b$ = 1100 psi

$F_t$ = 725 psi

$F_c$ = 1350 psi

$E_{min}$ = 550000 psi

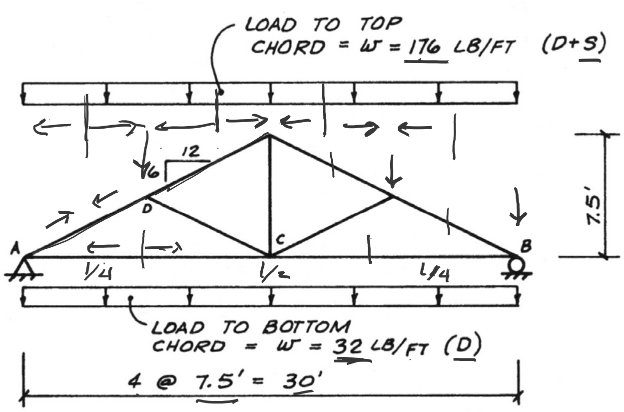
span = 30 ft. spaced 48" o.c.

D + S Load = 44 psf (projected)

D (attic + ceiling) = 8 psf

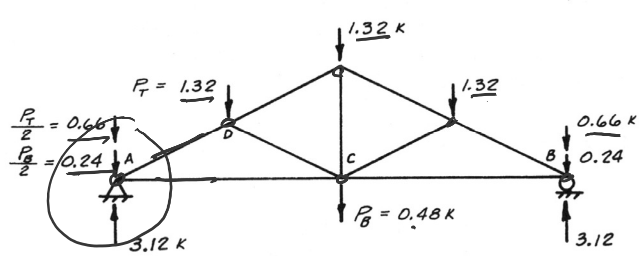
bottom chord: 2x8

top chord: 2x10




Find: pass/fail

$$\frac{f_t}{F_{t'}} + \frac{f_b}{F_b*} \leq 1.0 \qquad \frac{f_b - f_t}{F_b**} \leq 1.0$$



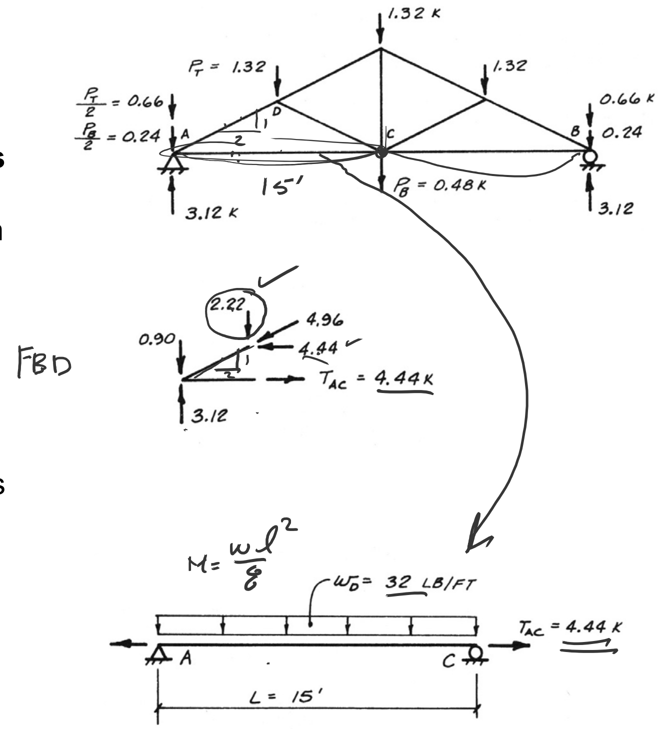

1. Determine truss joint loading

# Example (cont.)

2. Determine the external **end reactions** of the whole truss. The geometry and loads are symmetric, so each reaction is ½ of the total load.

3. Use an FBD of the reaction joint to find the **chord forces**. Sum the forces horizontal and vertical to find the components.

   Top chord = 4.96 k compression
   Bottom chord = 4.44 k tension



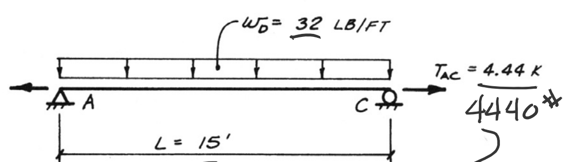



# Example
bottom chord 2x8

$$\frac{f_t}{F_t'} + \frac{f_b}{F_b^*} \le 1.0$$

**and**

$$\frac{f_b - f_t}{F_b^{**}} \le 1.0$$




4440#

$$f_t = \frac{P}{A} = \frac{4440 \text{ lbs}}{10.875 \text{ in}^2} = 408.3 \text{ psi}$$

4. Calculate the **actual** axial and flexural stress.

   $f_t$ = 408.3 psi
   $f_b$ = 821.9 psi

$$f_b = \frac{M}{S_x} = \frac{900\ (12)}{13.14 \text{ in}^3} = 821.9 \text{ psi}$$

$$M = \frac{w l^2}{8} = \frac{32\ (15)^2}{8} = 900 \text{ '-\#}$$

$$S_x = 13.14 \text{ in}^3$$

5. Determine **allowable** stresses using applicable factors:

   (tension: D+S)
   $F_t' = F_t\ (C_D\ C_F)$
   $F_t'$ = 725 (1.15 1.2) = 1000 psi > 408.3

   (flexure: D+S)
   $F_b' = F_b\ (C_D\ C_L\ C_F)$
   $F_b'$ = 1100 (1.15 1.0 1.2) = 1518 psi

$C_L$ IS 1.0 BY 4.4.1
d/b = 4, ENDS ARE HELD

# Example
bottom chord 2x8

$$\frac{f_t}{F_t'} + \frac{f_b}{F_b^*} \le 1.0$$

**and**

$$\frac{f_b - f_t}{F_b^{**}} \le 1.0$$

5. Determine **allowable** stresses using applicable factors:

(tension: D+S) S = 1.15

$F_t' = F_t\,(C_D\ C_F)$

$F_t' = 725\ (1.15\ \ 1.2) = 1000$ psi > 408.3

(flexure: D+S)

$F_b' = F_b\,(C_D\ C_L\ C_F)$

$F_b' = 1100\ (1.15\ 1.0\ 1.2) = 1518$ psi

TABLE

**Size Factors, $C_F$**

| Grades | Width (depth) | $F_b$ Thickness (breadth) 2" & 3" | $F_b$ Thickness (breadth) 4" | $F_t$ | $F_c$ |
|---|---|---|---|---|---|
| Select Structural, No.1 & Btr, No.1, No.2, No.3 | 2", 3", & 4" | 1.5 | 1.5 | 1.5 | 1.15 |
| | 5" | 1.4 | 1.4 | 1.4 | 1.1 |
| | 6" | 1.3 | 1.3 | 1.3 | 1.1 |
| | 8" | 1.2 | 1.3 | 1.2 | 1.05 |
| | 10" | 1.1 | 1.2 | 1.1 | 1.0 |
| | 12" | 1.0 | 1.1 | 1.0 | 1.0 |
| | 14" & wider | 0.9 | 1.0 | 0.9 | 0.9 |
| Stud | 2", 3", & 4" | 1.1 | 1.1 | 1.1 | 1.05 |
| | 5" & 6" | 1.0 | 1.0 | 1.0 | 1.0 |
| | 8" & wider | Use No.3 | | | |
| Construction Standard | 2", 3", & 4" | 1.0 | 1.0 | 1.0 | 1.0 |
| Utility | 4" | 1.0 | 1.0 | 1.0 | 1.0 |
| | 2" & 3" | 0.4 | — | 0.4 | 0.6 |

$C_L$ IS 1.0 BY 4.4.1

d/b = 4, ENDS ARE HELD



# Example
bottom chord 2x8

### 3.9.1 Bending and Axial Tension

Members subjected to a combination of bending and axial tension (see Figure 3G) shall be so proportioned that:

$$\frac{f_t}{F_t'} + \frac{f_b}{F_b^*} \le 1.0 \qquad \text{TENSION CRIT.} \qquad (3.9\text{-}1)$$

**and**

$$\frac{f_b - f_t}{F_b^{**}} \le 1.0 \qquad \text{FLEXURE CRIT.} \qquad (3.9\text{-}2)$$

**where:**

$F_b^*$ = reference bending design value multiplied by all applicable adjustment factors except $C_L$

$F_b^{**}$ = reference bending design value multiplied by all applicable adjustment factors except $C_V$

(3.9-1)

$$\frac{f_t}{F_t}\ \frac{408.3}{1000} + \frac{821.9}{1518}\ \frac{f_b}{F_b}$$

0.4083 + 0.5414 = 0.95

0.95 < 1.0 ✓PASS

(3.9-2)

$$\frac{f_b - f_t}{F_b}\quad \frac{821.9 - 408.3}{1518} = 0.2724$$

0.27 < 1.0 ✓PASS

# Bending + Axial Compression

### 3.9.2 Bending and Axial Compression

Members subjected to a combination of bending about one or both principal axes and axial compression (see Figure 3H) shall be so proportioned that:

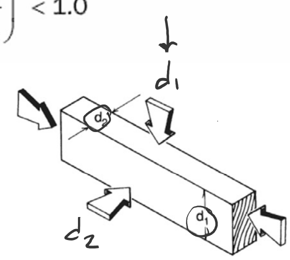
$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-\left(f_c/F_{cE1}\right)\right]} + \cancel{\frac{f_{b2}}{F_{b2}'\left[1-\left(f_c/F_{cE2}\right)-\left(f_{b1}/F_{bE}\right)^2\right]}} \le 1.0 \quad (3.9\text{-}3)$$

AMPLIFICATION FACTOR

PΔ EFFECT

and

$$\frac{f_c}{F_{cE2}} + \left(\frac{f_{b1}}{F_{bE}}\right)^2 < 1.0 \quad (3.9\text{-}4)$$




where:

$$f_c < F_{cE1} = \frac{0.822\,E_{min}'}{(\ell_{e1}/d_1)^2}$$ for either uniaxial edgewise bending or biaxial bending

and

$$f_c < F_{cE2} = \frac{0.822\,E_{min}'}{(\ell_{e2}/d_2)^2}$$ for uniaxial flatwise bending or biaxial bending

and

$$f_{b1} < F_{bE} = \frac{1.20\,E_{min}'}{(R_B)^2}$$ for biaxial bending

$f_{b1}$ = actual edgewise bending stress (bending load applied to narrow face of member), psi

$f_{b2}$ = actual flatwise bending stress (bending load applied to wide face of member), psi

$d_1$ = wide face dimension (see Figure 3H), in.

$d_2$ = narrow face dimension (see Figure 3H), in.



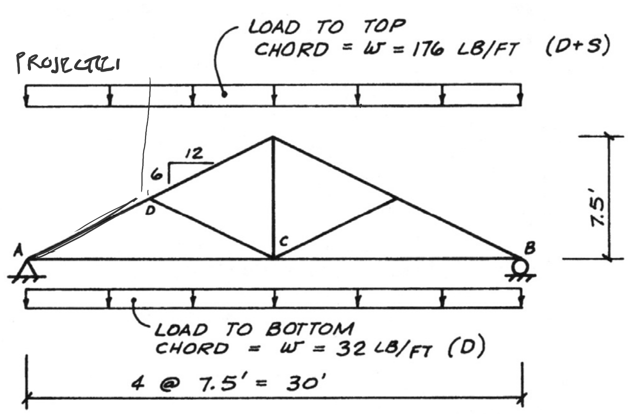
# Example

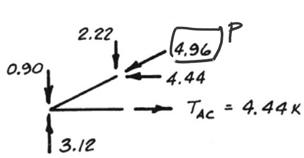
top chord 2x10

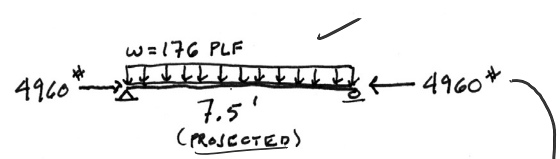
4. Calculate the **actual** axial and flexural stress.

$f_c$ = 357.5 psi
$f_b$ = 694.2 psi

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-\left(f_c/F_{cE1}\right)\right]}$$




$$f_c = \frac{P}{A} = \frac{4960\#}{1.5 \times 9.25} = 357.5 \text{ psi}$$

$$f_b = \frac{M}{S_x} = \frac{1237.5\,(12)}{21.39} = 694.2 \text{ psi}$$

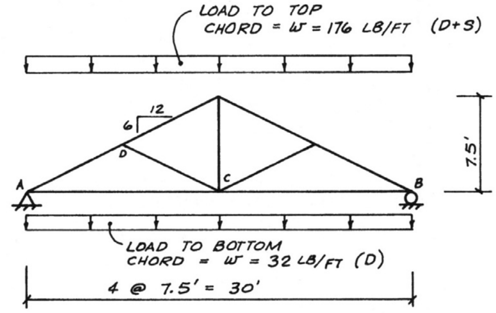
$$M = \frac{w\ell^2}{8} = \frac{176 \text{ PLF}(7.5')^2}{8} = 1237.5'\text{-}\#$$

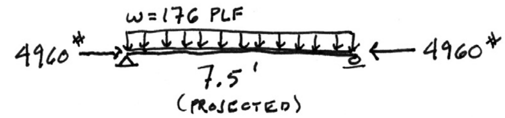
$$S_x = 21.39 \text{ in}^3$$

# Example

top chord 2x10

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-\left(f_c/F_{cE1}\right)\right]}$$




5. Determine **allowable** stresses using applicable factors:

   (compression: D+S)
   $F_c' = F_c\,(C_D\ C_F\ C_P)$
   $F_c' = 1350\ (1.15\ \ 1.0\ \ 0.897\ ) = 1392.7$ psi > 357.5

   (flexure: D+S)
   $F_b' = F_b\,(C_D\ C_L\ C_F)$
   $F_b' = 1100\ (1.15\ \ 1.0\ \ 1.1) = 1392$ psi > 694.2

$C_P$

$l_e = 8.385'$ $d = 9.25''$

$l_e/d = \frac{8.385(12)}{9.25} = 10.88$

EULER

$F_{cE} = \frac{0.822\ E_{min}'}{(l_e/d)^2} = \frac{0.822\,(550\,000)}{10.88^2} = 3820$ psi

$F_c^* = 1350\,(1.15\ \ 1.0) = 1552.5$ psi

$F_{cE}/F_c^* = \frac{3820}{1552} = 2.46$ $c = 0.8$

$C_P = 0.897$



# Example

top chord 2x10

Eq. 3.9-3

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-\left(f_c/F_{cE1}\right)\right]} \le 1.0$$

COMP. + FLEXURE X-X

**where:**

EULER 1

$f_c < F_{cE1} = \frac{0.822\,E_{min}'}{(\ell_{e1}/d_1)^2}$ for either uniaxial edge-wise bending or biaxial bending

**and**

EULER 2

$f_c < F_{cE2} = \frac{0.822\,E_{min}'}{(\ell_{e2}/d_2)^2}$ for uniaxial flatwise bending or biaxial bending

**and**

LTB

$f_{b1} < F_{bE} = \frac{1.20\,E_{min}'}{(R_B)^2}$ for biaxial bending

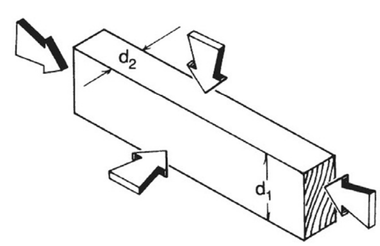
$f_{b1}$ = actual edgewise bending stress (bending load applied to narrow face of member)

$f_{b2}$ = actual flatwise bending stress (bending load applied to wide face of member)

$d_1$ = wide face dimension (see Figure 3H)

$d_2$ = narrow face dimension (see Figure 3H)

**Figure 3H Combined Bending and Axial Compression**




COMPRESSION:

$$\left[\frac{f_c}{F_c'}\right]^2 = \left[\frac{357.5}{1392.7}\right]^2 = 0.0659$$

# Example

top chord 2x10

Eq. 3.9-3

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-(f_c/F_{cE1})\right]} \le 1.0$$

COMP. + FLEXURE X-X

**where:**

$f_c < F_{cE1} = \dfrac{0.822\,E_{min}'}{(\ell_{e1}/d_1)^2}$ EULER 1 for either uniaxial edge-wise bending or biaxial bending

**and**

$f_c < F_{cE2} = \dfrac{0.822\,E_{min}'}{(\ell_{e2}/d_2)^2}$ ~~EULER 2 for uniaxial flatwise bending or biaxial bending~~

**and**

$f_{b1} < F_{bE} = \dfrac{1.20\,E_{min}'}{(R_B)^2}$ ~~LTB for biaxial bending~~

$f_{b1}$ = actual edgewise bending stress (bending load applied to narrow face of member)

$f_{b2}$ = actual flatwise bending stress (bending load applied to wide face of member)

$d_1$ = wide face dimension (see Figure 3H)

$d_2$ = narrow face dimension (see Figure 3H)

$f_c = 357.5$ psi

$E_{min} = 550000$ psi

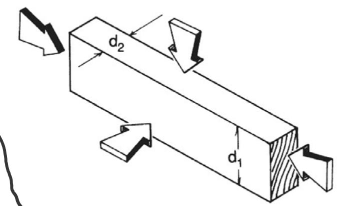
$\ell_{e1} = 8.385'$

$d_1 = 9.25''$

$\ell_{e1}/d_1 = \dfrac{8.385(12)}{9.25''} = 10.88$

$F_{CE1} = \dfrac{0.822(550000)}{10.88^2} = 3820$ psi

**Figure 3H Combined Bending and Axial Compression**




FLEXURE:

$\dfrac{f_{b1}}{F_{b1}'} = \dfrac{694.2}{1392} = 0.4987$

AMPLIFICATION FACTOR:

$\dfrac{1}{1-(357.5/3820)} = \dfrac{1}{0.906}$

$0.4987\,(1.103) = 0.550$

COMBINATION:

$0.0659 + 0.550 = 0.616$

$0.616 < 1.0$ ✓ PASS



# Combined Stress in NDS

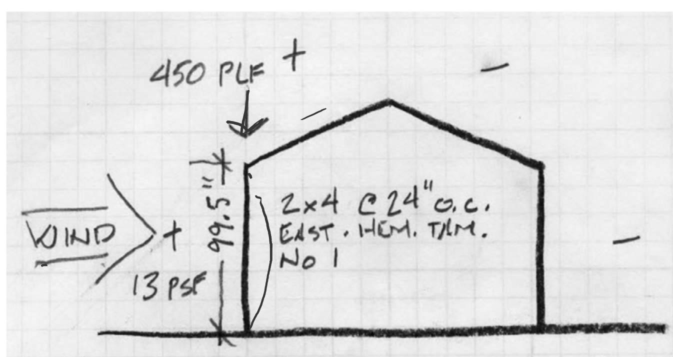
procedure

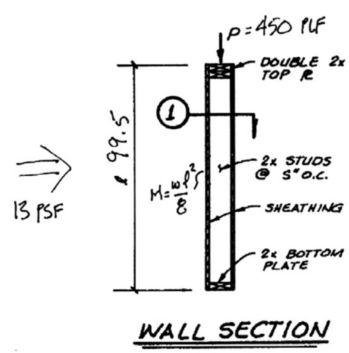
Exterior stud wall under bending + axial compression

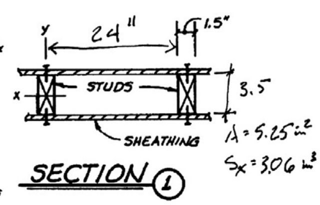
1. Determine load per stud
2. Use axial load and moment to find actual stresses $f_c$ and $f_b$
3. Determine load factors
4. Calculate factored stresses
5. Check NDS equations

NDS
COMPRESSION + FLEXURE

$$\left[\frac{f_c'}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-(f_c/F_{cE1})\right]} \le 1.0 \quad (3.9\text{-}3)$$




EASTERN HEMLOCK - TAMARACK
No 1

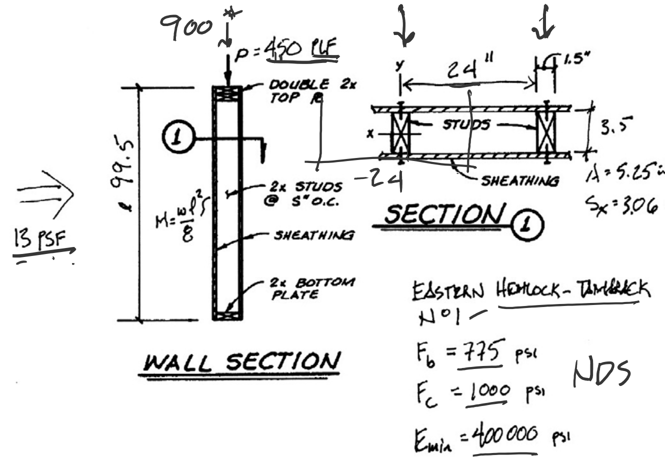
$F_b = 775$ psi

$F_c = 1000$ psi

$E_{min} = 400000$ psi

# Combined Stress in NDS
example

Exterior stud wall under
bending + axial compression




1. Determine load per stud

$P$ = LOAD/STUD

$P = 450 \text{ PLF } \frac{OC}{12} = 450 \frac{24}{12} = \boxed{900 \text{ LBS}}$

2. Use axial load and moment to find actual stresses fc and fb

$w = 13\text{PSF } \frac{OC}{12} = 13 \frac{24}{12} = 26 \text{ PLF/STUD}$

$M_x = \frac{wl^2}{8} = \frac{26\,(99.5''/12)^2}{8} = \boxed{223.4\ '\text{-}\#}$

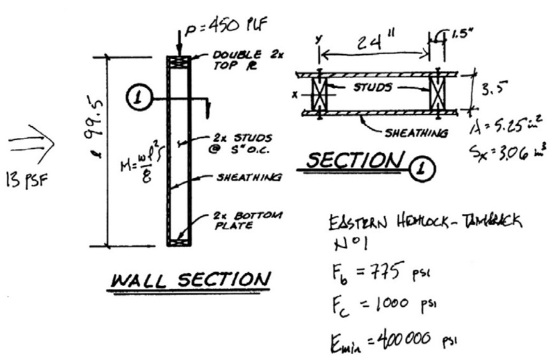
$f_c = \frac{P}{A} = \frac{900\#}{5.25 \text{ in}^2} = \boxed{171.43 \text{ PSI}}$

$f_b = M/S_x = \frac{223.4(12)''}{3.06 \text{ in}^3} = \boxed{875.5 \text{ psi}}$



# Combined Stress in NDS
example

Exterior stud wall under
bending + axial compression




**Size Factors, $C_F$**

| Grades | Width (depth) | $F_b$ Thickness (breadth) 2" & 3" | $F_b$ Thickness (breadth) 4" | $F_t$ | $F_c$ |
|---|---|---|---|---|---|
| Select Structural, No.1 & Btr, No.1, No.2, No.3 | 2", 3", & 4" | 1.5 | 1.5 | 1.5 | 1.15 |
| | 5" | 1.4 | 1.4 | 1.4 | 1.1 |
| | 6" | 1.3 | 1.3 | 1.3 | 1.1 |
| | 8" | 1.2 | 1.3 | 1.2 | 1.05 |
| | 10" | 1.1 | 1.2 | 1.1 | 1.0 |
| | 12" | 1.0 | 1.1 | 1.0 | 1.0 |
| | 14" & wider | 0.9 | 1.0 | 0.9 | 0.9 |
| Stud | 2", 3", & 4" | 1.1 | 1.1 | 1.1 | 1.05 |
| | 5" & 6" | 1.0 | 1.0 | 1.0 | 1.0 |
| | 8" & wider | Use No.3 | | | |
| Construction Standard | 2", 3", & 4" | 1.0 | 1.0 | 1.0 | 1.0 |
| Utility | 4" | 1.0 | 1.0 | 1.0 | 1.0 |
| | 2" & 3" | 0.4 | — | 0.4 | 0.6 |

NDS TABLE → $F_b = 775$ psi $F_c = 1000$ psi $E_{min} = 400\,000$ psi

3. Determine load factors (bending)

FACTORS :

$C_D = \boxed{1.6}$ (WIND)

$C_F = \boxed{1.5}$ ✓ (FOR $F_b$) $\boxed{1.15}$ (FOR $F_c$)

$- C_L = \boxed{1.0}$ (BRACED BY SHEATHING)

$C_r = \boxed{1.15}$ ($\leq 24''$ O.C.) ✓

# Combined Stress in NDS
example

Exterior stud wall under
bending + axial compression

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-\left(f_c/F_{cE1}\right)\right]}$$

$F_b = 775$ psi

$C_D = 1.6$ WIND $\quad C_F = 1.5$ 2x4

$\cancel{C_M = 1.0} \quad C_{fu} = 1.0$ ×

$\cancel{C_t = 1.0} \quad C_i = 1.0$ ×

$C_L = 1.0$ ✓ $\quad C_r = 1.15$ ✓

4. Calculate factored stresses
   (bending stress)

$$F_b' = 775(1.6)(1.5)(1.15) = \underline{2139 \text{ psi}}$$



# Combined Stress in NDS
example

Exterior stud wall under
bending + axial compression

$$C_P = \frac{1+\left(F_{cE}/F_c^*\right)}{2c} - \sqrt{\left[\frac{1+\left(F_{cE}/F_c^*\right)}{2c}\right]^2 - \frac{F_{cE}/F_c^*}{c}}$$

P = 900# D+W

99.5"
K = 1.0

$C_P$

$$F^* = 1000\underbrace{(1.6)}_{C_D}\underbrace{(1.15)}_{C_F} = \underline{1840}$$

Euler $\underline{F_{cE}} = \frac{0.822(400000)}{(99.5/3.5)^2} = \underline{406.8}$

$c = 0.8$

$C_p = 0.21$ ✓

3. Determine load factors
   (compression)

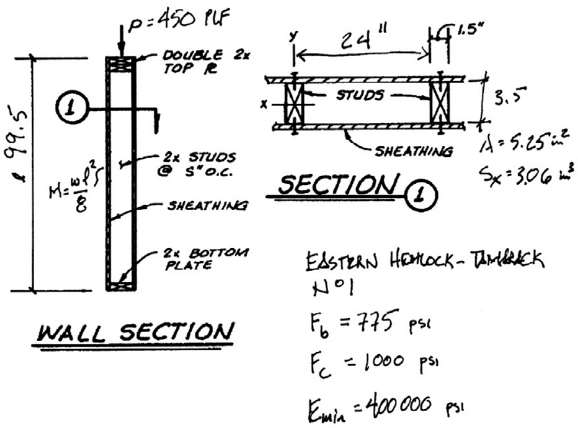
# Combined Stress in NDS
example

Exterior stud wall under
bending + axial compression

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-\left(f_c/F_{cE1}\right)\right]}$$

EULER

4. Calculate stresses
 (compression stress)




**Actual Stress**

$$f_c = \frac{P}{A} = \frac{900^*}{5.25} = 171.4 \text{ psi}$$

**Factored Allowable Stress**

$$F_c' = 1000\underset{C_D}{(1.6)}\underset{C_F}{(1.15)}\underset{C_P}{(0.21)} = 386.4 \text{ psi}$$



# Combined Stress in NDS
example

Exterior stud wall under
bending + axial compression

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'\left[1-\left(f_c/F_{cE1}\right)\right]} \le 1.0$$

COMP. + FLEXURE X-X

5. Combined Stress Calculation
 (eq. 3.9-3)

$$\left[\frac{f_c}{F_c'}\right]^2 + \frac{f_{b1}}{F_{b1}'}\ \frac{1}{1-\left(f_c/F_{cE1}\right)} \le 1.0$$

$$\left[\frac{171.4}{386.4}\right]^2 + \frac{876}{2139}\ \frac{1}{1-\left(171.4/406.8\right)}$$

$$0.1967 + (0.4095)(1.728) =$$

$$0.1967 + 0.7077 = 0.9045 \le 1.0 \checkmark \text{ok}$$