

Exterior Wall
14'-0"

Steel F_y	50 ksi	
Steel Modulus of Elasticity	29500	
Section Height	14 feet	168 inches
Studs X inches O.C.	12 in	1 feet
Wind Pressure	33.7 psf	
Axial Pressure Live Load	0 psf	
Axial Pressure Dead Load	6 psf	
Studs X inches O.C.	12 in	1 feet
Width of Hole in Studds	1.5 in	

Member Selection	600S250-54
Area gross	0.670 in ²
t	0.0566 in
I_x	3.820
S_x	1.270
r_x	2.390
V_n	4.520
F_{ya}	50.0
M_{nxo}	53.4
S_e	1.070
I_e	3.760
P_n at $f=F_y$	19.3

Given & Assumptions:

1. Steel $F_y = 50$ Modulus of Elasticity: 29500
2. Section simply supported at ends
3. Section fully braced against lateral-torsional, flexural-torsional and distortional buckling.
 $K_x = 1.0$; Height (L_x): 14 ft ; Contributory Width: 1 ft
 Wind Pressure: 33.7 psf
 Contributory Pressure: 33.7 p/lf or 0.0337 k/lf

Required:

Verify combined bending and compression strength of the section using ASD and LRFD methods with ASCE/SEC 7-05 load combinations.

Solution:

Calculate preliminary data for choosing member

$$\text{Max Wind deflection } \delta = \frac{L_x^4}{240} = 0.700 \text{ in}$$

$$I_{\text{minimum}} = \frac{(5 \cdot w \cdot L^4 \cdot 1728)}{(384 \cdot E \cdot \delta)} = 1.41 \text{ in}^4$$

ASD Contributory Pressure: 0.0337 k/lf
 LRFD Contributory Pressure 1.6W: 0.0539 k/lf

$$\text{Max}_{\text{moment}} = \frac{(w \cdot L^2)}{8} = 1.321 \text{ ft-k}$$

$$S_{\text{required}} = \frac{(M_{\text{max}})}{(0.9 \cdot F_y)} = 0.352 \text{ in}^3$$

Select Member using I_{minimum} and the S_{required} from above.

Member Selection: 600S250-54

Area _{gross}	0.67 in ²
I_x	3.82 in ⁴
S_x	1.27 in ³
r_x	2.39 in

$$M_n = S_e * F_y \quad 53.50 \text{ in-k}$$

Nominal axial strength, P_n (Section C4.1)

$$F_e = \frac{\pi^2 * E}{(K * L_x / r_x)^2} \quad 58.92 \text{ ksi}$$

$$\lambda_c = \sqrt{(F_y / F_e)} \quad 0.9212 < 1.5$$

$$F_n = 0.658 \lambda_c^2 * F_y \quad 35.053 \text{ ksi}$$

$$A_e = A_g - \text{hole} \quad 0.585 \text{ in}^2 \quad \text{Effective Area}$$

$$P_n = A_e * F_n \quad 20.51 \text{ k}$$

Required Strength

$$M = \frac{(wL^2)}{4}$$

$$M_{\text{dead}} \quad 31.705 \text{ in-k}$$

$$M_{\text{live}} \quad 0 \text{ in-k}$$

ASD

$$M_x = M_{\text{dead}} + M_{\text{live}} \quad 31.705 \text{ in-k}$$

$$P = P_{\text{dead}} + P_{\text{live}} \quad 0.084 \text{ k}$$

LRFD

$$M_{\text{ux}} = 1.2 M_{\text{dead}} + 1.6 M_{\text{live}} \quad 38.05 \text{ in-k}$$

$$P_u = 1.2 P_{\text{dead}} + 1.6 P_{\text{live}} \quad 0.101 \text{ k}$$

Combined compression and bending – ASD (Section C5.2.1)

$$\frac{(\Omega_c P)}{P_n} = 0.0074$$

$$C_{\text{mx}} = 1$$

$$P_{E_x} = \frac{(\pi^2 \cdot E \cdot I)}{(K_x \cdot L_x)^2} = 39.406 \text{ k}$$

$$\alpha_x = 1 - \frac{(\Omega_c P)}{(P_{E_x})} > 0 \quad 1.00$$

$$M_y = 0.0$$

$$\frac{(\Omega_c P)}{P_n} + \frac{(\Omega_b C_{m_x} M_x)}{(M_{n_x} \alpha_x)} + \frac{(\Omega_b C_{m_y} M_y)}{(M_{n_y} \alpha_y)} < 1.0 \quad 1 \text{ Out of Limits}$$

$$(\Omega_c P) \dots (\Omega_b M_x) \dots (\Omega_b M_y) \dots \quad 1 \text{ Within Limits}$$

$$\frac{P_u}{\phi P_n} + \frac{M_{ux}}{\phi M_{nx}} + \frac{M_{uy}}{\phi M_{ny}} < 1.0$$

Combined compression and bending – LRFD (Section C5.2.2)

$$P^- = P_u \quad 0.101 \text{ k}$$

$$M^-_x = M_{ux} = \quad 38.05 \text{ in-k}$$

$$\frac{P^-}{\phi_c P_n} = \quad > 0.15 \text{ therefore use Equations C5.2.2-0.01 1 and C5.2.2-2}$$

$$C_{mx} = \quad 1.0$$

$$P_{Ex} = \quad 39.406 \text{ k}$$

$$\alpha_x = 1 - \frac{P^-}{P_{Ex}} > 0 \quad 0.997$$

$$M_y = 0.0$$

$$\frac{P^-}{\phi_c P_n} + \frac{(C_{mx} M^-_x)}{(\phi_b M_{nx} \alpha_x)} + \frac{(C_{my} M^-_y)}{(\phi_b M_{ny} \alpha_y)} < 1.0 \quad 0.798 \text{ Within Limits}$$

$$\frac{P^-}{\phi_c P_{no}} + \frac{(M^-_x)}{(\phi_b M_{nx})} + \frac{(M^-_y)}{(\phi_b M_{ny})} < 1.0 \quad 0.796 \text{ Within Limits}$$