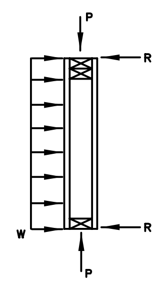
EXAMPLE 5.6 *Exterior Bearing Wall Design*

Given

Stud size and spacing	=	2x4 at 24 in on center
Wall height	=	8 ft
Species and grade	=	Spruce-Pine-Fir, Stud Grade
Exterior surface	=	7/16-in-thick OSB
Interior surface	=	1/2-in-thick, gypsum wall board
Wind load (100 mph, gust)	=	16 psf (see Chapter 3, Example 3.2)

Find Vertical load capacity of stud wall system for bending (wind) and axial compression (dead load) and for axial compression only (i.e., dead, live, and snow loads); refer to Chapter 3, Table 3.1, for applicable load combinations.



Wall Loading Diagram

Solution

1. Determine tabulated design values for the stud by using the NDS-S (Table A4)

F_b = 675 psi $F_{c\perp}$ = 425 psi
F_t = 350 psi F_c = 725 psi
F_v = 70 psi E = $1.2x10^6$ psi

2. Determine lumber property adjustments (see Section 5.2.4)

C_D = 1.6 (wind load combination)
= 1.25 (gravity/snow load combination)
C_r = 1.5 (sheathed wall assembly, Table 5.4)
C_L = 1.0 (continuous lateral bracing)
C_F = 1.05 for F_c
= 1.1 for F_t
= 1.1 for F_b

3. Calculate adjusted tensile capacity

Not applicable to this design. Tension capacity is OK by inspection.

4. Calculate adjusted bending capacity

$F_b' = F_bC_DC_LC_FC_r = (675)(1.6)(1.0)(1.1)(1.5) = 1{,}782 \text{ psi}$

5. Calculate adjusted compressive capacity (NDS•3.7)

$F_c^* = F_cC_DC_F = (725 \text{ psi})(1.6)(1.05) = 1{,}218 \text{ psi}$

$E' = E = 1.2\text{x}10^6 \text{ psi}$

$K_{cE} = 0.3$ visually graded lumber

$c = 0.8$ sawn lumber

$$F_{cE} = \frac{K_{cE}E'}{\left(l_e/d\right)^2} = \frac{0.3(1.2 \text{ x } 10^6 \text{ psi})}{\left[8 \text{ ft}(12 \text{ in/ft})/3.5 \text{ in}\right]^2} = 479 \text{ psi}$$

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

$$= \frac{1+\left(479/1{,}218\right)}{2(0.8)} - \sqrt{\left[\frac{1+\left(479/1{,}218\right)}{2(0.8)}\right]^2 - \frac{479/1{,}218}{0.8}} = 0.35$$

$F_c' = F_cC_DC_FC_P = (725 \text{ psi})(1.6)(1.05)(0.35) = 426 \text{ psi}$

Axial load only case

Calculations are same as above except use $C_D = 1.25$

$F_c^* = 952 \text{ psi}$

$C_p = 0.44$

$F_c' = F_cC_DC_FC_P = 725 \text{ psi } (1.25)(1.05)(0.44) = 419 \text{ psi}$

6. Calculate combined bending and axial compression capacity for wind and gravity load (dead only) by using the combined stress interaction (CSI) equation (NDS•3.9.2):

$$f_b = \frac{M}{S} = \frac{\frac{1}{8}w\ell^2}{S}$$

$$= \frac{\frac{1}{8}(24 \text{ in})(16 \text{ psf})\left[(8 \text{ ft})(12 \text{ in/ft})\right]^2(1 \text{ ft}/12 \text{ in})}{3.06 \text{ in}^3}$$

$= 1{,}004 \text{ psi}$

$$\left(\frac{f_c}{F_c'}\right)^2 + \frac{f_b}{F_b'\left[1-f_c/F_{cE1}\right]} \leq 1.0$$ (CSI equation for bending in strong axis of stud only)

$$\left(\frac{f_c}{426}\right)^2 + \frac{1{,}004}{1{,}782\left(1-f_c/479\right)} = 1.0$$ (solve CSI equation for f_c)