

Simply Supported Steel Beam Design (LRFD) v7.1.1 (9-25-13)

PROJECT

Material Properties and Loading

|                                 |              |       |            |              |
|---------------------------------|--------------|-------|------------|--------------|
| Beam span =                     | Cantilever   | Span  | Cantilever | Total Length |
|                                 |              | 20.00 | 4.00       | 24.00        |
| Braced Length, L <sub>b</sub> = | 2.00 ft      |       |            |              |
| Steel Shape =                   | W            |       |            |              |
| F <sub>y</sub> =                | 50000 psi    |       |            |              |
| E =                             | 29000000 psi |       |            |              |

|                       |         |
|-----------------------|---------|
| Section req'd for M = | W33X118 |
| Section to use =      | W40X167 |
| Section Orientation = | Strong  |
| Bearing Connection    |         |

|                         |                  |
|-------------------------|------------------|
| Local Buckling Criteria | Flange = Compact |
|                         | Web = Compact    |
|                         | Compact Section  |

MOMENT NG 216%  
 ΔTL DEFLECTION NG 136%

Point Loads

| P <sub>i</sub> | P <sub>L</sub> | P <sub>D</sub> | P <sub>T</sub> | a     | LL Type | Load description |
|----------------|----------------|----------------|----------------|-------|---------|------------------|
| P <sub>1</sub> |                | 1000000        | 1000000        | 6.00  | Floor   |                  |
| P <sub>2</sub> |                | 200000         | 200000         | 24.00 | Floor   |                  |
| P <sub>3</sub> |                |                | 0              |       |         |                  |
| P <sub>4</sub> |                |                | 0              |       |         |                  |
| P <sub>5</sub> |                |                | 0              |       |         |                  |
| P <sub>6</sub> |                |                | 0              |       |         |                  |

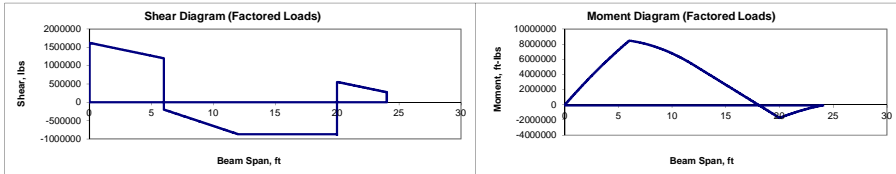
| Load type | R <sub>A</sub> | R <sub>B</sub> | lbs |
|-----------|----------------|----------------|-----|
| D         | 1159000        | 1021000        | lbs |
| L         | 0              | 0              | lbs |
| Lr        | 0              | 0              | lbs |
| S         | 0              | 0              | lbs |
| R         | 0              | 0              | lbs |
| W         | 0              | 0              | lbs |
| E         | 0              | 0              | lbs |

Uniform Loads

| Live, psf | Dead, psf | Trib. Width | Roof slope: | W <sub>L</sub>     | W <sub>D</sub> | W <sub>T</sub> | Start @ | End @ | LL Type | Load description |
|-----------|-----------|-------------|-------------|--------------------|----------------|----------------|---------|-------|---------|------------------|
| 0         | 50000     | 1.00        | :12         | W <sub>1</sub> = 0 | 50000          | 50000          | 0.00    | 6.00  | Floor   |                  |
| 0         | 80000     | 1.00        |             | W <sub>2</sub> = 0 | 80000          | 80000          | 6.00    | 12.00 | Floor   |                  |
| 0         | 50000     | 1.00        |             | W <sub>3</sub> = 0 | 50000          | 50000          | 20.00   | 24.00 | Floor   |                  |
|           |           |             |             | W <sub>4</sub> = 0 |                |                |         |       |         |                  |
|           |           |             |             | W <sub>5</sub> = 0 |                |                |         |       |         |                  |
|           |           |             |             | W <sub>6</sub> = 0 |                |                |         |       |         |                  |

Triangular Loads (Starting or ending load must be 0)

| T <sub>i</sub> | Start W <sub>L</sub> | Start W <sub>D</sub> | End W <sub>L</sub> | End W <sub>D</sub> | Start W <sub>T</sub> | End W <sub>T</sub> | Start @ | End @ | LL Type | Load description |
|----------------|----------------------|----------------------|--------------------|--------------------|----------------------|--------------------|---------|-------|---------|------------------|
| T <sub>1</sub> |                      |                      |                    |                    | 0                    | 0                  |         |       |         |                  |
| T <sub>2</sub> |                      |                      |                    |                    | 0                    | 0                  |         |       |         |                  |
| T <sub>3</sub> |                      |                      |                    |                    | 0                    | 0                  |         |       |         |                  |
| T <sub>4</sub> |                      |                      |                    |                    | 0                    | 0                  |         |       |         |                  |



Bending Design

Design controlled by 1.4D

F2. Doubly Symmetric Compact I-Shaped Members and channels bent about their major axis

1. Yielding

$$\phi Mn = 0.9 F_y Z_x$$

$$F_y = 50000 \text{ psi}$$

$$Z_x = 693.00 \text{ in}^3$$

$$Mp = F_y Z_x = 34650000 \text{ lb-in}$$

$$\phi Mn = 0.9 Mp = 2598750 \text{ lb-ft}$$

2. Lateral Torsional Buckling

$$M_p = 34650000 \text{ lb-in}$$

$$L_b = 2.000 \text{ ft}$$

$$M_{max} = 8471392 \text{ lb-ft}$$

$$M_A = 0 \text{ lb-ft}$$

$$M_B = 0 \text{ lb-ft}$$

$$M_C = 0 \text{ lb-ft}$$

$$F_L = 40000 \text{ psi}$$

$$Mr = FL S_x = 2000000 \text{ lb-ft}$$

$$R_m = 1.00$$

$$h_o = 36.54$$

$$c = 1.00$$

$$r_{ts} = (I_y C_w)^{0.5} / S_x = 2.975$$

$$F_{cr} = (C_b \pi^2 E) / (L_b / r_{ts})^2 \sqrt{1 + 0.078 Jc / (S_x h_o)} (L_b / r_{ts})^2 \sqrt{1 + 0.078 Jc / (S_x h_o)} = 13218696$$

$$L_r = 24.83 \text{ ft}$$

$$L_p = 8.477 \text{ ft}$$

$$C_b = 3.000$$

$$L_b \leq L_p, Mp = N/A \text{ lb-in}$$

$$\phi Mn = 0.9 Mp = N/A \text{ lb-ft}$$

Beam Section Properties

|                |          |                 |
|----------------|----------|-----------------|
| A <sub>y</sub> | 49.2     | in <sup>2</sup> |
| depth          | 38.6     | in              |
| b <sub>f</sub> | 11.8     | in              |
| t <sub>f</sub> | 1.03     | in              |
| t <sub>w</sub> | 0.65     | in              |
| I <sub>x</sub> | 10000.00 | in <sup>4</sup> |
| I <sub>y</sub> | 283      | in <sup>4</sup> |
| Z <sub>x</sub> | 693.00   | in <sup>3</sup> |
| S <sub>x</sub> | 600.00   | in <sup>3</sup> |
| r <sub>x</sub> | 15.300   | in              |
| r <sub>y</sub> | 2.40     | in              |
| C <sub>w</sub> | 99700    | in <sup>6</sup> |
| J              | 14       | in <sup>4</sup> |
| G              | 11200    | ksi             |
| b/t            | 5.76     |                 |
| h/tw           | 52.60    |                 |
| Flange         | Web      |                 |
| λ <sub>p</sub> | 9.15     | 90.55           |
| λ <sub>r</sub> | 24.08    | 137.27          |

G2. Shear Design

$$Aw = 25.090 \text{ in}^2$$

$$h/tw = 52.60$$

$$kv = 5.00$$

$$Cv = 1.00$$

$$\phi = 1.00$$

$$\phi Vn = 0.9(0.6)F_y Aw Cv = 752700 \text{ lbs}$$

$$V_u = 1622600 \text{ lbs}$$

NG

For webs of rolled I-shaped members with h/tw ≤ 260, Φ = 1.0 and Cv = 1.0  
 For webs of all other doubly and singly symmetric shapes and channels, Cv equals:  
 For h/tw ≤ 1.10\*sqrt(kv\*E/Fy), Cv = 1.00  
 For 1.10\*sqrt(kv\*E/Fy) < h/tw ≤ 1.37\*sqrt(kv\*E/Fy), Cv = 1.10\*sqrt(kv\*E/Fy)/(h/tw)  
 For h/tw > 1.37\*sqrt(kv\*E/Fy), Cv = 1.51\*E\*kv/((h/tw)<sup>2</sup>Fy)  
 1.10\*(kv\*E/Fy)/2 = 59.24  
 1.37\*(kv\*E/Fy)/2 = 73.78

Web local crippling

$$\text{if } lb/d \leq 0.2, \phi Rn = 0.75 * (0.40 * tw) * [1 + 3(lb/d)(t_f/t_w)^{1.5}] * \text{sqrt}(E * F_y * t_w / t_f)$$

$$\text{if } lb/d > 0.2, \phi Rn = 0.75 * (0.40 * tw) * [1 + (4lb/d - 0.2)(t_f/t_w)^{1.5}] * \text{sqrt}(E * F_y * t_w / t_f)$$

$$lb/d = 0.104$$

$$\phi Rn = 222073 \text{ lbs}$$

Web stiffeners required

Web local yielding

$$\text{Bearing length, } lb = 4.00 \text{ in}$$

$$\phi Rn = 1.0 * (2.5k + lb) * F_y * tw = 309563 \text{ lbs}$$

Web stiffeners required

Deflection

Camber = 0.00 in

| Mid Span Deflection   |                        |                      |                     |                         |       |
|-----------------------|------------------------|----------------------|---------------------|-------------------------|-------|
| Loading               | Ratio <sub>allow</sub> | Δ <sub>allowed</sub> | Δ <sub>actual</sub> | Ratio <sub>actual</sub> | Check |
| Δ <sub>LL</sub>       | 360                    | 0.667                | 0.000               | #DIV/0!                 | OK    |
| Δ <sub>TL</sub>       | 240                    | 1.000                | 1.201               | L/199                   | NG    |
| Cantilever Deflection |                        |                      |                     |                         |       |
| Loading               | Ratio <sub>allow</sub> | Δ <sub>allowed</sub> | Δ <sub>actual</sub> | Ratio <sub>actual</sub> | Check |
| Δ <sub>LL</sub>       | 180                    | 0.267                | 0.000               | N/A                     | OK    |
| Δ <sub>TL</sub>       | 120                    | 0.400                | 0.542               | L/88                    | NG    |

