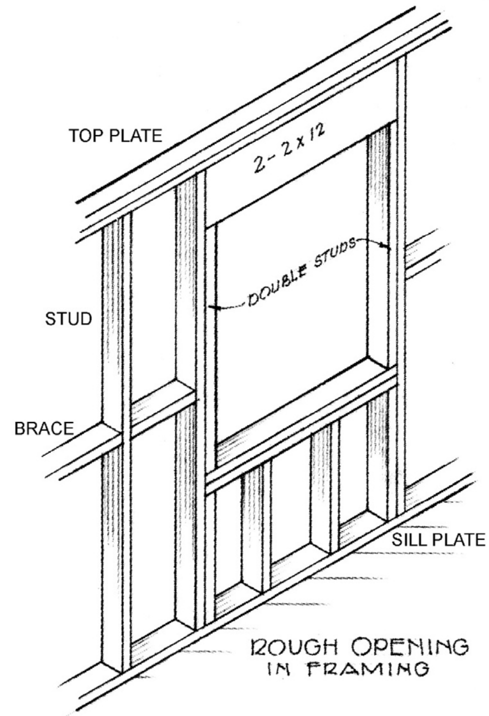
Architecture 544

Wood Columns

- Stud wall detailing
- Stud walls in compression



Wall Systems

Types:

- Exterior (WFCM 2.4.1)
- Interior Loadbearing (WFCM 2.4.2)
- Interior Non-Loadbearing (WFCM 2.4.3)

Figure 2.4d Vertical Wall Offset on I-Joist Floor Assembly

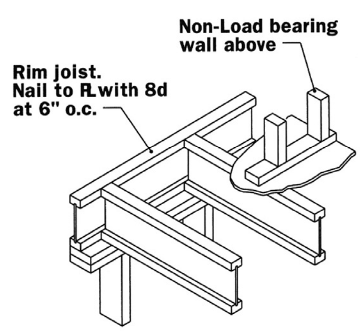
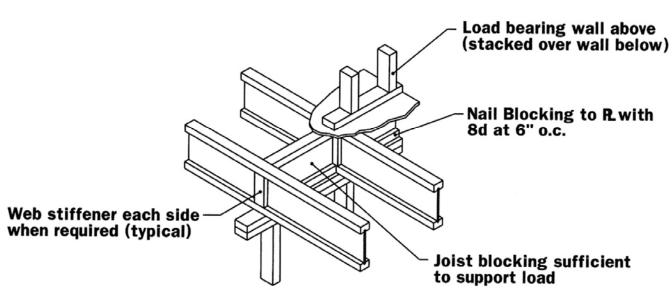


Figure 2.4c Continuous I-Joist Over a Bearing Wall Supporting a Wall Above

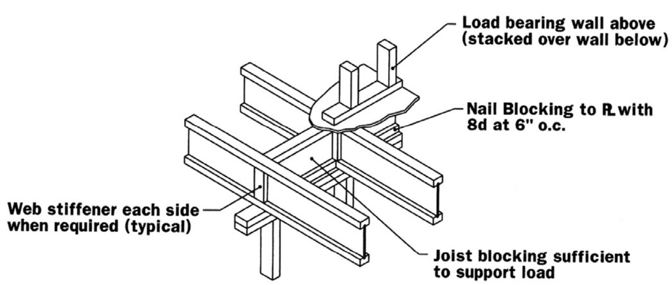


Wall Systems

Types:

- Exterior (WFCM 2.4.1)
- Interior Loadbearing (WFCM 2.4.2)
- Interior Non-Loadbearing (WFCM 2.4.3)

Figure 2.4c Continuous I-Joist Over a Bearing Wall Supporting a Wall Abo



2.4.2 Interior Loadbearing Partitions

2.4.2.1 Wood Studs

Interior loadbearing studs shall be in accordance with the requirements of Table 2.9C or Table 2.11 for gravity loads.

2.4.2.1.1 Notching and Boring Notches in either edge of studs shall not be located in the middle one-third of the stud length. Notches in the outer thirds of the stud length shall not exceed 25% of the actual stud depth. Bored holes in interior loadbearing studs shall not exceed 40% of the actual stud depth and shall not be closer than 5/8-inch to the edge. Notches and holes shall not occur in the same cross-section (see Figure 3.3b).

> **EXCEPTION:** Bored holes shall not exceed 60% of the actual stud depth when studs are doubled.

2.4.2.1.2 Stud Continuity Studs shall be continuous between horizontal supports, including but not limited to: girders, floor diaphragm assemblies, ceiling diaphragm assemblies, and roof diaphragm assemblies.

2.4.2.2 Top Plates

Interior loadbearing partition walls shall be capped with a single or double top plate with bearing capacity in accordance with Table 2.9C, and bending capacity in accordance with Table 2.11. Top plates shall be tied at joints, corners, and intersecting walls. Double top plates shall be lap spliced and overlap at corners and at intersections with other exterior and interior loadbearing walls.

2.4.2.3 Bottom Plate

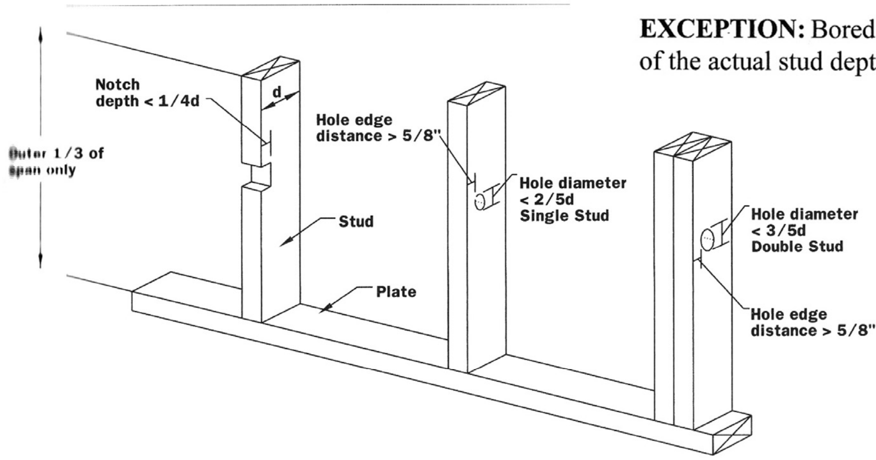
Wall studs shall bear on a bottom plate with bearing capacity in accordance with Table 2.9C. The bottom plate shall not be less than 2 inch nominal thickness and not less than the width of the wall studs. Studs shall have full bearing on the bottom plate.

Wall Systems

Types:

- Interior Loadbearing (WFCM 2.4.2)

Figure 3.3b Stud Notching and Boring Limits



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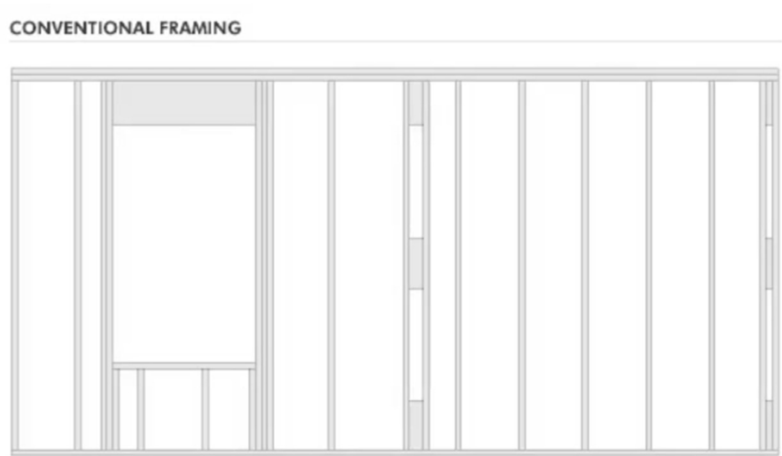
Stud Wall Systems – Matt Bangs

APA – Converntional vs Advanced Framing



CONVENTIONAL FRAMING	ADVANCED FRAMING
2x4 or 2x6 wood framing spaced 16 inches on center	2x6 wood framing spaced 24 inches on center
Double top plates	Single top plate
Three-stud corners	Two-stud corners
Multiple jack studs	Minimal jack studs
Double or triple headers	Single headers
Multiple cripple studs	Minimal cripple studs

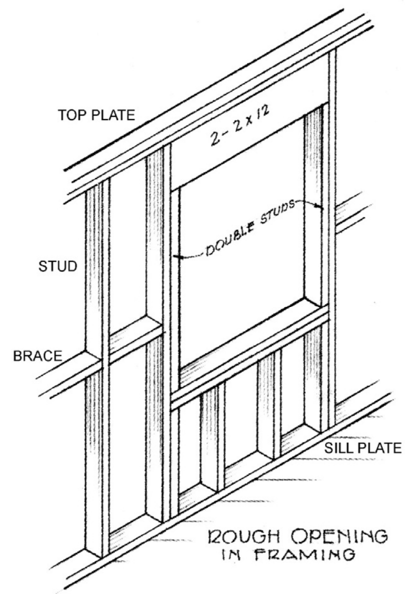
Stud Wall Analysis

Given:

- Lumber species, grade and size
- Conditions of use
- spacing

Required:

- Load Capacity



1. Lookup Fc, E_{min} in NDS Table 4A
2. Calculate slenderness ratio l_e/d
   largest ratio governs. Must be < 50
3. Find adjustment factors (all except C_P)
   C_D C_M C_t C_F C_i
4. Calculate C_P
5. Determine F'c by multiplying the tabulated Fc
   by all the above factors
6. Set actual stress = allowable: fc = F'c
7. Find the capacity of one stud: P_{stud} = fc A
8. Find the load on the wall for the given o.c. spacing
9. Check bearing

Stud Wall Analysis

Given:

- Lumber species, grade and size
- Conditions of use
- spacing

Required:

- Load Capacity

EXAMPLE 7.11 Capacity of a Stud Wall Using ASD

Determine the vertical load capacity of the stud shown in Fig. 7.13*a*. There is no bending. Express the maximum load in pounds per lineal foot of wall. Lumber is Standard-grade Hem-Fir. Load is (D + S). $C_M = 1.0$, $C_t = 1.0$, and $C_i = 1.0$.

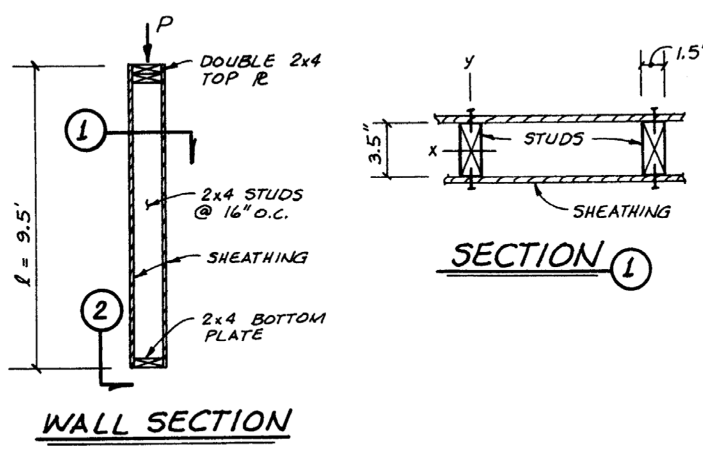


Figure 7.13a Sheathing provides lateral support about *y* axis of stud.

Stud Wall Analysis - Capacity

1. Lookup Fc, E_{min} in NDS Table 4A

NDS Supplement Table 4A:

$F_c = 1300$ psi

$E_{min} = 440{,}000$ psi

$l_{e_x} = 9.5'(12) = 114''$

$\frac{l_{ex}}{d} = \frac{114''}{3.5''} = 32.57 < 50$ ✓

2. Calculate slenderness ratio l_e/d. The largest ratio governs. Must be < 50
3. Find adjustment factors (all except C_P) C_D C_M C_t C_F C_i

$C_D = 1.15$ (SL)

$C_M = 1.0$

$C_t = 1.0$

$C_F = 1.0$

$C_i = 1.0$

$E'_{min} = E_{min} C_M C_t C_i = 440\,000$ psi

Stud Wall Analysis - Capacity

4. Calculate C_P

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

5. Determine F'c by multiplying the tabulated Fc by all the adjustment factors

$$F'_c = F_c(C_D)(C_M)(C_t)(C_F)(C_P)(C_i)$$

6. Set actual stress = allowable: fc = F'c
7. Find the capacity of one stud: P_{stud} = fc A
8. Find the load on the wall for the given o.c. spacing

C_P

$F_{cE} = \frac{0.822(440000)}{32.57^2} = 340.9$ psi

$F_c^* = 1300(1.15)(1.0)(1.0)(1.0)(1.0) = 1495$

$\frac{F_{cE}}{F_c^*} = \frac{340.9}{1495} = 0.228$

$\frac{1 + F_{cE}/F_c^*}{2c} = \frac{1 + 0.228}{2(0.8)} = 0.7675$

$C_P = 0.7675 - \sqrt{0.7675^2 - \frac{0.228}{0.8}}$
$= 0.216$

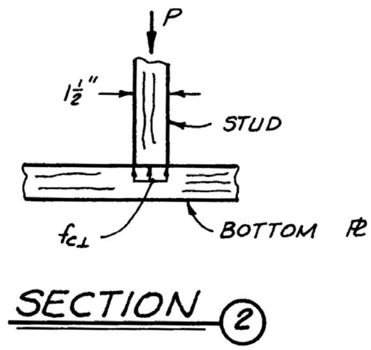
$F'_c = 1300(1.15)(0.216) = 323$ psi

$P_{STUD} = 323(5.25) = 1695$ #

$P_{WALL} = P_{STUD}\frac{12}{o.c.} = 1695\frac{12}{16} = 1271$ PLF

Stud Wall Analysis - Capacity

9. Check bearing.



$F_{c\perp} = 405$ psi

$F'_{c\perp} = F_{c\perp}(C_M)(C_t)(C_b)$
$= 405(1)(1)(1.25) = 506$ psi

$P_{STUD} = F'_c\ A = 506(5.25) = 2657^{\#}$

BEARING CAPACITY $= 2657^{\#} > 1695^{\#}$ ∴ OK ✓

Table 3.10.4 Bearing Area Factors, C_b

ℓ_b	0.5"	1"	1.5"	2"	3"	4"	6" or more
C_b	1.75	1.38	1.25	1.19	1.13	1.10	1.00

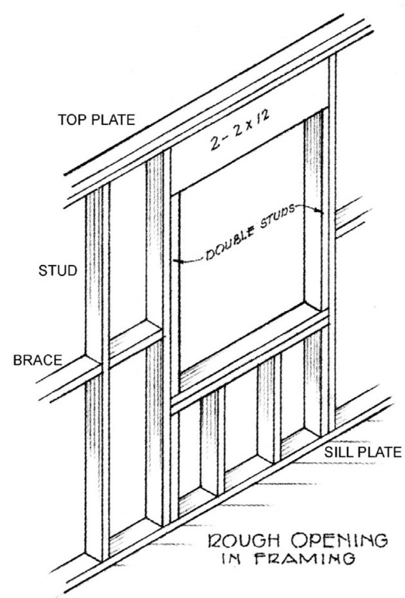
Stud Wall Design

Given:

- Lumber species, grade and size
- Conditions of use
- Load

Required:

- Stud spacing



1. Calculate slenderness ratio l_e/d largest ratio governs. Must be < 50
2. Find adjustment factors (all except C_P) C_D C_M C_t C_F C_i
3. Calculate C_P
4. Determine F'c by multiplying the tabulated Fc by all the above factors
5. Set actual stress = allowable: fc = F'c
6. Find the capacity of one stud: Pmax = F'c A
7. Find allowable capacity for given spacing (12", 16" or 24" o.c.)
8. Check bearing.

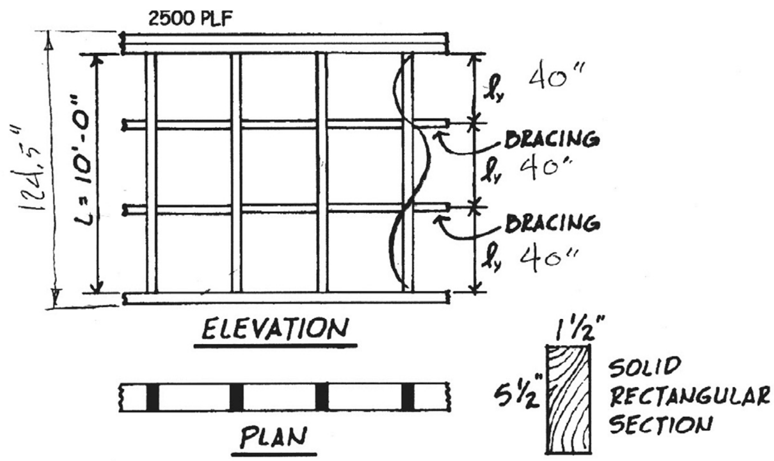
Stud Wall Example

Data:

- 2x6
- S-P-F, Stud   M.C. = 12%
- D+L Load = 2500 PLF
- Braced as shown K_e=1.0

Required:

- o.c. spacing



From NDS Supplement Table 4A

Fc = 725 psi

Emin = 440000 psi

C_D = 1.0 (LL)

C_{Mc} = 1.0 C_{ME} = 1.0

C_t = 1.0

C_F = 1.0 (stud grade)

C_i = 1.0

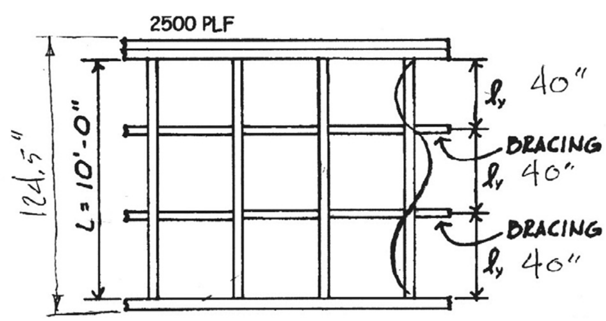
C_P = ?

Stud Wall Example

Data:

- 2x6
- S-P-F, Stud   M.C. = 12%
- D+L Load = 2500 PLF
- Braced as shown K_e=1.0

  C_F = 1.0 (stud grade)



Size Factors, C_F

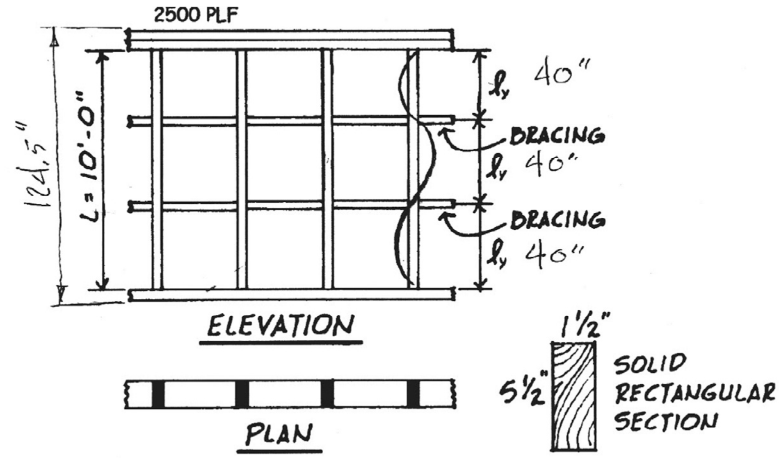
		F_b		F_t	F_c
		Thickness (breadth)			
Grades	Width (depth)	2" & 3"	4"		
Select Structural, No.1 & Btr, No.1, No.2, No.3	2", 3", & 4"	1.5	1.5	1.5	1.15
	5"	1.4	1.4	1.4	1.1
	6"	1.3	1.3	1.3	1.1
	8"	1.2	1.3	1.2	1.05
	10"	1.1	1.2	1.1	1.0
	12"	1.0	1.1	1.0	1.0
	14" & wider	0.9	1.0	0.9	0.9
Stud	2", 3", & 4"	1.1	1.1	1.1	1.05
	5" & 6"	1.0	1.0	1.0	1.0
	8" & wider	Use No.3 Grade tabulated design values and size factors			
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

Stud Wall Example

From NDS Supplement Table 4A

Fc = 725 psi

Emin = 440000 psi



X - X

$l_{e_x} = 124.5''$

$l_e/d = \frac{124.5}{5.5} = 22.6$ (124.5")

Y - Y

$l_{e_y} = 40''$

$l_e/d = \frac{40}{1.5} = 26.7$ (40")

CONTROLLING $l_e/d = 26.7$

Stud Wall Example

C_P

X - X

$l_{e_x} = 124.5''$

$l_e/d = \frac{124.5}{5.5} = 22.6$ (124.5")

Y - Y

$l_{e_y} = 40''$

$l_e/d = \frac{40}{1.5} = 26.7$ (40")

CONTROLLING $l_e/d = 26.7$

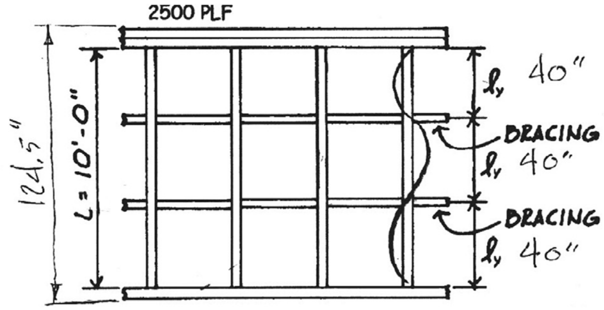
$$F_{cE} = \frac{0.822\,E_{min}'}{(l_e/d)^2} = \frac{0.822(440\,000)}{26.7^2} = 508.6$$

$$F_c^* = 725(1\times1\times1) = 725\text{ psi}$$

$$F_{cE}/F_c^* = \frac{508.6}{725} = 0.702$$

NDS eq. 3.7-1 $\rightarrow C_p = 0.559$

Stud Wall Example



Find max allowable stress, F'c

$$F'_c = 725\,(0.559) = 405.6 \text{ psi}$$

Calculate max load per stud

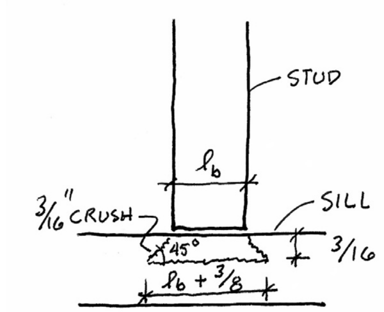
$$P = F'_c A = 405.6 \text{ psi} \times 8.25 \text{ in}^2 = 3345\ \#$$

Determine max stud spacing

$$\frac{2500 \text{ PLF}}{3345 \text{ LBS/STUD}} : \frac{12}{S} \qquad 16.06'' \qquad S = 16'' \text{ o.c. (ROUND DOWN)}$$

Stud Wall Example

Check bearing on sill plate



3.10.4 Bearing Area Factor, C_b

Reference compression design values perpendicular to grain, $F_{c\perp}$, apply to bearings of any length at the ends of a member, and to all bearings 6" or more in length at any other location. For bearings less than 6" in length and not nearer than 3" to the end of a member, the reference compression design value perpendicular to grain, $F_{c\perp}$, shall be permitted to be multiplied by the following bearing area factor, C_b:

$$C_b = \frac{\ell_b + 0.375}{\ell_b} \qquad (3.10\text{-}2)$$

where:

ℓ_b = bearing length measured parallel to grain, in.

Equation 3.10-2 gives the following bearing area factors, C_b, for the indicated bearing length on such small areas as plates and washers:

Table 3.10.4 Bearing Area Factors, C_b

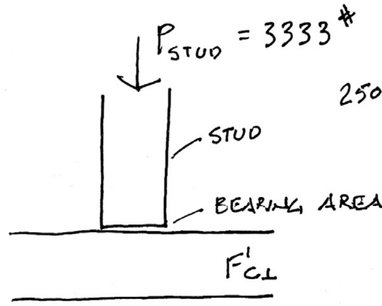
ℓ_b	0.5"	1"	1.5"	2"	3"	4"	6" or more
C_b	1.75	1.38	1.25	1.19	1.13	1.10	1.00

For round bearing areas such as washers, the bearing length, ℓ_b, shall be equal to the diameter.

Stud Wall Example

Check bearing on sill plate

- determine Cb
- calculate $F'_{c\perp}$
- calculate $f_{c\perp}$
- check stress



$2500\,PLF \; \frac{16''}{12} = 3333\,LB$

$b = 1.5''$

$C_b = 1.25$

$F_{c\perp} = 425\,psi \qquad F'_{c\perp} = 425(1.25) = 531\,psi$

$f_{c\perp} = \frac{P}{A} = \frac{3333^{\#}}{8.25\,in^2} = 404\,psi$

$f_{c\perp} = 404 < 531 = F'_{c\perp}$ ✓OK