Version: 3.1

Posts/Studs Analysis and Design

wwpa.org

ASD Method

How to Enter Data

Designed on: September 21, 2016

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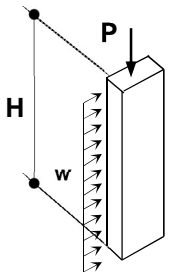
Developed by: **Forum Engineers**

Member # Typical Wall Stud
Location : North Wall
Sits on Sill Plate ? No | Yes

	** Dimension Lumber **			** Dimension Lumber **		
Nominal Size :	(1) 2	x	6	Sill Plate Nominal Size :	2	x 6
Species =	Douglas Fir-Larch			Species or Symbol =	Douglas Fir-Larch	
Grade =	No.2			Grade =	No.2	

Bearing at < 3" of Sill End? No

Height (H) = 10 ft - 0 in
Unbraced Length (l_1) = 10 ft - 0 in
Unbraced Length (l_2) = 1 ft - 0 in



P = **2400** lb = DL + SL
w = **40.0** plf = Wind
lu = 10 ft - 0 in

Setup (pressed-down buttons are selected)

Repetitive Use ?	No	Yes	
Incised for PT ?	No	Yes	
Flat Use :	No	Yes	
Moisture Content :	<19%	>19%	
Temperature (° F) :	<100	100~125	125~150

Why is this 0.65 fb? to check interaction against 1 instead of 1.33 allowable increase?

Set Duration Factors	C_D = 1.15 (P) & 1.60 (P+w)	for P only, **fc** (psi) =	291	< 781	= **Fc -|**
Set Effective-Length Factor	K = 1.00	for P + w, **fc** (psi) =	291	< 781	= **Fc -|**
Set Deflection Limit	Δ / H = 240	**(1.3/2) fb** (psi) =	516	< 871	= **Fb**
		$(fc / F'c)^2 + fb / [F'b (1 - fc / Fce)]$ =	0.94	< 1.00	**OK**
		Mid-H Deflection due to w, Δ (inch) =	0.19	< H / 240	**OK**

I can not reproduce this value

Section Properties

	Post/Stud		Sill PL
breadth (b) =	1.5	in	1.5
depth (d) =	5.5	in	5.5
Area (A) =	8.3	in^2	8.3
Section Modulus (S) =	7.6	in^3	
Moment of Inertial (I) =	20.8	in^4	

Adjustment Factors

		Bending	Comp //	E	Comp -| (Sill PL)
Wet Service	C_M =	1.00	1.00	1.00	1.00
Temperature	C_t =	1.00	1.00	1.00	1.00
Beam Stability	C_L =	0.56	N/A	N/A	N/A
Size	C_F =	1.30	1.10	N/A	N/A
Flat Use	C_{fu} =	1.00	N/A	N/A	N/A
Incising	C_i =	1.00	1.00	1.00	1.00
Repetitive Member	C_r =	1.15	N/A	N/A	N/A
Column Stability (P)	C_P =	N/A	0.49	N/A	N/A
Column Stability (P+w)	C_{Pw} =	N/A	0.38	N/A	N/A
Bearing Area	C_b =	N/A	N/A	N/A	1.25

Design Values (psi)

	Fb	Fc //	E	Fc -| (Sill PL)	Emin
Reference	900	1350	1600000	625	580000
Adjusted (P)		839	1600000	781	580000
Adjusted (P+w)	871	894	1600000	781	580000

Product of factors *Fb is 866 psi

These verify by my calcs

BEARING WALL STUDS WITH AXIAL & BENDING

Section Properties: $n := 3$ number of plates

$b := 1.5\ in$ $d := 5.50\ in$ $l := 10\ ft + 4.50\ in$ $t_{pl} := 1.5\ in$

$l_y := 1\ ft + 0\ in$ $l_x := l - n \cdot t_{pl} = 120\ in$ $l_b := 10\ ft + 0\ in$

$K_{ey} := 1.0$ $K_{ex} := 1.0$ $l_u := l_y$

$A := b \cdot d = 8.25\ in^2$ $S_x := b \cdot \frac{d^2}{6} = 7.5625\ in^3$ $I_x := b \cdot \frac{d^3}{12} = 20.7969\ in^4$

Wall Stud Spacing $s := 24\ in$

Axial Force $DL := 600\ \frac{lbf}{ft}$ $LL := 600\ \frac{lbf}{ft}$

$P := s \cdot (DL + LL) = 2400\ lbf$

Lateral Forces: $w_{wall} := 20\ \frac{lbf}{ft^2}$ $w := w_{wall} \cdot s = 40\ \frac{lbf}{ft}$

Wood Species and Properties, 2012 NDS:

Doug-Fir No 2

$F_b := 900\ psi$ $F_{Cperp} := 625\ psi$ $F_{cll} := 1350\ psi$ $E_{min} := 580000\ psi$ $E := 1.6 \cdot 10^6\ psi$

Applicable Adjustment Factors:

$C_{DPsnow} := 1.15$ $C_M := 1.0$ $C_t := 1.0$ $C_L := 1.0$ $C_{Fc} := 1.10$ $C_i := 1.0$

$C_{fu} := 1.0$ $C_T := 1.0$ $C_p := 1.0$ (C.p recalced below)

Determine capacity due to column equation:

$$LED := \max\left(\begin{bmatrix} \frac{K_{ey} \cdot l_y}{b} \\ \frac{K_{ex} \cdot l_x}{d} \end{bmatrix}\right) = 21.8$$

$\frac{K_{ey} \cdot l_y}{b} = 8$ $\frac{K_{ex} \cdot l_x}{d} = 21.8182$

$E`_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_T \cdot C_i = 580000\ psi$

$E' := E \cdot C_M \cdot C_t \cdot C_t = 1.6 \cdot 10^6\ psi$ $E = 1.6 \cdot 10^6\ psi$

$c := 0.8$ for visually graded sawn lumber

$F_{cE} := \frac{0.822 \cdot E`_{min}}{LED^2} = 1001.5\ psi$ $F_{cE} = 1002\ psi$

$F_{cSTAR} := F_{cll} \cdot C_{DPsnow} \cdot C_M \cdot C_t \cdot C_{Fc} \cdot C_i = 1707.75\,psi$ $\quad F_{cSTAR} = 1707.75\,psi$

Calculate Cp (column stability factor):

$$C_p := \frac{1+\frac{F_{cE}}{F_{cSTAR}}}{2\cdot c} - \sqrt{\left(\frac{1+\frac{F_{cE}}{F_{cSTAR}}}{2\cdot c}\right)^2 - \frac{\frac{F_{cE}}{F_{cSTAR}}}{c}} = 0.4915$$

These check against WWPA ok

$C_p = 0.4915$

$F`_c := F_{cll} \cdot C_{DPsnow} \cdot C_M \cdot C_t \cdot C_{Fc} \cdot C_p \cdot C_i = 839\,psi$ $\quad F`_c = 839\,psi$

$f_c := \frac{P}{A} = 291\,psi$

if $f_c \le F`_c$ = "AXIAL CHECK OK"
  "AXIAL CHECK OK"
else
  "AXIAL CHECK NG"

$P_a := F`_c \cdot A = 6924\,lbf$ $\quad P_a = 6924\,lbf$

Maximum Wall Loading $\quad w_{max} := \frac{P_a}{s} = 3462\,\frac{lbf}{ft}$ $\quad w_{max} = 3462\,\frac{lbf}{ft}$

Bearing Capacity Check of bottom plate

$F_{Cpl} := 625\,psi$ Compression Capacity of Wall Plate

$C_b := \frac{b + 0.375\,in}{b} = 1.25$ $\quad C_b = 1.25$

$F`_{Cpl} := F_{Cpl} \cdot C_M \cdot C_t \cdot C_b = 781\,psi$ $\quad F`_{Cpl} = 781\,psi$

if $F`_{Cpl} \ge f_c$ = "BEARING CHECK OK"
  "BEARING CHECK OK"
else
  "BEARING NO GOOD"

Capacity with Bending

$C_{DWind} := 1.6$ $C_{Fc} = 1.1$ $C_{Fb} := 1.3$ $C_D := \min\left(\begin{bmatrix} C_{DPsnow} \\ C_{DWind} \end{bmatrix}\right) = 1.15$ $C_r := 1.150$

$M_{col} := \frac{w \cdot l_b^2}{8} = 6000\ lbf\ in$ $f_{bx} := \frac{M_{col}}{S_x} = 793\ psi$ $f_{bx} = 793\ psi$

$F_{cE} = 1002\ psi$ $C_D = 1.15$ $C_M = 1$ $C_t = 1$ $C_{Fc} = 1.1$ $C_i = 1$

$F_{cSTAR} := F_{cll} \cdot C_{DWind} \cdot C_M \cdot C_t \cdot C_{Fc} \cdot C_i = 2376\ psi$ $F_{cSTAR} = 2376\ psi$

$\frac{F_{cE}}{F_{cSTAR}} = 0.4215$ $\frac{1 + \frac{F_{cE}}{F_{cSTAR}}}{2 \cdot c} = 0.8884$

$C_{pw} := \frac{1 + \frac{F_{cE}}{F_{cSTAR}}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE}}{F_{cSTAR}}}{2 \cdot c}\right)^2 - \frac{\frac{F_{cE}}{F_{cSTAR}}}{c}} = 0.3762$ $C_{pw} = 0.3762$

$F_{cll} = 1350\ psi$

$F`_c := F_{cll} \cdot C_{DWind} \cdot C_M \cdot C_t \cdot C_{Fc} \cdot C_{pw} \cdot C_i = 894\ psi$

$l_u := 120\ in$

if $\frac{l_u}{d} < 7$ $= 212.1\ in$ $l_e = 212.1\ in$ $F_b = 900\ psi$

$l_e := 2.06 \cdot l_u$

else

$l_e := 1.63 \cdot l_u + 3 \cdot d$

$R_B := \sqrt{\frac{l_e \cdot d}{b^2}} = 22.7699$ $F_{bE} := \frac{1.2 \cdot E`_{min}}{R_B^2} = 1342\ psi$

$C_L = 1$ $F_b = 900\ psi$ $C_D = 1.15$ $C_r = 1.15$ $C_{Fb} = 1.3$

$F`_{bx} := C_L \cdot F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fb} \cdot C_r \cdot C_L = 1547.325\ psi$

$C_L := \frac{1 + \frac{F_{bE}}{F`_{bx}}}{1.9} - \sqrt{\left(\frac{1 + \frac{F_{bE}}{F`_{bx}}}{1.9}\right)^2 - \frac{\frac{F_{bE}}{F`_{bx}}}{0.95}} = 0.7529$

This value in the WWPA spreadsheet is 0.49

$F`_{bx} := C_L \cdot F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fb} \cdot C_r \cdot C_L = 877\ psi$

This value is expressed as 0.65fb in the WWPA spreadsheet

CHECK INTERACTION OF BENDING AND AXIAL

$f_c = 291\ psi$

$f_{bx} = 793\ psi$

$F`_c = 894\ psi$

$F`_{bx} = 877\ psi$

This value is 871 in the WWPA spreadsheet.

$F_{cE} = 1002\ psi$

These check

$\left(\frac{f_c}{F`_c}\right) = 0.3255$

$\frac{1}{1 - \frac{f_c}{F_{cE}}} = 1.4094$

$\frac{f_{bx}}{F`_{bx}} = 0.9046$

$IE := \left(\frac{f_c}{F`_c}\right)^2 + \frac{f_{bx}}{F`_{bx} \cdot \left(1 - \frac{f_c}{F_{cE}}\right)} = 1.3808$

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if 1.0 ≥ IE                 = "INTERACTION NOT GOOD"
  "INTERACTION CHECK OK"
else
  "INTERACTION NOT GOOD"
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I am OVER by this check!