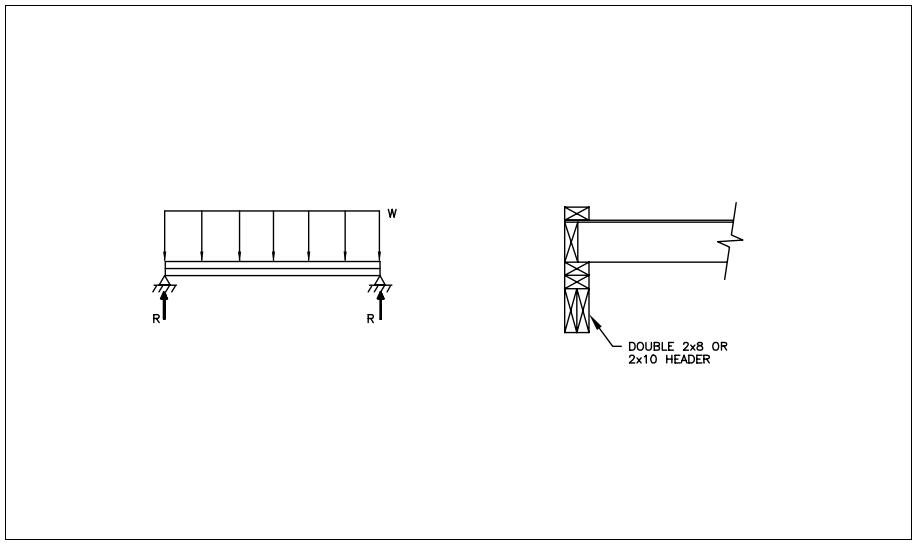
EXAMPLE 5.7 Header System Design

Given

Two-story house

Required header span = 6.3 ft (rough opening)
Species and grade = Spruce-Pine-Fir (south), No. 2
Loads on first-story header
w_{floor} = 600 plf (includes floor dead and live loads)
w_{wall} = 360 plf (includes dead, live, and snow loads supported by wall above header)*
w_{total} = 960 plf (includes dead, live, and snow loads)*
*Combined loads are determined in accordance with Table 3.1 of Chapter 3.

Find Determine header size (2x8 or 2x10) by considering system effect of all horizontal members spanning the opening.



Header System

Solution

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

F_b = 775 psi
F_v = 70 psi
$F_{c\perp}$ = 335 psi
E = 1.1×10^6 psi

2. Determine lumber property adjustments (Section 5.2.4)

C_r = 1.3 (2x10 double header per Table 5.8)
= 1.2 (2x8 double header per Table 5.4)
C_D = 1.25 (snow load)
C_F = 1.1 (2x10)
= 1.2 (2x8)
C_H = 2.0
C_b = 1.0
C_L = 1.0 laterally supported

$F_b' = F_b C_D C_r C_F C_L = (775\ psi)(1.25)(1.3)(1.1)(1.0) = 1{,}385\ psi$ [2x10]
$= (775\ psi)(1.25)(1.2)(1.1)(1.0) = 1{,}279\ psi$ [2x8]
$F_v' = F_v C_D C_H = (70\ psi)(1.25)(2) = 175\ psi$
$F_{c\perp}' = F_{c\perp} C_b = (335 psi)(1) = 335\ psi$
$E' = E = 1.1x10^6\ psi$

With double top plate, F_b can be increased by 5 percent (Table 5.8)

$F_b' = F_b'(1.05) = 1{,}385\ psi\ (1.05) = 1{,}454\ psi$ [2x10]
$F_b' = F_b'(1.05) = 1{,}279\ psi\ (1.05) = 1{,}343\ psi$ [2x8]

3. Determine header size due to bending for floor load only

$$M_{max} = \frac{w\ell^2}{8} = \frac{(600\ plf)(6.5\ ft)^2}{8} = 3{,}169\ ft\text{-}lb$$

$$f_b = \frac{M_{max}}{S} \leq F_b'$$

$$1{,}454\ psi = \frac{3{,}169\ ft-lb\ (12\ in/ft)}{S}$$

$S = 26.2\ in^3$
S for 2 2x10 $= 2(21.39\ in^3) = 42.78\ in^3 > 26.2\ in^3$ (OK)

Try 2 2x8s

$$1{,}343\ psi = \frac{3{,}169\ ft-lb\ (12\ in/ft)}{S}$$

$S = 28.3\ in^3$
S for 2 2x8 $= 2\ (13.14) = 26.3\ in^3 < 28.3\ in^3$ (close, but no good)

4. Determine member size due to bending for combined floor and supported wall loads by using the 1.8 system factor from Table 5.8, but not explicitly calculating the load sharing with the band joist above.

$F_b' = F_b\ (C_D)(C_r)(C_F)(C_L) = 775\ psi\ (1.25)(1.8)(1.1)(1.0) = 1{,}918\ psi$

$$M_{max} = \frac{w\ell^2}{8} = \frac{(360\ plf + 600\ plf)(6.5\ ft)^2}{8} = 5{,}070\ ft\text{-}lb$$

$$f_b = M/S \leq F_b'$$

$$1{,}918\ psi = \frac{5{,}070\ ft-lb\ (12\ in/ft)}{S}$$

$S = 31.7\ in^3$
S for 2-2x10 $= 42.78\ in^3 > 31.7\ in^3$ (OK)

5. Check horizontal shear

$$V_{max} = \frac{w\ell}{2} = \frac{(600\ plf)(6.5)}{2} = 1{,}950\ lb$$

$$f_v = \frac{3V}{2A} = \frac{3(1{,}950\ lb)}{2(2)(1.5\ in)(9.25\ in)} = 106\ psi$$

$f_v \leq F_v'$

$106\ psi < 175\ psi$ (OK)