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Introduction to Project

Background:

The Wine History Project of San Luis Obispo documents and preserves the unique food and wine history of the area. They educate the community through inviting exhibits that teach people about the importance of viticulture and its impact on making San Luis Obispo what it is today. They came forth with a proposal for our studio to design a temporary moving pavilion that will showcase their displays and exhibits at various wineries in the county.

Integrated Project Delivery:

This was an interdisciplinary senior project class that was made up of architectural engineering, construction management and architecture students. We utilized the integrated project delivery method (IPD) to carry out the design process of this project. The class was also sponsored by LPA design firm as they practice IPD and were able to help us understand more about this method through several meetings. IPD is an emerging form of project delivery that includes engineers, contractors and owner as well as the architect in an iterative-opposed to linear- design process. This collaborative method is meant to make for a faster and more successful project delivery as communication between all parties should cut down on confusion and leave less room for error.

Constraints:

This project was very challenging in that it required the structure to be very flexible yet very portable. The pavilion must be initially built by construction management students utilizing the CAED shop then constructed by “unskilled labor” (i.e. movers, the clients, friends of the clients, etc.) as it moves from site to site. It must be transportable via typical moving truck and assembled without machinery. There should be little disturbance to the ground it sits on, yet it should be stable and have adequate foundations. There was little design direction but it should provide nearly unlimited display options as our clients exhibits change often with various artifacts and posters of various sizes.
Architectural Renders and Site Plan
What is the Heart? A flower opening.

The intellectual quest is exquisite like pearls and coral. But it is not the same as the spiritual quest. The spiritual quest is on another level altogether. Spiritual wine has a subtler taste. The intellect and the senses investigate cause and effect. The spiritual senses surrender to the wonder.

- Rumi

PROJECT GOALS

The Wine History Project of San Luis Obispo has outsourced Cal Poly Architecture, Engineering, and Construction Management, a group with the task of designing a pavilion to function as a trail-revealing and visitor-educating center. It will also hold an inviting year’s worth of artifacts showcasing the region’s interlinked cultural traditions the cultivation and consumption of wine. In an emergent “interdisciplinary” design studio format, students have been asked to produce a design, inspired by the history, one which will foster a rotating public display of the WHP’s hard work and dedication to preserving two centuries of elements’ livelihoods; and which will not continue rebuilding with the same material. Wine’s & tasting room carrying the tradition forward.

"urchinesque explosion"

Early experiments in the architectural process revealed several research of the Rhythm Chordineer’s, which includes sea stars, archives, and the like. The constructions of these solutions are becoming the ‘urchinesque’ spaces which are related tight by simple collagen fibers in form. In Bloom seeks to combine that “urchinesque” space utilizing a surprising explosion of loose-fitting textile modules. The concept is an introductory creative exhibit for aerial display, light fixtures, and renewables.
Assembly, Transportation and Cost Estimate
<table>
<thead>
<tr>
<th>Material</th>
<th>Qty</th>
<th>Supplier</th>
<th>Unit Price</th>
<th>Total Price</th>
<th>Notes/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2&quot;x2-1/2&quot;x1/8&quot; HSS</td>
<td>447'</td>
<td>B&amp;B</td>
<td>$61.00</td>
<td>$1,403.00</td>
<td>Sold in 20' Lengths</td>
</tr>
<tr>
<td>2-1/4&quot; x 2-1/4&quot; x 3/16&quot; HSS</td>
<td>20'</td>
<td>B&amp;B</td>
<td>$67.00</td>
<td>$67.00</td>
<td>Sold in 20' Lengths</td>
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<tr>
<td>Schedule 40 1-1/2&quot; Steel Pipe</td>
<td>445'</td>
<td>B&amp;B</td>
<td>$50.40</td>
<td>$1,108.80</td>
<td>Sold in 21' Lengths</td>
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<tr>
<td>Schedule 40 2&quot; Steel Pipe</td>
<td>20'</td>
<td>B&amp;B</td>
<td>$55.00</td>
<td>$55.00</td>
<td>Sold in 21' Lengths</td>
</tr>
<tr>
<td>20 Gauge Sheet Metal</td>
<td>440 sq ft</td>
<td>B&amp;B</td>
<td>$57.00</td>
<td>$627.00</td>
<td>Sold in 4x10 sheets</td>
</tr>
<tr>
<td>1/8 X 3 Hot Rolled Steel Flat Bar</td>
<td>1</td>
<td>Metals Depot</td>
<td>$29.80</td>
<td>$29.80</td>
<td>20' Length</td>
</tr>
<tr>
<td>Seaman 8421 Architectural Fabric</td>
<td>43 yds</td>
<td>SLO Sail and Canvas</td>
<td>$28.00</td>
<td>$1,204.00</td>
<td>$28/yard 72&quot; wide roll</td>
</tr>
<tr>
<td>Structural bolts A325, Hot dipped galvanized steel, 1/2&quot;-11 x 3&quot;</td>
<td>200</td>
<td>Bolt Depot</td>
<td>$81.80</td>
<td>$163.60</td>
<td>Bulk Pricing</td>
</tr>
<tr>
<td>Structural washers F436, Hot dipped galvanized steel, 1/2&quot;</td>
<td>500</td>
<td>Bolt Depot</td>
<td>$62.20</td>
<td>$62.20</td>
<td>Bulk Pricing</td>
</tr>
<tr>
<td>Structural nuts A194 grade 2H, Hot dipped galvanized steel, 1/2&quot;-11</td>
<td>250</td>
<td>Bolt Depot</td>
<td>$59.10</td>
<td>$59.10</td>
<td>Bulk Pricing</td>
</tr>
<tr>
<td>Hex bolts, Zinc plated steel, 1/2&quot;-18</td>
<td>100</td>
<td>Bolt Depot</td>
<td>$7.91</td>
<td>$7.91</td>
<td>Bulk Pricing</td>
</tr>
<tr>
<td>SAE flat washers, Zinc plated steel, 1/2&quot;</td>
<td>100</td>
<td>Bolt Depot</td>
<td>$2.18</td>
<td>$2.18</td>
<td>Bulk Pricing</td>
</tr>
<tr>
<td>1x8 Oak Board</td>
<td>40 LF</td>
<td>Home Depot</td>
<td>$5.92</td>
<td>$236.80</td>
<td>Sold per LF</td>
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<tr>
<td>1-1/2 in. x 72 in. Plain Steel Angle with 1/8 in. Thick</td>
<td>1</td>
<td>Home Depot</td>
<td>$19.91</td>
<td>$19.91</td>
<td>72&quot; Length</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$5,046.30</strong></td>
<td></td>
</tr>
</tbody>
</table>
ISOMETRIC VIEW: HSS STRUCTURAL FRAME
TOP/DOWN VIEW

NORTH/SOUTH ELEVATIONS

- Scale: 1/4" = 1'-0"

- = Column
- = Entrance
- = Atrium

Atrium/Entrance

Display Module
HSS Member Sizes/Weights

Notes:
2-1/2" x 2-1/2" x 1/8" HSS
Weight: 3.90 lbs/ft

Notes:
*Members colored in BLUE are 3" x 2-1/2" x 3/16" HSS*
Weight: 6.23 lbs/ft

Total Weight of HSS: 1135.2 lbs
Truss Dimensions/Weight

Truss A

- Quantity: 22.67 LF
- Weight: 88.4 lbs

Truss B

- Quantity: 23.67 LF
- Weight: 92.3 lbs

Truss C

- Quantity: 24.67 LF
- Weight: 96.2 lbs

Scale: 1/4" = 1'-0"
HSS Member Sizes/Weights

- 10'-0" = 39 lbs
- 8'-0" = 31.2 lbs
- 5'-0" = 19.5 lbs

Notes:
2-1/2" x 2-1/2" x 1/8" HSS
Weight: 3.90 lbs/ft

Total Weight of HSS: 733.2 lbs
Wall Panel Diagram/Portability

Notes:
- Wall panels will be prefabricated off-site.
- All members will be welded together, if panel requires cross bracing then custom fabricated connecting plates will be welded on.
- During transportation/construction cross brace will be left off until panel is set in place.
- Total weight of wall panel is ~170 lbs, recommended to be carried by 2-3 people.

Notes:
- Final wall panel with cross bracing that will be used to construct the display module.

Notes:
- Wall panel that will be used at the entrance to the atrium.
A secondary smaller truck will be needed to transport the remaining prefabricated material.

*All material is to be strapped down and secured during transportation*

Interior of Truck Dimensions

Volume: 1,583 cu. ft.
Max Weight: 9,010 lbs
Structural Calculation Package for

Wine History Project Moving Pavilion:
In Bloom

Site 1: Saucelito Canyon Winery Tasting Room
3180 Biddle Ranch Rd, San Luis Obispo, CA 93401

Rachel Jakel
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<th>Page Number</th>
</tr>
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<td>2. Load Takeoff</td>
<td>D3</td>
</tr>
<tr>
<td>3. Key Plan</td>
<td>D4-D5</td>
</tr>
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<td>C1-C2</td>
</tr>
<tr>
<td>7. Connections</td>
<td>J1-J9</td>
</tr>
<tr>
<td>8. Footing Design</td>
<td>F1-F3</td>
</tr>
</tbody>
</table>
Project Description

The Wine History Project documents and preserves the unique food and wine history of San Luis Obispo County. This pavilion made for them will house their exhibits and travel from winery to winery in the San Luis Obispo County. The first site it will see is at the tasting room of Saucelito Canyon Winery. The design of the pavilion stemmed from a biomimetic structure of a mollusk. The use of biomimicry in the design helps it to live and function at any site by adapting the way that a mollusk would. Just as the shell of a mollusk is made up of several different layers of different structure types, In Bloom is made up of two different structures- one that comprises the gravity and lateral force resisting systems as well as an outer shell that provides architectural interest and protection from the elements with that together form the pavilion for the Wine History Project.

The structure itself stands 8 feet tall with protruding architectural elements up to 11 feet with a footprint of 150 square feet for the atrium module and 100 square feet for the optional addition module. The two modules are structurally independent and can be set up according to the needs of the Wine History Project. It is comprised of hollow structural steel for the gravity as well as lateral systems. From site to site the pavilion will be constructed on relatively flat ground and is connected to the ground via pressure treated wood bearing footings with earth anchors.

Design Criteria

1) Codes used:
   - International Building Code 2018
   - American Society of Civil Engineers 7-16
   - American Institute of Steel Construction 360-16

2) Design Loads:
   - Dead Loads- weights of all materials as shown per calculations
   - Live Loads- uniformly distributed- assumed as 10 psf uninhabitable attic without storage per ASCE 7-16 Table 4.3-1
   - Wind Loads per IBC, Exposure C and wind speed V of 95 mph based off process in ASCE 7-16.

3) Foundation Design:
   - With no geotechnical report provided and soil class unknown, worst case soil bearing pressure of 1000 psf will be used.
Material Criteria

4) Steel
   - For framing members, HSS SQ A500 used for beams columns and braces
   - For canopy members, X-strong pipe
5) Aluminum
   - Auger anchors for foundations
6) Timber
   - Pressure treated lumber for foundation bearing pads.

Load Takeoff

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSS 2.5x2.5x1/8</td>
<td>3.90 plf</td>
</tr>
<tr>
<td>Pipe 1 ½ X-strong</td>
<td>3.63 plf</td>
</tr>
<tr>
<td>Architectural Fabric</td>
<td>~3 psf</td>
</tr>
</tbody>
</table>

SAP2000 Modeling Criteria

The model uses the same member type throughout and is modeled under worst case conditions and a partially closed wind load. All connections are modeled as pinned though they will have more rigidity when constructed.
Dead loads are applied at worst case conditions and live as uniformly distributed based off of tributary area. Wind load is applied windward, leeward and as uplift pressure.
LRFD load combinations were ran for design code checks and ASD combinations were ran for foundation design.
SAMPLE BM CALC

\[ P = \text{dead} \]
\[ W = \text{live} \]
\[ W = 50\text{psf} \]
\[ P = 150\text{# CONSERVATIVE LOAD FROM SHELL} \]

LOAD COMBS (ASCE 7:16 2.3.1)
1. 1.1V0 = 1.1(150) = 210\text{#}
2. 1.2V1+V2 = 1.2(150) + 1.6(50 \times 5' \text{LENGTH}) = 580\text{#} \leftarrow \text{COMB}L\]

[HSS 3\times 2.5 \times 3/16]

\[ E = 29000 \text{ ksi}, I = 1.39 \text{ in}^4 \]

\[ P = 50\text{psf} \]
\[ \text{V}_{\text{max}} = \frac{.58}{2} = .29\text{k} \]

\[ M_{\text{max}} = \frac{WL^2}{8} + \frac{PL}{4} \]

\[ 1.6 \left( 50(5)^3 \right) + 1.2 \left( 150(5)^3 \right) \]

\[ .475k = 5.7k \]

DEFL (UNFACTORED)

\[ \text{DEFL} \]

\[ \frac{5W(5)^4}{384EI} + \frac{PL(3)^3}{4BEI} \]

\[ \frac{5(150)(5)^4}{384(29000)(1.39)} + \frac{150(3)^3}{4(29000)(1.39)} \]

\[ .015 + .015 \]

\[ = .03 \text{in} \]
SAMPLE BIM CALC CONT'd

BENDING CHECK:
\[ \phi W_n = \phi F_e \frac{L}{2} \quad (AISC \ 360-10F) \]
\[ \phi W_n = (9)(50ksi)(1.73in^3) \]
\[ \phi W_n = 7785lb > 5.7k \]
\[ \frac{d_1}{d} = \frac{5.7}{77.85} = 0.073 < 1.0 \]

SHEAR CHECK:
\[ \phi W_n = \phi (\frac{F_e A w C_w}{L}) \quad (AISC \ 360-61) \]
\[ \phi W_n = (9)(5)(50ksi)(1.0)(1.7) \]
\[ \phi W_n = 410.17k > 2.9k \]
\[ \frac{d_1}{d} = \frac{2.9}{410.17} = 0.0068 < 1.0 \]

DEFLECTION CHECK:
ROOF MEMBER NOT SUPPORTING CEILING (IBC 2018 T1604.3)

LIVE:
\[ \Delta_{allow} = \frac{L}{180} = \frac{5x12}{180} = 0. 133\text{in} \]
\[ \Delta_{actual} = \frac{5xwL^2}{384EI} = 0.015\text{in} \]
\[ 0.015\text{in actual} < 0.13\text{in allow} \]

DEAD + LIVE:
\[ \Delta_{allow} = \frac{L}{120} = \frac{5x12}{120} = 0.5\text{in} \]
\[ \Delta_{actual} = 0.03\text{in} \]
\[ 0.03\text{in actual} < 0.5\text{in allow} \]
**Shell Check**

Pl.5 x Strong I = \(0.372\)

\[ W = \text{Shell WT} \]

\[ q' \]

\[ W = 5.39 \text{ plf} \]

\[ L = 9 \text{ LENGTH CONSERVATIVE} \]

\[ V_{\text{max}} = \frac{5.39(9^2)}{2} = 24.26\text{#} \]

\[ W_{\text{max}} = \frac{W}{8} = \frac{5.39(9)^2}{8} = 0.055 \text{ k'f} \]

\[ \text{DEFL} = \frac{5WL^4}{384EI} \]

\[ 5(0.005\text{ ksi})(9/12)^4 \]

\[ \frac{584(7000\text{ ksi})(0.372)}{584(27000\text{ ksi})(0.372)} \]

\[ \Delta = 0.053\text{ in} \]
SHELL CHECK COMBOS

BENDING:
\[ \phi M_n = \phi E f_y I \]  
\[ \phi M_n = 0.9 (35 ksi)(549 in^3) \]  
\[ \phi M_n = 1729 k" - 1.44 k' > 0.55 k' \]
\[ \frac{d}{C} = \frac{0.55 k'}{1.44 k'} = 0.4 \leq 1.0 \checkmark \]

SHEAR:
\[ \phi V_n = \phi V (0.65 A_w C_w) \]  
\[ \phi V_n = 0.96 (35 ksi)(10 in)(10) \]  
\[ = 18.9 k > 0.024 k \]
\[ \frac{d}{C} = \frac{0.024 k}{18.9 k} = 0.001 < 1.0 \checkmark \]

DEFLECTION CHECK:
DEAD+LIVE  
\[ \Delta_{allow} = \frac{f}{120} = \frac{9(12)}{120} = 0.9 " \]
\[ \Delta_{actual} = 0.53 " \]
\[ 0.53 \text{in actual} \leq 0.9 \text{in allow} \checkmark \]
**SAMPLE COLUMN CHECK**

\[ W = \text{WIND} = 18.53 \text{ PSF} (5' \times 5' \text{ TRIB WIDTH}) = 92.105 \text{ kip} \]

\[ P = \text{LIVE} = 10 \text{ PSF} (5' \times 5' \text{ TRIB AREA}) = 250 \text{k} \]

\[ \text{DEAD} = \frac{150}{2} = 75 \text{k} \]

4 LOAD COMBO 1.2 COMBOS \[ F_{um} = 290 \text{k} \] (see EM CALC R)

\[ P_1 = 4 \times 85 \times 290 = 1160 \text{k} \]

\[ P_2 = 150 \text{ k CONSERVATIVE LOAD FROM SHELL} \]

HSS 2\'1/2 x 2\'1/2 x 1/8

**COMBINED AXIAL & BENDING (AISC 360 C & H)**

\[ \frac{P_2}{P_{ec}} = \frac{134k}{12.9k} \geq (AISC 360 T4-4) \]

\[ = 0.1 \leq 0.2 \]

\[ M_{max} = \frac{Wl^2}{8} = \frac{92.105(11)^2}{8} = 1.4k^4 = 16.82k'' \]

\[ V_{max} = 30.1k \]

\[ A_{max} = 1.31k \]
SAMPLE COLUMN CHECK CONT

\[ \frac{P_e}{P_c} \leq 0.2 \quad (\text{USE AISC EQN H1-1b}) \]

\[ \frac{P_c}{2P_e} + \left( \frac{Mr}{\phi M_c} \right) \leq 1.0 \]

\[ \frac{1.31}{2(12.9)} + \frac{11682}{3552} \]

AISC T3-13

\[ = 0.45 \leq 1.0 \checkmark \]
LATERAL WIND LOADS

PARTIALLY ENCLOS ED BLDG, LOW RISE BLDG W < 600' 
ASCE 7-16 CH 28

1. RISK CATEGORY: II (ASCE 7-16 T 1.5-1)

2. BASIC WIND SPEED V = 95 MPH (ASCE 7-16 FIG 26.5-18)

3. EXPOSURE CATEGORY: C (ASCE 26.7)

4. TOPOGRAPHIC FACTOR Z1 = 1.0 (FLAT) (ASCE 7-16 26.8-1)

5. ENCLOSURE: PARTIALLY ENCLOS ED → HIGH INTERNAL PRESSURE (ASCE 26.13-1)

6. WIND DIRECTIONALITY Kd = 0.85 (ASCE 7-16 T 26.6-1)

7. GROUND ELEVATION FACTOR Z2 = 1 (ASCE 7-16 26.9)

8. INTERNAL PRESSURE COEFFICIENT GC1P = 1.05 (ASCE 7-16 T 26.13-1)

9. VELOCITY PRESSURE EXPANSION COEFFICIENT K0 / K2 = 0.85 (ASCE 7-16 T 26.10-1)

10. VELOCITY PRESSURE q2/g0 = (ASCE 7-16 CON 26.10-1)

\[ q2 = 0.0256 K2 Kc1 Kc2 V^2 (\text{#} / \text{ft}^2) \]

\[ = 0.0256 (1.85)(1)(0.85)(1.0)(95) \]

\[ = 110.69 \text{ #/ft}^2 \]

11. EXTERNAL PRESSURE COEFFICIENT GC1P (ASCE 7-16 FIG 26.3-1)

BLDG SURFACE

<table>
<thead>
<tr>
<th>LOAD CASE A</th>
<th>LOAD CASE B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.50</td>
</tr>
<tr>
<td>2</td>
<td>.21</td>
</tr>
<tr>
<td>3</td>
<td>.22</td>
</tr>
<tr>
<td>4</td>
<td>.22</td>
</tr>
<tr>
<td>5</td>
<td>.22</td>
</tr>
<tr>
<td>6</td>
<td>.22</td>
</tr>
</tbody>
</table>
WIND PRESSURE $p$ (ASCE 7-10 28.3-1)

\[ p = \eta \left( 6C_{w} - G_{p} \right) \# / \text{ft}^2 \]

\[ B = 10.69 \left( \frac{.50 + .55}{1} \right) = 18.53 \text{ psf} \]
\[ B = 10.69 \left( .21 + .55 \right) = 12.08 \text{ psf} \]
\[ B = 10.69 \left( .43 - .55 \right) = -10.80 \text{ psf} \]
\[ B = 10.69 \left( .37 - .55 \right) = -15.35 \text{ psf} \]

\[ P_{0} = 10.69 \left( - .45 - .55 \right) = -10.69 \text{ psf} \]
\[ P_{0} = 10.69 \left( - .69 - .55 \right) = -20.19 \text{ psf} \]
\[ B = 10.69 \left( - .37 - .55 \right) = -15.35 \text{ psf} \]
\[ B = 10.69 \left( - .45 - .55 \right) = -10.69 \text{ psf} \]
\[ B = 10.69 \left( - .40 + .55 \right) = 15.85 \text{ psf} \]
\[ B = 10.69 \left( - .29 - .55 \right) = -14.02 \text{ psf} \]

\* $p$ NOT TO BE LESS THAN 10.0 psf ON WALLS & 80 psf ON ROOF

(ASCE 7-10 28.3-4)
SAMPLE BRACE CALCULATION

\[ W = 18.53 \text{ psf} \times (5' \times 8') = 741.2 \]  

\[ F_{\text{brac}} = \frac{W}{5} = \frac{741.2}{9.74} \]

\[ F_0 = 1.4K \quad T&C \text{ FOR } W \text{ BOTH DIRECTIONS} \]

\[ P_0 = 150ks \text{ (FROM BM CALC S)} \]

\[ W_L = 50ks \text{ (FROM BM CALC S)} \]

LOAD COMBOS (ASCE 7-10 2.3.1)

\[ 4.1.12K + 1.0W + 1.0L = 1.2 \times (4K) + 1.4K + .05(2.5) = 1.52K \ (C) \]

\[ 1.2 \times (15K) - 1.4K + .05(2.5) = -1.29K \ (T) \]

\[ P_0 = 1.52K \quad \text{C CONTROLS} \]

\[ \phi P_0 = 15.0K \quad \text{CONSERVATIVE Q 16} \quad (AISC 360 T4-9) \]

\[ \phi P_0 = 1.52 \]

\[ \frac{\phi P_0}{180} = 0.1 < 1.0 \]
BEAM TO COL CONNECTION:

RUN FROM BCM SEE BMI CALS (Worst Case)

\[ R_b = 150 \# \]

RUPTURE ON HSS:

\[ \Phi_{Rn} = \Phi_{Fy, A_{eq}} (\text{ASCE EON T4-91}) \]

\[ (75)(6)(58)(2.5) - (\frac{1}{2} + \frac{1}{8})(1.16) \]

\[ \Phi_{Rn} = 6.07 \text{ k} > 1.5 \]

\[ d/W = 0.15/0.07 = 0.21 < 1.0 \]

YIELD ON HSS:

\[ \Phi_{Rn} = 0.6Fy, A_{eq} \]

\[ (1.0)(6)(58)(2.5)(1.16) \]

\[ \Phi_{Rn} = 8.7 \text{ k} \]

\[ d/W = 0.15/8.7 = 0.02 < 1.0 \]

RUPTURE ON FLANGE:

\[ \Phi_{Rn} = \Phi_{Fy, A_{eq}} \]

\[ (75)(6)(58)(58)/(2.5) - (\frac{1}{2} + \frac{1}{8})(1.16) \]

\[ \Phi_{Rn} = 10.12 \text{ k} \]

\[ d/W = 0.15/10.12 = 0.02 < 1.0 \]

YIELD ON FLANGE:

\[ \Phi_{Rn} = 0.6Fy, A_{eq} \]

\[ (1.0)(6)(58)(2.5)(1.16) \]

\[ \Phi_{Rn} = 6.75 \text{ k} \]

\[ d/W = 0.15/6.75 = 0.02 < 1.0 \]
BEAM TO COL COND

BEARING:

DIMENSIONAL LIMITATIONS PER AISC CH 10

\[ L_{eh} \geq 2d = 2(\frac{1}{2}) = 1 \text{ in} \]

\[ L_{eh} = 1 \text{ in} \]

\[ b_p = \frac{d}{2} + \frac{1}{16} = \frac{1}{2} + \frac{1}{16} = 0.3125 \]

\[ \frac{1}{8} \text{ in} \]

0.125 < 0.3125 \checkmark

BEARING OF BOLT ON SHEAR TAB:

AISC EQ 53-6A

\[ \phi R_n = \phi_2 A d t f_u \]

\[ = 0.75(2.4)(\frac{1}{2})(110)(60 \text{ ksi}) \]

\[ \phi R_n = 65.25 \text{ k} \]

\[ d/c = 0.15/65.25 = 0.002 < 1.0 \]

WELD: (FILLET STRENGTH)

\[ \phi R_n = \phi F_n w A w e \] (AISC J2.4)

\[ = 0.75(0.707)(\frac{1}{16})(1.0)(1.0)(70 \text{ ksi}) \]

\[ \phi R_n = 1.392 \text{ k}/\text{in} \text{/}16'' \text{ of FILLET} \]

USE MIN 3/16'' WELD \[ \phi R_n = 1.392(3)(2.5 \text{ k}) = 10.44 \text{ k} \]

3/16'' WELD 2.5'' LONG
BEAM TO COL. CONNECT
WELD CONNECT
IN DIRECTION OF LOADING ->

YIELD:
\[ \phi_{Rn} = \phi_{Fy} A_{bm} \]
\[ = 1.0 (0.6 \times 30 \text{ ksi}) (\frac{\frac{1}{8}}{25}) \]
\[ = 1.0 (0.6) (30 \text{ ksi}) (\frac{1}{8}) (25) \]
\[ \phi_{Rn} = 0.75 \quad d/c = 0.15/6.75 = 0.02 < 1.0 \]

RUPTURE:
\[ \phi_{Rn} = \phi_{Fy} A_{bm} \]
\[ = 0.75 (0.6) (30 \text{ ksi}) (\frac{1}{8}) (25) \]
\[ \phi_{Rn} = 8.15 \text{ k} \quad d/c = 0.15/6.75 = 0.02 < 1.0 \]

GRAVITY ON WELD + SHEAR
ASD 1/8" FR. SHEAR TAB

YIELD:
\[ \phi_{Rn} = 0.6 F_y A_{bm} \]
\[ = 0.6 (30 \text{ ksi}) (2.5) (0.125) \]
\[ \phi_{Rn} = 6.75 \text{ k} \quad d/c = 0.15/6.75 = 0.02 < 1.0 \]

RUPTURE:
\[ \phi_{Rn} = 0.75 (0.6) (30 \text{ ksi}) (2.5) (0.125) \]
\[ \phi_{Rn} = 8.15 \text{ k} \quad d/c = 0.15/6.75 = 0.02 < 1.0 \]
BEAM TO COL CONN

1/2" BOLT IN SHEAR (A325)

\[ \Phi R_n = \frac{\Phi R_n A_b}{0.75(2.748)(\pi)(\frac{1}{2})^2} \]

\[ \Phi R_n = 898 k \quad d/c = \frac{15}{8} A \quad \text{CAUTION} \leq 1.0 \]

1/2" A325 BOLT IN 2.5" x 2.5" x 1/8" HSS W/ WIFE OKAY

1 BOLT SUFFICIENT, USE TWO TO CREATE A MORE RIGID CONNECTION.
BRACE DETAIL

HSS 2.5X2.5X1/8

1/2" BOLT

HSS 2.5X2.5X1/8

HSS 3X3X3/16

1/2" BOLT TYP

6" SQ 1/8" PL
Brace Connection:

From Brace Calc

\[ F_0 = 1.4k \quad \theta = \tan^{-1}(\frac{8}{15}) = 58^\circ \]

\[ F_x = 1.4 \cos 58^\circ = 0.74k \]

\[ F_y = 1.4 \sin 58^\circ = 1.19k \]

Check Bolt for Shear:

Rupture on HSS: (A1x Eqn 14)

\[ \phi \tau_n = 0.6 F_y A_y \]

\[ = 0.6(200)(62)(2.5 - (12 + 1/3)(0.116) \]

\[ \phi \tau_n = 6.07k \quad d/c = 1.116 < 1.0 \]

Yield on HSS:

\[ \phi \tau_n = 0.6 F_y A_y \]

\[ = 0.6(200)(62)(2.5)(0.116) \]

\[ \phi \tau_n = 8.17k \quad d/c = 1.19 > 1.0 \]

Rupture on Flanges:

\[ \phi \eta_n = 0.6 F_y A_y \]

\[ = 0.6(200)(30)(5.8)(2.5 - (12 + 1/3)(0.125) \]

\[ \phi \eta_n = 6.12k \quad d/c = 1.416 > 1.0 \]

Yield on Flanges:

\[ \phi \eta_n = 0.6 F_y A_y \]

\[ = 0.6(200)(30)(1.0)(30)(0.125) \]

\[ \phi \eta_n = 6.75k \quad d/c = 1.19 > 1.0 \]
BEAM CONNECTION CONTD

WELD:

FILLET WELD STRENGTH

\[ \phi R_n = \frac{F_{n, A}}{F_{n, A, m}} \] (AISC 314)

\[ \phi R_n = 10.94 \text{kN} \] for 3/16" FILLET WELD 2.5" long

6.582 BM to col. for full call

IN DIRECTION OF LOADING →

YIELD

\[ \phi R_n = \frac{F_{n, B}}{F_{n, A, m}} \]

\[ \phi R_n = 0.75 > 0.74 \text{kN} \]

\[ \phi R_n = 8.15 \text{kN} \] for 0.75"

\[ \phi R_n = 0.75 > 0.74 \text{kN} \]

\[ \phi R_n = 8.15 \text{kN} \] for 0.75"

\[ \phi R_n = 0.75 > 0.74 \text{kN} \]

RIPPLE

\[ \phi R_n = \frac{F_{n, A, m}}{F_{n, A}} \]

\[ \phi R_n = 8.15 \text{kN} \] for 0.75"

\[ \phi R_n = 0.75 > 0.74 \text{kN} \]

\[ \phi R_n = 8.15 \text{kN} \] for 0.75"
**SHELL TO STRUCTURE CONNECTION**

- 1/2" x 2" angle
- 1/2" x 2" angle
- 1/2" bolt

A/2x O.D. dia 1.9"  
P/2x I.D. dia 1.74"

1.9A > 1.9" snug fit

**WIND UPLIFT:** 20.69 PSF

**WORST CASE:** (20.69 PSF)(5'x5' gross) = 517.25# => USE 600# T

**CHECK BOLT (1/2") PEAKOUT**

**SPACING & EDGE DISTANCE**

MIN EDGE DISTANCE = 3A" (AISC J3A)

1/2" ABOT BOLT IN DOUBLE SHEAR (PLATE W1) THREATS EXCLUDED

\[
\phi_Rn = \phi_Tn \phi_A \quad \text{(AISC J3-1)}
\]

\[
\phi_Tn = 0.75(27 \text{ ksi}) (\frac{1}{2})^2 \pi
\]

\[
\phi_A = 3.98 \quad > \quad 600 #
\]

\[
\frac{a}{c} = 0.1398 = 0.15 \leq 1.0
\]

**MIN SPACING**

\[
2^{\frac{d}{2}} \times 2^{\frac{d}{2}} (1/2) = 1.33" \Rightarrow \text{USE } 1.5" \quad \text{(N/A, ONE BOLT)}
\]
SHELL TO STRUCTURE COND:

**YIELD OF PIPE:**

\[ \phi_{P_n} = \phi_{F_{y}} A_{g} \]

\[ \phi_{P_n} = 9 \times \frac{85}{101} \text{ksi} \]

\[ \phi_{P_n} = 31.5 \text{ kpsi} > 0.6k \]

\[ d/c = \frac{0.62}{1.0} < 1.0 \]

**RUPTURE OF PIPE:**

\[ dP = \phi_{F_{u}} A_{g} \]

\[ = 75 (60 \text{ksi}) (1.0 - 1/2 - 1/8) \]

\[ \phi_{P_n} = 16.88 k > 0.6k \]

\[ d/c = \frac{0.6}{16.88} < 0.05 < 1.0 \]
FOOTING DETAIL
FOOTING DESIGN

WORST CASE:
(0.2x) FROM SAP ANALYSIS

USE SOIL BEARING PRESSURE $F_{bk} = 1000$ psi (WORST CASE)

$\phi = \frac{P/A}{6000}$

$A = 6.2 \text{ ft}^2$

$2' \times 1.3'$ FTG FOR BEARING

USE LOW PRESSURE TREATED TIMBER w/ $6''$ SQ FL

A $2' \times 1.3' = 6.10 \text{ ft}^2 < 6.2$ BUT BEARING FROM EARTH ANCHORS IS AT LEAST TEAROUT VALUE, WILL COVER DIFFERENCE

CHECK $F_{ct}$ ON TIMBER

$F_{ct} = \frac{P_{UB}}{A_{UB}}$

$= \frac{1200}{6 \times 0.5}$

$= 4000$ psi

$C_2$ GRADZ 20FL = 625 psi (NDS 20S R-4A)

$F_{ct} \text{ ALLOW} = 625 \text{ psi} > F_{ct} \text{ ACTUAL} = 4000 \text{ psi}$
FOOTING CONT.

WORST UPLIFT CASE

4.2k↑ FROM SAP ANALYSIS (APPENDIX)

UNKNOWN SOIL CLASSIFICATIONS

ASSUME SILTY LOAMY SAND

USE AMERICAN EARTH 18#RES, SEE CAPACITY IN APPENDIX

4½" P416-HC

TENSION CAPACITY ~ 3.3k PER THIS SOIL CONDITION

USE TWO

CAPACITY 3.3(2) = 6.6k  \[ \frac{d}{c} = 4.2 \frac{10}{0.6} = 6.6 \leq 1.0 \]

CHECK UPLANTS:

WIND \leq \frac{0.3}{0.6} \text{ COEFFICIENT OF FRICTION}

VECT RKN FROM SAP = 0.05k \text{ - GRAVITY}

X RKN = 0.00978k \text{ - WIND}

Y RKN = 0.0008k

0.03(0.06) = 0.18k > 0.00978k

0.018k \leq 0.0008k
UPLIFT ⇒ SEE SAP RESULTS
SAP RUN = -4.3% WORST CASE

COL DIM = 2.5"
FIT CASE DIM = 3 - 2(3/16) = 2.625"
2.625" > 2.5" ⇒ SNL BUT FITS

CHECK BOLTS (1/2") shear:
SPACING & EDGE DISTANCE
MIN EDGE DIST = 3/4" (AISC J3-4)
1/2" BOLT IN DOUBLE SHEAR (HSS) THREADS EXCLUDED

ϕ₀n = ϕ₁nA₀ (AISC J3-1)
ϕ₀n = 75(27 ksi)(1/2)²Ti (27 ksi FROM T.J3.2)
ϕ₀n = 3.98 k

Δ₁c = 9.3/3.98 = 2.35 ⇒ 1.08 > 1.0 → N.G.
USE 2" SPACING TO CREATE MORE RIGID CONNECTION

2" SPACING

\[ \frac{4.3k}{3 \text{ bolts}} = 1.43k \]

\[ \Delta_1c = \frac{143k}{5.98k} = 23.6 \leq 10 \]

MIN SPACING
2\" BOLTS = 2\"/3(1/2) = 1.33"
⇒ USE 2" W/ 3 BOLTS FOR MORE RIGID CONNECTION
FOOTING CONT'D

COL ON PF1G
COL ON 6" x 6" BASC R BEARING

\[ t_{\text{min}} = \frac{2P_e}{\sqrt{f_{fy}N_{s}b}} \quad (\text{AISC 19-79}) \]

\[ 1.25 \sqrt{\frac{2(38.2k)}{0.9(36\text{ in})(6\text{ in})}} \]

\[ t_{\text{min}} = 0.157" \Rightarrow \text{USE 3/16" R BEARING} \]

CHECK BOLT THROUGH R & NOOD
62k IN TENSION

1/2" A307 BOLT  \[ f_{yt} = 45 \text{ ksi} \quad (\text{AISC TJ3.2}) \]

\[ \phi R_n^2 \phi F_n A_d \quad (J3-1) \]

\[ 0.75(45 \text{ ksi})(0.125)^2 \pi \]

\[ 0.02k \quad A_c = \frac{0.12}{0.02} = 0.9 < 1.0 \]

CLOSE TO 1.0,
USE TWO BOLTS FOR EVEN DISTRIBUTION ANYWAY
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<thead>
<tr>
<th>Joint</th>
<th>OutputCase</th>
<th>CaseType</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
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<tr>
<td>9</td>
<td>COMB4asdx</td>
<td>Combination</td>
<td>-0.116</td>
<td>-0.001277</td>
<td>-0.0046</td>
<td>0</td>
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<td>0</td>
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<td>12</td>
<td>COMB1asd</td>
<td>Combination</td>
<td>-0.000765</td>
<td>-0.001272</td>
<td>0.395</td>
<td>0</td>
<td>0</td>
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<td>COMB2ASDx</td>
<td>Combination</td>
<td>-0.092</td>
<td>-0.014</td>
<td>6.222</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>12</td>
<td>COMB3ASDy</td>
<td>Combination</td>
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<td>58</td>
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<td>COMB3asdx</td>
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<td>0.026</td>
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<td>-0.001143</td>
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<tr>
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<td>COMB2ASDx</td>
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Penetrator Load Capacity Chart - US lbs

Notes about Penetrator Load Capacity

- Field-tested vertical PULLOUT strength
- PUSHDOWN strength (as when Penetrators are used for footings) is typically equal to or greater than pullout strength because of unlimited undisturbed soil below the Penetrator
- When installed through asphalt, pullout strength is increased because of the Penetrator’s grip in the asphalt and in the compacted soil directly below the asphalt
Basic Load Cases

Diagrams

Load Case A

Load Case B

Notation

\[ a \] 10% of least horizontal dimension or 0.4 \( h \), whichever is smaller, but not less than either 4\% of least horizontal dimension or 3 ft (0.9 m).

**Exception:** For buildings with \( \theta = 0 \) to 7° and a least horizontal dimension greater than 300 ft (90 m), dimension \( a \) shall be limited to a maximum of 0.8 \( h \).

\[ h \] Mean roof height, in feet (meters), except that eave height shall be used for \( 0 \leq 10^\circ \).

\[ \theta \] Angle of plane of roof from horizontal, in degrees.

FIGURE 28.3-1 Main Wind Force Resisting System, Part 1 \([h \leq 60 \text{ ft} (h \leq 18.3 \text{ m})]\): External Pressure Coefficients, \((GC)_{\text{pr}}\), for Enclosed and Partially Enclosed Buildings—Low-Rise Walls and Roofs
Architectural Renders and Site Plan
Assembly, Transportation and Cost Estimate
<table>
<thead>
<tr>
<th>Material</th>
<th>Qty</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Total</th>
</tr>
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<tr>
<td>HSS Super Structure</td>
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<td></td>
<td></td>
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<tr>
<td>2 1/2&quot;x1/8&quot; HSS 300 LF</td>
<td>300 LF</td>
<td>$69.00 per 20'</td>
<td>$1,035.00</td>
<td></td>
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<tr>
<td>2&quot;x 1/8&quot; HSS 40 LF</td>
<td>40 LF</td>
<td>$55.00 per 20'</td>
<td>$110.00</td>
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<td>1/2 in.-13 x 4 in. Galvanized Hex Bolt 188 Count</td>
<td>188 Count</td>
<td>$2.16 each</td>
<td>$362.88</td>
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<tr>
<td>6 in. x 16 in. x 8 ft. Hem-Fir Brown Stain Ground Contact Pressure-Treated Lumber 104 LF</td>
<td>104 LF</td>
<td>$18.27 per 8'</td>
<td>$237.51</td>
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<tr>
<td>1/2 in.-13 x 4 in. Galvanized Hex Bolt 336 count</td>
<td>336 count</td>
<td>$0.46 each</td>
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<td>1/2 in. Galvanized Lock Washer 336 count</td>
<td>336 count</td>
<td>$0.31 each</td>
<td>$104.16</td>
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<td>4&quot;x8&quot;x1/4&quot; Plate Steel (A36) 5 counts</td>
<td>5 counts</td>
<td>$258.76 each</td>
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<td>SUM</td>
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<tbody>
<tr>
<td>1&quot;x 1/16&quot; Square Steel Tube 2600 LF</td>
<td>2600 LF</td>
<td>$11.00 per 20'</td>
<td>$1,430.00</td>
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<tr>
<td>1/4&quot; Square Bar</td>
<td>60 LF</td>
<td>$5.00 per 20'</td>
<td>$15.00</td>
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<tr>
<td>Stainless Steel Uncoated Wire Rope 3/32 in. x 200 ft</td>
<td>200 LF</td>
<td>$53.98 per 200'</td>
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<tr>
<td>48 in. x 96 in. x 0.157 in. Clear Corrugated Plastic Sheet (10-Pack) 6 Count</td>
<td>6 Count</td>
<td>$208.49 per pack</td>
<td>$1,250.94</td>
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<tr>
<td>Stainless Steel Hook and Eye Turnbuckle (5-Pack) 10-24 x 5-5/8 in. 1 Count</td>
<td>1 Count</td>
<td>$1.68</td>
<td>$1.68</td>
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<tr>
<td>3/8 in. x 4 in. Zinc-Plated Eye Bolt with Nut 4 Count</td>
<td>4 Count</td>
<td>$0.95</td>
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<td>3/8 in. Zinc-Plated Flat Washer 6 Count</td>
<td>6 Count</td>
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<td>Spray Paint/Primer</td>
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<td>Caulking</td>
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<td>1/2 4 ft. x 8 ft. Oriented Strand Board 10 Count</td>
<td>10 Count</td>
<td>$17.55</td>
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<td>2&quot;x4&quot;x96&quot; Stud 400 LF</td>
<td>400 LF</td>
<td>$3.00 per 8'</td>
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<tr>
<td>3 in. Construction Screw (10 lb.-Box) 2 Count</td>
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<td>$33.57 per 10lb box</td>
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<td>4&quot;x8&quot; x 5/8&quot; Dens Deck 10 Count</td>
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<td>$49.00</td>
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<td>Thermo Plastic Membrane</td>
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<td>$6.00 Per SF</td>
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**Module Totals**

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<td>Module 3 Total</td>
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<tr>
<td>TOTAL With 8 Bays</td>
<td>$15,978.40</td>
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PORTABILITY DIAGRAM

INSIDE USEABLE DIMENSIONS

Length: 23’5”
Width: 7’3”
Inside Height: 8’3”
Door Height: 6’10”

STEEL FRAME PORTABILITY

Members:
12’:
6’:
10’:
11’-8’:

NOTE
1. Heaviest Steel Member is 60#
WALL PORTABILITY

Divide of two parts of wall

DIMENSIONS OF MODULAR WALL

6’8”

4’6”
DESCRIPTION

This is depicting the mobility of the form. The plan is to build wood framed structures that hold and protect forms for transportation. There are 8 different frames that will be built for the different parts of the form. This form shows the largest shipping size, which can fit within the U haul. The heaviest mobility structure including the form is 120#.
Structural Calculation Package for

Wine History Project Moving Pavilion:
Bivouacky Shack

Site 1: Saucelito Canyon Winery Tasting Room
3180 Biddle Ranch Rd, San Luis Obispo, CA 93401

Rachel Jakel
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<td>D3</td>
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<tr>
<td>3. Key Plan</td>
<td>D4-D5</td>
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<td>5. Column Design</td>
<td>C1-C2</td>
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<td>7. Connections</td>
<td>J1-J9</td>
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<td>8. Footing Design</td>
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</tbody>
</table>
Project Description

The Wine History Project documents and preserves the unique food and wine history of San Luis Obispo County. This pavilion made for them will house their exhibits and travel from winery to winery in the San Luis Obispo County. The first site it will see is at the tasting room of Saucelito Canyon Winery. The design of the pavilion stemmed from a biomimetic relationship of the army ant and how they create shelter- the bivouac. The use of biomimicry in the design helps it to live and function at any site by adapting the way that the army ant would. Just as the army ant uses each individual member of the colony to create their bivouac, the Bivouacky Shack is made up of several different but similar elements that come together to form the pavilion for the Wine History Project.

The structure of the pavilion stands 10 feet tall and 12 feet wide with a length that can be adjusted to either 12, 18 or 24 feet with total square footage of 144, 216 or 288 respectively to fit the client’s desires. It is comprised of hollow structural steel for the gravity as well as lateral systems. From site to site the pavilion will be constructed on relatively flat ground and is connected to the ground via pressure treated wood bearing footings with earth anchors.

Design Criteria

1) Codes used:
   - International Building Code 2018
   - American Society of Civil Engineers 7-16
   - American Institute of Steel Construction 360-16

2) Design Loads:
   - Dead Loads- weights of all materials as shown per calculations
   - Live Loads- uniformly distributed- assumed as 10 psf uninhabitable attic without storage per ASCE 7-16 Table 4.3-1
   - Wind Loads per IBC, Exposure C and wind speed V of 95 mph based off process in ASCE 7-16.

3) Foundation Design:
   - With no geotechnical report provided and soil class unknown, worst case soil bearing pressure of 1000 psf will be used.
Material Criteria

1) Steel
   - For framing members, HSS SQ A500 used for beams columns and braces
2) Aluminum
   - Auger anchors for foundations
3) Timber
   - Pressure treated lumber for foundation bearing pads.

Load Takeoff

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSS 2.5x2.5x1/8</td>
<td>3.90 plf</td>
</tr>
<tr>
<td>1” SQ Steel Tube</td>
<td>1.20 plf</td>
</tr>
<tr>
<td>Corrugated Plastic</td>
<td>~.5 psf</td>
</tr>
</tbody>
</table>

SAP2000 Modeling Criteria

The model uses the same member type throughout and is modeled under worst case conditions with point loads at the midpoint of each beam and a partially closed wind load. All connections are modeled as pinned though they will have more rigidity when constructed. Dead loads are applied at worst case conditions and live as uniformly distributed based off of tributary area. Wind load is applied windward, leeward and as uplift pressure. LRFD load combinations were ran for design code checks and ASD combinations were ran for foundation design.
Sample Beam Calc

\[ P = 10 \text{ psf} \times \text{trib width (ft)} \]
\[ W = \text{live} \]
\[ E = 5000 \text{ psi} \]
\[ I = 1200 \text{ in}^4 \]

Load Combinations (Case 7/10 2.5:1)
1. \[ 1.4 \times 1A(500) = 700 \text{#} \]
2. \[ 1.2 \times 1.06 = 1.2(500) + 1.6(60 \times 10) = 1170 \text{#} \]

HSS 2.5 \times 2.5 \times \frac{1}{8}

\[ E = 29000 \text{ ksi} \]
\[ I = 0.998 \text{ in}^4 \]

\[ V_{\text{max}} = \frac{0.45k}{e} \]
\[ M_{\text{max}} = \frac{Wl}{8} + \frac{P l}{4} \]

\[ 1.0 \left( \frac{500(0^2)}{8} \right) + \frac{500(60)}{4} = 1.2 \]
\[ = 1.33 \times 15.910k'' \]

\[ D = \frac{5WL^4}{384EI} + \frac{PL^3}{4BE} \text{ (unfactored)} \]
\[ = \frac{5(500)(60)^4}{384(12)^4(9000)} + \frac{5(60)^3}{4(998)(29000)} \]
\[ = 0.19 \text{ in} \]
SAMPLE BIM CONTD

BENDING CHECK:

\[ \phi_{Mn} = \phi_f \frac{d}{c} \quad (AISC 360-10F) \]

\[ \phi_{Mn} = 0.9(50k\text{ksi})(447in^3) \]

\[ \phi_{Mn} = 42.05k'' > 15.91k'' \]

\[ \frac{d}{c} = \frac{15.91}{42.05} = 0.37 \leq 1.0 \checkmark \]

SHEAR CHECK:

\[ \phi_{Vn} = \phi (1.0F_y A_n C_n) \quad (AISC 360-01) \]

\[ \phi_{Vn} = 0.9(1.4)(50k\text{ksi})(1.0)(1.07in) \]

\[ \phi_{Vn} = 28.89k'' > .45k'' \]

\[ \frac{d}{c} = \frac{.45}{28.89} = .015 \leq 1.0 \checkmark \]

DEFLECTION CHECK:

ROOF MEMBER NOT SUPPORTING CEILING (IBC 2018 T1604.3)

LIVE

\[ \Delta_{allow} = \frac{L}{180} = \frac{12}{180} = 0.067 \text{in} \]

\[ \Delta_{actual} = \frac{5wL^4}{384EI} = \frac{5(1000lb)(12in)^4}{384(240\text{ksi})(1.98\text{in}^4)} = 0.00in \]

\[ 0.00in \text{ actual} \leq 0.067 \text{ in allow} \checkmark \]

DEAD + LIVE

\[ \Delta_{allow} = \frac{L}{120} = \frac{12}{120} = 0.10 \text{in} \]

\[ \Delta_{actual} = 0.19 \text{ in} \]

\[ 0.19 \text{ in actual} \leq 0.10 \text{ in allow} \checkmark \]
SAMPLE COLUMN CHECK:

\[ W = W_{\text{wind}} = 10.109 \text{ PSF (width \times 10') = 100.14 PLF} \]

\[ P_e = \text{live} = 100 \text{ PSF (10' \times 10' area)} = 3600 \text{ #} \]

\[ \text{dead} = 5000 \div 2 = 2500 \text{ #} \]

Load combo #2 controls. \( R = 450 \) (see BH calc R)

\[ P_e = 3 	ext{ BMS} \times 450 = \frac{1.35}{2} \]

HSS 2'1/2 x 2'1/2 x 1/8

Combined axial & bending (AISC310 C4 H)

\[ \frac{P_c}{P_e} = \frac{1.35 \text{ k}}{450 \text{ k}} \leq (\text{AISC310 T4-4}) = 0.09 < 0.2 \]

\[ P = 1.35 \text{ k} \]

\[ M_{\text{max}} = \frac{W_e^2}{8} = \frac{100.14(10)^2}{8} = 1.25 \text{ k} = 15 \text{ k} \]

\[ V_{\text{max}} = 0.5 \text{ k} \]

\[ A_{\text{max}} = 1.35 \text{ k} \]
SAMPLE BM CALC COUPD

\[ \frac{P_r}{P_c} \leq 0.2 \quad \text{(USE AISC EON H1-1b)} \]

\[ \frac{P_r}{2P_c} + \left( \frac{M_r}{W_c} \right) \leq 1.0 \]

\[ \frac{1.35k}{15.0k} + \frac{15.1k}{3.55k/12''/A} \leftarrow \text{AISC T3-13} \]

= 0.44 < 1.0 √
LATERAL WIND LOADS

PARTIALLY ENCLOSLED BLDG., LOW RISE BLDG

ASCE 7-110 CH 28

1. RISK CATEGORY: II (ASCE 7-110 T1.5-1)

2. BASIC WIND SPEED V=95 MPH (ASCE 7-110 FIG 26.5-1B)

3. EXPOSURE CATEGORY: C (ASCE 26.7)

TOPOGRAPHIC FACTOR K_24: 1.0 (FLAT) (ASCE 7-110 26.8-1)

ENCLOSURE: PARTIALLY ENCLOSLED > HIGH INTERNAL PRESSURE (ASCE 26.13-1)

WIND DIRECTIONALITY K_0: 0.85 (ASCE 7-110 T 26.6-1)

GROUND ELEVATION FACTOR K_e: 1 (ASCE 7-110 26.9)

INTERNAL PRESSURE COEFFICIENT g_C,pc: 4.05 (ASCE 7-110 T 26.13-1)

4. VELOCITY PRESSURE EXPOSED COEFFICIENT k_0/k_e: 0.85 (ASCE 7-110 T 26.10-1)

5. VELOCITY PRESSURE g_2/g_0: (ASCE 7-110 EQN 26.10.1)

\[ g_2 = 0.00256 K_2 K_2 e K_1 K_e V^2 \quad (\text{lb/ft}^2) \]

\[ = 0.00256(0.85)(1)(0.85)(1.0)(95)^2 \]

\[ = 110.69 \text{ lb/ft}^2 \]
D. EXTERNAL PRESSURE COEFFICIENT (GC)  (ASCE 7-10 Fig 28.3-1)

Load Case A

<table>
<thead>
<tr>
<th>θ = 0°</th>
<th>1  2  3  4  5  6  7  8  9</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>2.09</td>
</tr>
</tbody>
</table>

Load Case B

<table>
<thead>
<tr>
<th>θ = 0°</th>
<th>1  2  3  4  5  6  7  8  9</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.45</td>
<td>-0.61</td>
</tr>
</tbody>
</table>

7. WIND PRESSURE P  (ASCE 7-10 28.3-1)

\[ P = g_n \times (GC_{pf} - GC_{pc}) \times 1 \times 2 \]

\[ P_a = 16.69 \times (0.4 + 0.55) = 15.85 \text{ psf} \]

\[ P_b = 16.69 \times (-0.69 - 0.55) = -20.69 \text{ psf} \]

\[ P_c = 16.69 \times (0.37 - 0.55) = -13.35 \text{ psf} \]

\[ P_d = 16.69 \times (-0.27 - 0.55) = -14.02 \text{ psf} \]

\[ P_e = 16.69 \times (-0.45 - 0.55) = -16.09 \text{ psf} \]

\[ P_f = 16.69 \times (-0.69 - 0.55) = -20.69 \text{ psf} \]

\[ P_g = 16.69 \times (0.37 - 0.55) = -13.35 \text{ psf} \]

\[ P_h = 16.69 \times (-0.45 - 0.55) = -16.09 \text{ psf} \]

\[ P_i = 16.69 \times (0.4 + 0.55) = 15.85 \text{ psf} \]

\[ P_j = 16.69 \times (-0.27 - 0.55) = -14.02 \text{ psf} \]

*P not to be less than 10 psf on walls & 8 psf on roof  (ASCE 7-10 28.3.4)*
SAMPLE BRACE CALCULATION

\[ W = 100 \times 0.0931 \times (8 \text{ ft} \times 10 \text{ in}) \times 10 \text{ ft} = 1001.4 \text{#} \]

\[ F_{brace} = \frac{W}{10} = \frac{1001.4}{10} \]

\[ F_0 = 195 \text{ k} \] (T & C for W in both directions)

\[ P_0 = 500 \text{#} \] (from BM calc)

\[ W_L = 100 \text{#} \] (from BM calc)

LOAD COMPOS (ASCE7-10 2.3.1)

A. 1.2D + 1.0W + 1.0L = 1.2(5.5) + 1.95k + .09(3.5) = 2.43k ON BRACE C

1.2(5.5) - 1.95k + .09(3.5) = -1.47k ON BRACE T

\[ P_0 = 2.43k \text{ CONTROLS (C)} \]

\[ \phi P_0 = 10.9\% \text{ (CONSERVATIVE @ 12\% ASCE8500 T.4-4)} \]

\[ \frac{d}{c} = \frac{2.43}{10.9} = 0.22 \leq 1.0 \]
BEAM ON TOP OF COLUMN DETAIL

HSS 2.5X2.5X1/8

0' - 1"
0' - 2"
0' - 1"

1/8" PL TYP

1/2" BOLT TYP

HSS 2.5X2.5X1/8
BEAM ON TOP OF COLUMN

RUN FROM BM → SEE BM CALCS

\[ R_b = 450 \text{ kips} \]

\[ P_u = 450 \times 0.2 = 90 \text{ kips} \]

BEARING:

\[ \sigma = \frac{P}{A} = \frac{90}{1.9 + 112^2} \approx 0.05 \text{ ksi} \]

\[ f_{y,HS} = 50 \text{ ksi} > \sigma \text{ BEARING} \checkmark \]

BOLTS FOR SHEAR:

WIND ~17 psf, FROM WIND CALCS

\[ C_{BM} (10/2 \times 6') (17 \text{ psf}) = 510 \text{ kips} \]

USE 1/2" A325 BOLT

Rupture on HSS

\[ \phi R_n = \phi V F_t A_n \]

\[ = 75.6 \times 12 \times 0.256 \times (20 - (5 + 0.12) \times 0.12) \]

\[ \phi R_n = 0.12 \text{ ksi} \]

\[ \phi C = 0.5 \text{ ksi} \]

\[ \phi R_n = 0.06 \text{ ksi} \]

\[ \phi C = 0.06 \text{ ksi} \]

\[ \phi C = 0.06 < 1.0 \text{ ksi} \]

Yield on HSS

\[ \phi R_n = 0.6 \text{ ksi} \]

\[ 1.0 \times 12 \times 0.256 \times (20 - (5 + 0.12) \times 0.12) \]

\[ \phi R_n = 8.7 \text{ ksi} \]

\[ \phi C = 51/8.7 = 0.6 < 1.0 \text{ ksi} \]
BEAM ON COL COVID

STEEL:

ROPE ON STEEL TAB:

\[
\phi_{kn} = 0.6 F_y A_{eq}
\]

\[
= 0.6 \times 58.0 \times \frac{1}{2} \times (2.5 - 0.125) (125''^2)
\]

\[
= 0.625 \times 0.51 \times 0.125 = 0.08 < 1.0
\]

YIELD ON STEEL TAB:

\[
\phi_{kn} = 0.6 F_y A_{eq}
\]

\[
= 0.6 \times 58.0 \times \frac{1}{2} \times (2.5 - 0.125) (125''^2)
\]

\[
\phi_{kn} = 0.75 \times 0.51 / 0.75 = 0.18 < 1.0
\]

1/2' A367 BOLT IN STEEL:

\[
\phi_{kn} = \frac{\phi_{kn A_{eq}}}{A_{eq}} = \frac{1.32}{12}
\]

\[
= 3.98 \times 2.71 (\text{ksi}) (\pi/12)^2
\]

\[
\phi_{kn} = 3.98 \times 0.51 / 3.98 = 0.13 < 1.0
\]

1/2" A367 BOLT IN 2'x2'x2'x 1/2" HSS "W' HOLE OKAY"!

BOLT SUFFICIENT USE TWO TO CREATE A MORE
RIGID CONNECTION
BEAM TO COLUMN DETAIL

HSS 2.5X2.5X1/8

0' - 1"

0' - 2"

0' - 1"

1/2" BOLT TYP

HSS 2.5X2.5X1/8

3/16

3/16
BEAM TO COL CONNECTION:

**RAN FROM BIM SEE BIM CALLS (WORST CASE)**

R = 150#

**Rupture on HSS:**

\[ \Phi_{RN} = \Phi_{W} \cdot F_{u} \cdot A_{n} \cdot \left( \frac{L}{2} \right) \]

\[ \Phi_{RN} = 0.07 \text{ k} < 1.5 \text{ k} \]

\[ \frac{d}{L} = \frac{0.15}{0.07} = 0.02 < 1.0 \text{ k} \]

**YIELD on HSS:**

\[ \Phi_{RN} = \Phi_{W} \cdot F_{u} \cdot A_{n} \cdot \left( \frac{L}{2} \right) \]

\[ \Phi_{RN} = 8.7 \text{ k} \]

\[ \frac{d}{L} = \frac{0.15}{8.7} = 0.02 < 1.0 \text{ k} \]

**Rupture on Flange**

\[ \Phi_{RN} = \Phi_{W} \cdot F_{u} \cdot A_{n} \cdot \left( \frac{L}{2} \right) \]

\[ \Phi_{RN} = 10.12 \text{ k} \]

\[ \frac{d}{L} = \frac{0.15}{10.12} = 0.02 < 1.0 \text{ k} \]

**Yield on Flange**

\[ \Phi_{RN} = \Phi_{W} \cdot F_{u} \cdot A_{n} \cdot \left( \frac{L}{2} \right) \]

\[ \Phi_{RN} = 6.75 \text{ k} \]

\[ \frac{d}{L} = \frac{0.15}{6.75} = 0.02 < 1.0 \text{ k} \]
BEAM TO COL COND

BEARING:

DIMENSIONAL LIMITATIONS PER AISC CH 10

\[ L_{eff} = 2d - 2(\frac{1}{2}) = 1\text{ in} \]

\[ L_{eff} = 1\text{ in} \]

\[ L_p = \frac{\phi_d 4}{2} + \frac{1}{16} = \frac{1}{2} + \frac{1}{16} = 0.3125 \]

\[ 1/8" P \leq 0.125 < 0.3125 \checkmark \]

BEARING OF BOLT ON SHEAR TAB:

AISC EQ J3-6A

\[ \phi_Rn = \phi_d Ad_f \]

\[ \phi R_n = 0.85(2.4)(0.75)(60000) \]

\[ \phi R_n = 605.25 \text{ k} \]

\[ d/c = 0.15/0.25 = 0.6 \leq 1.0 \]

WELD: (FLUENT STRENGTH)

\[ \phi R_n = \phi FwAwe \ (AISC J2.4) \]

\[ 75(0.707)(1/16)(1.0)(0.6)(70000) \]

\[ \phi R_n = 1.392 \text{ k/in/m" OF FLUENT} \]

USE MIN 3/16" WELD \[ \phi R_n = 1.392(3)(2.5\text{ in}) = 10.44\text{ k} \]

3/16" WELD 2.5" LONG
BEAM TO COL COND:
WELD COND:
IN DIRECTION OF LOADING →

YIELD:

\[ \Phi R_y = \Phi F_{yBm} A_{bm} \]
\[ = 1.0 (0.6 F_y) (t_c) \]
\[ = 1.0 (0.6)(30,000)(\frac{1}{8})(125) \]
\[ \Phi R_y = 8.150 k \quad d/l_c = 0.75/0.75 = 1.02 < 1.0 \]

RUPTURE:

\[ \Phi R_p = \Phi F_{pBm} A_{pm} \]
\[ = 0.75(0.6)(30,000)(\frac{1}{8})(125) \]
\[ \Phi R_p = 8.150 k \quad d/l_c = 0.75/0.75 = 1.02 < 1.0 \]

GRAVITY ON WELD ↓, SHEAR↓
ASO 1/8" FL. SHEAR TAB

YIELD:

\[ \Phi R_y = 0.6 F_{yA} A_{bm} \]
\[ = 0.6(30,000)(2.5)(125) \]
\[ \Phi R_y = 6.750 k \quad d/l_c = 0.75/0.75 = 1.02 < 1.0 \]

RUPTURE:

\[ \Phi R_p = 0.75(0.6)(30,000)(2.5)(125) \]
\[ \Phi R_p = 8.150 k \quad d/l_c = 0.75/0.75 = 1.02 < 1.0 \]
BEAM TO COL CONNECT

1/2" BOLT IN SHEAR (A325)

$$\phi R_n = \phi F_n A_b$$

$$0.75 (2\pi 0.8) (\pi) (1.5/2)^2$$

$$\phi R_n = 3386$$

$$d/l = 0.15 \text{in}$$

1/2" A325 BOLT IN 2'12" x 2'12" x 1/8" HSS W/ 3/8" OKAY

1 BOLT SUFFICIENT USE TWO TO CREATE A MORE RIGID CONNECTION
BRACE DETAIL

HSS 2.5X2.5X1/8

1/2" BOLT

HSS 2.5X2.5X1/8

3/16" WELD

HSS 3X3X3/16

1/2" BOLT TYP

6" SQ 1/8" PL
SPACe CONNECTION

\[ F_0 = 1.95k \quad \theta = \tan^{-1}(19\%) = 9^\circ \]

\[ F_x = 1.95\cos 59^\circ = 1.00k \]
\[ F_y = 1.95\sin 59^\circ = 1.17k \]

STEER:

RUPTURE ON HSS (AISC Eqn J9.1)

\[ \phi_{Rn} = \phi_{G} F_{Auv} \]
\[ = 1.75(0.6)(0.24kSI)(2.5 - (0.2 + 0.18))(0.116) \]
\[ \phi_{Rn} = 10.1k \quad d/c = 1.95/10.11 = 0.2 < 1.0^2 \]

YIELD ON HSS

\[ \phi_{Rn} = \phi_{G} F_{Auv} \]
\[ = 1.75(0.6)(50kSI)(2.5'' \times 0.116) \]
\[ \phi_{Rn} = 8.7k \quad d/c = 1.95/8.7 = 0.22 < 1.0^2 \]

RUPTURE ON STEER TAB:

\[ \phi_{Rn} = \phi_{G} F_{Auv} \]
\[ = 1.75(0.6)(38kSI)(2.5 - (0.2 + 0.18))(0.125) \]
\[ \phi_{Rn} = 6.1 \quad d/c = 1.95/6.1 = 0.32 < 1.0^2 \]

YIELD ON STEER TAB:

\[ \phi_{Rn} = \phi_{G} F_{Auv} \]
\[ = 1.75(0.6)(30kSI)(2.5'' \times 0.125) \]
\[ \phi_{Rn} = 6.75k \quad d/c = 1.95/6.75 = 0.3 < 1.0^2 \]
WELD:

**Filler Weld Strength**

\[ \Phi_n = \Phi_f \frac{A_{we}}{A_{se}} \quad (AISC J2.4) \]

\[ \Rightarrow \Phi_n = 10.44k \quad \text{FOR 3/16" FILLER WELD 2S" COX} \]

(5 SEE BM TO COL FOR FULL CALL)

**In Direction of Loading** →

**Yield**

\[ \Phi_n = \Phi_f n_{B_m} A_{B_m} \]

\[ (1.0)(1.0)(30\times8)(\frac{1}{8})(2.5) \]

\[ \Phi_n = 6.75k > 1k \]

\[ \frac{d_c}{c} = \frac{1}{6.75} = 0.15 < 1.0 \]

**Rupture**

\[ \Phi_n = \Phi_f n_{B_m} A_{B_m} \]

\[ 175(1.6)(58\times8)(\frac{1}{8})(2.5) \]

\[ \Phi_n = 8.15k > 1k \]

\[ \frac{d_c}{c} = \frac{1}{8.15} = 0.12 < 1.0 \]
BRACE CONNECTION CONTO

GRAVITY ON WELD, SI/ZAR

FLANGE PLATE
A36 1/8" R

YIELD
\[ \phi R_n = 0.10 \sqrt{A} \]
\[ = 0.10 \times 10^8 \text{ksi} \times (2.5\")(0.125\"") \]
\[ = 0.75 \text{ksi} > 1.07 \text{ksi} \]
\[ \frac{q}{q_{n}} = \frac{1.07}{0.75} = 1.4 < 1.0 \]

RUPTURE
\[ \phi R_n = 0.75 \times 10^{8} \text{ksi} \times (2.5\")(0.125\"") \]
\[ = 8.156 \text{ksi} > 1.07 \text{ksi} \]
\[ \frac{q}{q_{n}} = \frac{1.07}{8.156} = 0.13 < 1.0 \]
FORM TO BEAM DETAIL

HSS 2.5X2.5X1/8

0' - 1"

1/8" PL TYP

1" SQ TUBE

1/2" BOLT TYP

3/16
FORM TO BEAM CONNECTION

RXN OF FORM : \( \frac{5000 \times 1/2}{\text{Worst Case}} = 250 \) #

BLU RXN = \( \frac{250}{2} = 125 \) #

SHEAR:

Rupture on tube
\( \phi_R = 0.6F_y \alpha \nu \)
\( 0.75(16)(62.5)(1) - 1.5(1.5)(0.0246) \)
\( \phi_R = 250 \text{ kN} \quad d_k = 0.125 / 0.75 = 0.19 < 1.0 \)

Yield on tube
\( \phi_R = 0.6F_y A_{qu} \)
\( 1.0(6)(50)(5)(1.0)(0.0246) \)
\( \phi_R = 738 \text{ kN} \quad d_k = 125 / 738 = 0.17 < 1.0 \)

Rupture on shear tab:
\( \phi_R = 0.6F_y \alpha \nu \)
\( = 0.75(6)(58.5)(1 - 0.5(1.8))(0.125) \)
\( \phi_R = 819 \text{ kN} \quad d_k = 125 / 815 = 0.15 < 1.0 \)

Yield on shear tab:
\( \phi_R = 0.6F_y A_{qu} \)
\( = 1.0(6)(50)(5)(1.0)(0.12) \)
\( \phi_R = 270 \text{ kN} \quad d_k = 125 / 270 = 0.46 < 1.0 \)
**FEM TO BEAM CONNECTION CONID**

1/2" BOLT IN SHEAR

\[ \phi P_n = \phi P_n A_v \]

\[ = 54 \text{ ksi} \times \pi \times \left( \frac{1}{2} \right)^2 \]

\[ \phi P_n = 7.95 \text{ k}\]

\[ d/l_c = 0.125 / 3.05 = 0.0415 \leq 1.0 \]

**BEARING**

**DIMENSIONAL LIMITATIONS PER AISI CH 10**

\[ L_{th} \geq 2a = 2(1/2) = 1" \]

\[ t_p \leq \frac{d_{bolt}}{2} + \frac{1}{16}" \]

\[ = \frac{1}{2} + \frac{1}{16} = 0.3125" \]

1/8" \leq 0.3125" \checkmark

1/8" REL. OK

**BEARING OF BOLT ON SHEAR TAB**

(AISI EQ. 3.6a)

\[ \phi n P = \phi 24 d_{bf} u \]

\[ = 0.75 (24) (1/2) (1/8) (68 \text{ k}) \]

\[ \phi P_n = 6.525 \text{ k} \]

\[ d/l_c = 0.125 / 6.525 = 0.02 \leq 1.0 \]
FOOTING DESIGN

WORST GRAVITY CASE:

2.3k ft from SAP Analysis (see Appendix)

Use soil bearing pressure $F_b = 1000$ psi (worst case)

$5\frac{0}{A} = 1000$ psi = $2300\frac{\text{lb}}{A}$

$A = 2.3\text{ ft}^2$

Use 1.6" x 1.3" ft6 pressure treated lumber

Un 16 w/ 6" square bearing flisors

$1.6\times1.3\frac{\text{in}}{\text{in}} = 2.08\text{in}^2 < 2.3\text{ft}^2$ but bearing from earth anchors will cover .22 extra sf.

CHECK $F_{cl}$ ON TIMBER

$F_{cl} = \frac{E_{kn}}{A_{bearing}}$

$\frac{2300}{6\text{in}^2} = 383.33$ psi

C1 grade 2 DFC = 625 psi L&NDS 2015 4A

$F_{cl}$ allow = 625 psi > $F_{cl}$ actual 63.89 psi
FOOTING CONTO
WORST UPLIFT CASE:
1.4 FT FROM SAP ANALYSIS
UNKNOWN SOIL CLASSIFICATIONS
ASSUME SILTY/CLAYEY SAND
USE AMERICAN EARTH ANCHORS, SEE APPENDIX FOR CAPACITIES
36" PE360
REASON CAPACITY ~ 2000# BET THIS SOIL CONDITION
USE TWO TO OVERESTIMATE FOR UNKNOWN SOIL
CAPACITY ~ 4200#
\[ d/c = 1.4/4.2 = \frac{1.33}{1.0} < 1.0 \]
CHECK SLIDING:
\[ P_{\text{wind}} = 2.50 \quad \text{COEFFICIENT OF FRICTION} \]
VERT RUN FROM SAP .2k \( \neq \) GRAVITY
\[
\begin{align*}
X_{\text{RUN}} &= .0000786k \\
Y_{\text{RUN}} &= .0000526k \\
\end{align*}
\]
\[ X_{\text{RUN}} = .0000786k > .0000526k \quad \checkmark \\
.0000786k > .0000526k \quad \checkmark \]
UPLIFT SEE SAP RESULTS

SAP RUN = 1.4 k WORST CASE

\[
2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{16} HSS
\]

\[
3 \times 3 \times \frac{3}{16} HSS
\]

- COL. DIM = 2.5"
- FIT CASE: DIM = 3 - 2(3\frac{3}{4}) = 26.25"
- 2.625" > 2.5" OK

CHECK BOLTS (1/2") TIEARAD:

SPACING & EDGE DISTANCE

MIN EDGE DIST = 3/4" (AISC-J3.4)

1/2" BOLT IN DOUBLE SHEAR (HSS) THREADS EXCLUDED

\[
\phi_n = \phi_n A_b \quad (AISC-J3.1)
\]

\[
\phi_n = 75(27 \text{ ksi}) (1/2)^{2/3} \quad (27 \text{ ksi FROM T.53.2})
\]

\[
\phi_n = 3.78 \quad a/c = 1.4 / 0.98 = 0.85 < 1.0
\]

MIN SPACING

\[
2\frac{1}{2}a_d = 2\frac{1}{2}(1/2) = 1.33"
\]

USE 2" SPACING & 3 BOLTS TO CREATE A MORE RIGID CONNECTION
FOOTING CONT'D

COL ON FTG

COL ON 6" x 6" BASE & BEARING

\[ t_{\text{min}} = \frac{4}{\sqrt{1.25 \cdot 0.9}} \left( \frac{2R_p}{F_{\text{ult}} \cdot 0.6} \right) \] (AISC M-76)

\[ = 1.25 \cdot \frac{2(2.3k)}{0.9(30\text{ksi})(0.6)} \]

\[ t_{\text{min}} = 0.678 \text{ in} \quad \Rightarrow \text{USE } \frac{7}{8} \text{" RC BEARING} \]

CHECK BOLT THROUGH BEARING R \& WOOD

1.9 k IN TENSION

\[ \frac{1}{2} " \text{ A325 BOLT F_{\text{ult}} = 43.5\text{ksi}} \] (AISC T13.2)

\[ \phi \cdot R_0 = \phi \cdot F_{\text{ult}} \cdot A_b \] (T3-1)

\[ = 0.75(43.5\text{ksi})(\frac{1}{2})^2 \pi \]

\[ = 6.62k \quad \text{CHECK: } 1.4/1.62 \leq 0.2 \leq 1.0 \text{V} \]

USE TWO BOLTS FOR EVEN DISTRIBUTION
<table>
<thead>
<tr>
<th>Joint</th>
<th>OutputCase</th>
<th>CaseType</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
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<td>COMB3asdx</td>
<td>Combination</td>
<td>-0.557</td>
<td>0.008486</td>
<td>0.426</td>
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<td>0</td>
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<td>-0.059</td>
<td>0.452</td>
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</tbody>
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Penetrator Load Capacity Chart - US lbs

Notes about Penetrator Load Capacity

- Field-tested vertical PULLOUT strength
- PUSHDOWN strength (as when Penetrators are used for footings) is typically equal to or greater than pullout strength because of unlimited undisturbed soil below the Penetrator
- When installed through asphalt, pullout strength is increased because of the Penetrator's grip in the asphalt and in the compacted soil directly below the asphalt
Notation

\( a \)

10\% of least horizontal dimension or 0.4 \( h \), whichever is smaller, but not less than either 4\% of least horizontal dimension or 3 ft (0.9 m).

\textbf{Exception:} For buildings with \( \theta = 0 \) to 7° and a least horizontal dimension greater than 300 ft (90 m), dimension \( a \) shall be limited to a maximum of 0.8 \( h \).

\( h \)

Mean roof height, in feet (meters), except that eave height shall be used for \( \theta \leq 10° \).

\( \theta \)

Angle of plane of roof from horizontal, in degrees.

\textbf{FIGURE 28.3-1 Main Wind Force Resisting System, Part 1 \([h \leq 60 \text{ ft} (h \leq 18.3 \text{ m})]\): External Pressure Coefficients, \((G_{p})\), for Enclosed and Partially Enclosed Buildings—Low-Rise Walls and Roofs}
Credits

Renderings and Site Plan

Project “In Bloom”  Moises De La Cruz
                     Mereck Palazzo

Project “Bivouackly Shack”  Erica David
                           Jerome Deck
                           Alex Urasaki

Assembly, Transportation and Cost Estimate

Project “In Bloom”  Albert Gutierrez

Project “Bivouackly Shack”  Gannon Van Sickle