



Appendix B: Analysis 1: Prefabrication

B.1 Exterior Skin Costs

| <i>Aluminum & Glass Curtain Wall</i> | Qty | Unit | Mat Cost/Unit | Material | Labor Cost/Unit | Labor | Total |
|---|--------|------|---------------|-----------|-----------------|-----------|-----------|
| 2-1/2" x 7-1/2" Extruded Aluminum 6063-T5 .125" Thick | 4,280 | LF | \$16 | \$68,480 | \$12 | \$51,360 | \$119,840 |
| 5/8" Thick Insulated & Spandrel Glazing | 13,750 | SF | \$36 | \$495,000 | \$22 | \$302,500 | \$797,500 |
| Column Covers | 6 | EA | \$2,700 | \$16,200 | \$300 | \$1,800 | \$18,000 |
| Aluminum Doors & Glass | 8 | EA | \$5,000 | \$40,000 | \$500 | \$4,000 | \$44,000 |

Aluminum & Glass Curtain Wall: \$979,340

| <i>Architectural Pre-cast Concrete Panels</i> | Qty | Unit | Mat Cost/Unit | Material | Labor Cost/Unit | Labor | Total |
|---|-------|------|---------------|-----------|-----------------|----------|-----------|
| Precast Panels | 7,386 | SF | \$21 | \$155,106 | \$11 | \$81,246 | \$236,352 |
| Furring, Insulation, & Gypsum Wallboard | 7,386 | SF | \$3 | \$18,465 | \$2 | \$11,079 | \$29,544 |

Architectural Pre-cast Concrete Panels: \$265,896

| <i>Metal Panel Walls & Windows</i> | Qty | Unit | Mat Cost/Unit | Material | Labor Cost/Unit | Labor | Total |
|---|-------|------|---------------|-----------|-----------------|----------|-----------|
| 5/8" Thick Insulated & Spandrel Glazing | 3,054 | SF | \$32 | \$97,728 | \$18 | \$54,972 | \$152,700 |
| 2" Metal Panel Walls | 6,912 | SF | \$21 | \$145,152 | \$11 | \$76,032 | \$221,184 |
| Metal Stud Framing | 6,912 | SF | \$6 | \$41,472 | \$4 | \$27,648 | \$69,120 |
| Gypsum Wall Board | 6,912 | SF | \$2 | \$10,368 | \$1 | \$6,912 | \$17,280 |

Metal Panel Walls & Windows: \$460,284

| <i>Roofing</i> | Qty | Unit | Mat Cost/Unit | Material | Labor Cost/Unit | Labor | Total |
|---------------------------------------|--------|------|---------------|----------|-----------------|----------|-----------|
| Membrane Roof, Insulation, & Flashing | 19,861 | SF | \$5 | \$99,305 | \$3 | \$59,583 | \$158,888 |
| Auditorium Roof, Future Green Roof | 4,855 | SF | \$10 | \$48,550 | \$4 | \$19,420 | \$67,970 |
| Metal Stud Framing | 600 | SF | \$18 | \$10,800 | \$7 | \$4,200 | \$15,000 |

Roofing: \$241,858



B.2 Bolt Connection Calculation

Reference Figure 1.18 for Structural Detail

Direct Shear on Each Bolt

$$R = 1.178^{\text{Kips}} / 2 \text{ bolts} = .589^{\text{Kips/Bolt}}$$

Galvanized A325 $\frac{3}{4}$ " Threads Excluded From Shear Plane AISC:LRFD Table 7-10

$$\text{Shear Strength} = 15.9^{\text{Kips}} > 0.589^{\text{Kips}} \text{ (OK)}$$

Bearing on Each Bolt

$$2.4 \text{ db}(t)(F_u) = 2.4 (\frac{3}{4}) * (0.5) * 58 \text{ksi} = 52.2^{\text{Kips/bolt}} \text{ (OK)}$$

Tear Out of Each Bolt

$$1.2 L_c (t) * (F_u) =$$

$$L_c = 2'' - (3/4'' + 1/16'') * 1/2 = 1.59$$

$$1.2 (1.59) * 0.5 * 58 = 55.3^{\text{Kips/Bolt}} \text{ (OK)}$$



B.3 Structural Column Calculations

Design Criteria: IBC 2003

Design Live Loads

| | |
|------------------------------------|---------|
| Floor Design Live Loads | 50 PSF |
| Partition Load (Office Area) | 20 PSF |
| Assembly Area | 100 PSF |

Snow Load 30 PSF

Roof Loads

| | |
|-------------------------|--------|
| Typical Roof Load | 30 PSF |
| Green Roof Load | 30 PSF |

Lateral Loads

| | |
|-----------------------------------|----------|
| Basic Wind Speed | V=90 MPH |
| Wind Load Importance Factor | I = 1.15 |
| Wind Exposure | C |

Column F-10.2: W12x96 ASTM
A992 Grade 50

Starting with the roof loads:

Tributary Area = $14' * 11'-3'' + 2' * 11'-3'' + \frac{1}{2} * 5'-6'' * 11'-3'' = 210.9$
SF

Compressive Column Load:
 $1.2D + 1.6L + 0.5S$

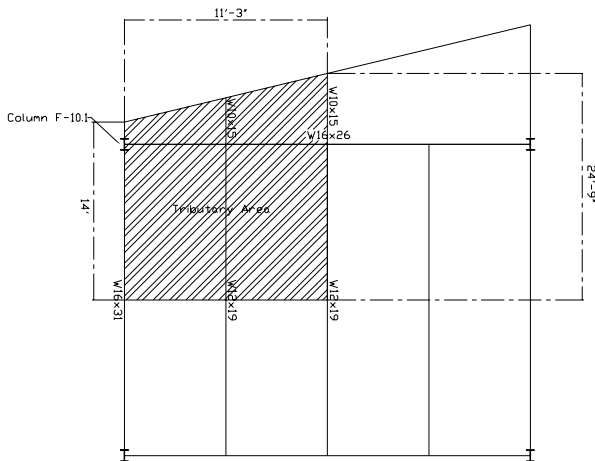
$1.2 (Deck + W-Shapes + MEP) + 1.6 (210.9 * 30PSF) + 0.5 (210.9 * 30PSF)$

W-Shapes = 1.43^{Kips}

Deck = $210.9 SF * 6 lbs/SF (Metal and Finish) = 1.27^{Kips}$

MEP = 10 PSF

$= 1.2 (1.27 + 1.43 + 10 * 210.9) + 1.6 (210.9 * 30PSF) + 0.5 (210.9 * 30PSF) = 15.8^{Kips}$





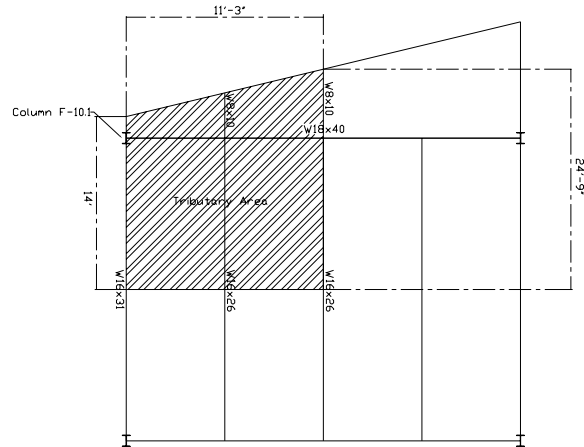
First floor loads:

Tributary Area = 210.9 SF

Compressive Column Load:
1.2D + 1.6L

1.2*(Deck + Slab + W-Shapes +
MEP) + 1.6*(210.9*70PSF)

Slab = 210.9 SF * 5'' = 87.9 CF *
150 lbs/CF = 13.2^{Kips}
W-Shapes = 14'*31+2*10*5'+
2*14'*26 = 1.2^{Kips}



1.2*(1.27+13.2+1.2+10*210.9) + 1.6(210.9*70PSF) = **26.2^{Kips}**

Curtain Wall Compressive Loads:

1 - 13' x 8' Unitized Glazing = 1.18^{Kips}

6 Panels in Tributary Area = 6*1.18^{Kips} = **7.08^{Kips}**

Total Compressive Load:

Roof Load + First Floor + Panel + Weight of Column
15.8^{Kips} + 26.2^{Kips} + 7.08^{Kips} + 96 lbs/ft*38'/1000 = **55.6^{Kips}**

Lightest Service Column Size for Compressive Load:

KL = 26' (Two-story open space)

W12x96 @ KL=26' = $\phi_c P_n = 569^{\text{Kips}} > 55.6^{\text{Kips}}$ (OK)

Checking Buckling Stress:

W12x96 (A = 28.2 in²; r_x = 5.44 in; r_y = 3.09)

Minimum L/r = 26'*12 / 3.09 = 100.9

Critical or Buckling Stress = $F_e = (\pi^2 * (E*I)) / (100.9^2)$

$F_e = (\pi^2 * 29 \times 10^3) / 100.9^2 = 28.11 \text{ ksi} < \text{proportional limit of 50 ksi}$ (OK)

Wind w/ Axial Compression and Flexure (Moment Frame):

Assumption: 26 PSF Wind Load on Column



$$W12x96: \quad A = 28.2 \text{ in}^2; Z_x = 147 \text{ in}^3; Z_y = 67.5 \text{ in}^3 \\ I_x = 131 \text{ in}^4; r_x = 5.44 \text{ in}; r_y = 3.09$$

$$\phi_c P_n = 569 \text{ Kips}$$

$$P / \phi_c P_n = 55.6 / 569 = .097 < 0.2$$

Therefore Equation H-1b Governs:

$$\frac{1}{2} (P_u / \phi_c P_n) + M_u / \phi_b M_n \leq 1$$

$$M_u = WL^2/8 = 1.6 * 26 \text{ PSF} * 14' * 38'^2 / 8 = 105.1 \text{ Kip-ft}$$

$$\phi_b M_n = 0.9 F_y Z_y = 0.9 * (50 \text{ ksi}) * (67.5 \text{ in}^3) * (1/12 \text{ in/ft}) = 253.1 \text{ Kip-ft}$$

$$\frac{1}{2} (55.6 / 569) + (105.1 / 253.1) = .46 < 1.0 \text{ (OK)}$$