6. Check for adequate bearing

$R_1 = R_2 = V_{max} = 1{,}950 \text{ lb}$

$$f_{c\perp} = \frac{R}{A_b} = \frac{1{,}950 \text{ lb}}{(2)(1.5 \text{ in})(\ell_b)} = \frac{650}{\ell_b}$$

$f_{c\perp} \leq F_{c\perp}'$

$$\frac{650}{\ell_b} = 335$$

$\ell_b = 1.9 \text{ in}$ OK for bearing, use 2-2x4 jack studs ($\ell_b = 3$ in)

7. Check deflection

$$\rho_{max} = \frac{5w\ell^4}{384EI} = \frac{5(600 \text{ plf})(6.5 \text{ ft})^4(1{,}728 \text{ in}^3/\text{ft}^3)}{384(1.1\text{x}10^6 \text{ psi})[(98.9 \text{ in}^4)(2)]} = 0.11 \text{ in}$$

$$\rho_{all} = L/240 \quad \frac{(6.5 \text{ ft})(12 \text{ in/ft})}{240} = 0.325 \text{ in}$$

$\rho_{max} < \rho_{all}$

Conclusion

Using a system-based header design approach, a 2-2x10 header of No. 2 Spruce-Pine-Fir is found to be adequate for the 6 ft-3 in span opening. The loading condition is common to the first story of a typical two-story residential building. Using a stronger species or grade of lumber would allow the use of a 2-2x8 header. Depending on the application and potential savings, it may be more cost-effective to use the header tables found in a typical residential building code. For cost-effective ideas and concepts that allow for reduced header loads and sizes, refer to *Cost Effective Home Building: A Design and Construction Handbook* (NAHBRC, 1994). The document also contains convenient header span tables. For headers that are not part of a floor-band joist system, the design approach of this example is still relevant and similar to that used for floor girders. However, the 1.8 system factor used here would not apply, and the double top plate factor would apply only as appropriate.

EXAMPLE 5.8 *Column Design*

Given

Basement column supporting a floor girder
Spruce-Pine-Fir, No. 2 Grade
Axial design load is 4,800 lbs (D + L)
Column height is 7.3 ft (unsupported)

Find Adequacy of a 4x4 solid column

Solution

1. Determine tabulated design values by using the NDS-S (Table 4A)

F_c = 1,150 psi
E = $1.4 x 10^6$ psi

2. Lumber property adjustments (Section 5.2.4):

C_D = 1.0
C_F = 1.15 for F_c

3. Calculate adjusted compressive capacity (NDS•3.7):

Trial 4x4

F_c^* = $F_cC_DC_F$ = 1,150 psi (1.0)(1.15) = 1,323 psi
E' = E = $1.4 x 10^6$ psi
K_{cE} = 0.3 for visually graded
c = 0.8 for sawn lumber

$$F_{cE} = \frac{K_{cE}E'}{\left(\ell_e / d\right)^2} = \frac{0.3(1.4 \times 10^6 \text{ psi})}{\left(7.3 \text{ ft}(12 \text{ in/ft}) / 3.5 \text{ in}\right)^2} = 670 \text{ psi}$$

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

$$= \frac{1+\left(670/1{,}323\right)}{2(0.8)} - \sqrt{\left[\frac{1+\left(670/1{,}323\right)}{2(0.8)}\right]^2 - \frac{670/1{,}323}{0.8}} = 0.44$$

F_c' = $F_cC_DC_FC_p$ = (1,150 psi)(1.0)(1.15)(0.44) = 582 psi
P_{all} = F'_cA = (582 psi)(3.5 in)(3.5 in) = 7,129 lb > 4,800 lb
OK