Existing Conditions - March 2017

MODULAR HOUSE
SENIOR PROJECT

ARCE & CM

BUILDING 21 - 122E
CALIFORNIA POLYTECHNIC
STATE UNIVERSITY
SAN LUIS OBISPO, 93401

STAMP:

DRAWN BY:
Chris Martinez

DATE:
5/2/17

DRAWING TITLE:
Existing Conditions Rendering

SCALE:

SHEET NUMBER:
T.0.01
Phase I Construction - June 2017
Phase II Construction - December 2017
Modular House Project Narrative
Senior Project - Spring 2017

Completed by:
Kevin Chiang · Spencer Dilley · Sarah Dowthwaite
Trevor Houghton · Ryan Lefebvre · Michele Leung
Cameron Lober · Chris Martinez · Katie Mayer
February 24, 2017

Project Summary
The Modular House, located in Poly Canyon, has seen extensive damage since the last caretaker left nearly ten years ago. To prevent further damage and improve the safety and appeal of the structure, we are proposing a renovation of the existing building that removes the existing cladding and partitions. By the end of Spring Quarter 2017, the Modular House will have a guardrail system replacing the wood paneling on the walls and a new steel composite deck to replace the current flooring system. The structural steel framing system will remain as is.

Purpose
The Modular House has been subject to the most damage due to vandalism in Poly Canyon. After the last caretaker left in 2010, steps were taken to preserve the structures. The Modular House used to be a symbol of livelihood in the area and was once used as housing for the caretaker of the canyon. Now, it is a boarded up house. We hope to revive this structure by improving its structural and aesthetic qualities, thereby creating a safe and welcoming space for the Cal Poly community to utilize and enjoy.

Our focus is a remodel of the Modular House which emphasizes the unique structural and architectural aspects of the house. In terms of architectural design, what makes the house unique are the road signs that act as the building’s skin. In terms of structural design, the house was built using 8’0” cubes with a few forty-five degree offsets around the perimeter of the house. Our goal is to highlight the frames and utilize them in the design of a new guardrail system.

The new design will remove all of the walls from the structure, revealing the cubic modules, and will replace the perimeter walls with a guardrail that integrates the road signs into the design. This will effectively transform the structure from a closed off house into an open observation deck (overlooks a creek) to be used by the public.

Multi-Phase Project
**With this being such a large project to finish in 10 weeks, the construction will be split into two phases. We propose to complete Phase I, which will offer a new usable space, while Phase II will bring the addition of a 2nd level and the connecting stairs.**

Phase I: A complete demolition of the walls, roof, and floor will be performed. The new floor (LW concrete over steel decking) and guardrails for the first level will be installed.

Phase II: The second level guardrails and floor will be added, as well as the linking stairs and structural components necessary for the stairs (footings and columns). Since the design of the guardrails and floor will have been completed in Phase I, the design focus of Phase II will be the stairs.
Scope of Work (Phase I)

**Design:** This project will include the design of a new guardrail system, connections between the rails and the existing frame, and a new steel deck with concrete fill. The Modular House will have a new guardrail system surrounding every exterior side on both the lower and upper levels. We will be incorporating the existing road signs from the south wall of the structure into the design to maintain the unique charm they currently give to the Modular house. The guardrail will be made of steel for ease of connection to the frame through welds. These connections will be designed to ensure adequate strength. Additionally, a steel deck with concrete fill will be designed to replace the existing deck on both floors. A seismic analysis will be performed on the structure to ensure that the proposed solution will be adequate for the canyon. Analysis will also be performed on the existing structure to confirm that the structure is adequate for continuation of proposed design.

**Demolition/Construction:** For the repair and remodel for the Modular House, the following is a deconstruction and construction phase as proposed. The goal is to deconstruct the original modular house while maintaining the structural frame. For demolition, the interior and non-structural components (cabinets, furniture and other design aspects) are to be removed from the structure first. Following the removal of non-structural components will be the removal of the exterior walls whilst preserving the original signs. The signs will be reused for use of the handrail design. All waste will be disposed and removed from the premise to begin construction. The tentative construction phase proposal shall consist of the finalised design as described in the section above. All construction pertaining to the structural aspect of the building shall be completed first. Following the completion of the structural portion of construction will be the architectural finishes as proposed.

**Existing Repairs:** The floors will be removed and replaced with a new steel deck with concrete fill. Any decking that is damaged should also be replaced with new materials. For all other components of the Modular House, anything that is damaged, either by natural weathering or intentional mischief, shall be replaced and repaired. After all demolition is complete, a survey and analysis of the existing frame will be done, and then construction of the remodel will begin.

**Timeline:** The timeline below shows a tentative schedule of this project.

<table>
<thead>
<tr>
<th>Date</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late February 2017</td>
<td>Conduct Site Investigation</td>
</tr>
<tr>
<td>Mid March 2017</td>
<td>Complete Structural Analysis and Design</td>
</tr>
<tr>
<td>Late April 2017</td>
<td>Complete Permit to Send Off for Approval</td>
</tr>
<tr>
<td>Early May 2017</td>
<td>Begin Demolition</td>
</tr>
<tr>
<td>Late May 2017</td>
<td>Begin Panel Prefabrication</td>
</tr>
<tr>
<td>Early June 2017</td>
<td>Complete Phase I</td>
</tr>
</tbody>
</table>
NOTES:
1. ALL FOOTINGS AND COLUMNS CURRENTLY EXIST UNLESS LABELED (N)
2. (N) COLUMNS AND FOOTINGS ARE PART OF PHASE 2
3. ALL EXISTING FOOTINGS ARE 16.75" SQ. AND (N) FOOTINGS WILL BE MADE TO MATCH
4. ALL EXISTING COLUMNS ARE TS3x3x3/16 AND (N) COLUMNS WILL BE HSS3x3x3/16
5. TOP OF FOOTING ELEVATIONS VARY

- 8'-4" 8'-4" 8'-4"
- 25'-0"
- 5'-10 3/4"
- 6'-10 3/4" 6'-10 3/4" 6'-10 3/4"
- 4'-2" 4'-2" 4'-2"

SCALE: 1/4" = 1'-0"
NOTES:
1. TYP. ELEVATION: 0'-0" (ELEVATION DATUM IS TOP OF FIRST FLOOR)
2. ALL BEAMS & COLUMNS ARE EXISTING UNLESS LABELED (N)
3. ALL EXISTING COLUMNS ARE TS5x3x3/16
4. (N) FLOOR IS 1 1/2" LW CONCRETE FILL OVER 18 GAGE VERCO PLB
   FORMLOK DECK. SPAN DENOTES SPAN DIRECTION FOR METAL DECK
5. TOP OF CONCRETE SLAB IS RELATIVE TO TYPICAL FLOOR ELEVATION
6. TYPICAL TOP OF STEEL ELEVATION IS (+0'-0") RELATIVE TO TOP OF
   CONCRETE ELEVATION
7. ALL STEPS AND STAIRS ARE 36" WIDE

LEVEL 1 FRAMING
1/4" = 1'-0"

1ST FLOOR PLAN

1/4" = 1'-0"
NOTES:
1. SECOND FLOOR SLAB AND STAIRS ARE PART OF PHASE 2
2. TYP. ELEVATION: 8'-4" (TOP OF FLOOR)
3. ALL BEAMS & COLUMNS ARE EXISTING UNLESS LABELED (N)
4. SEE SHEET NOTES ON DWG S.3.2 FOR ADDITIONAL INFORMATION

LEVEL 2 FRAMING
1/4" = 1'-0"
NOTES:
1. TYP. ELEVATION: 16'-8" (TOP OF BEAM)
2. TYPICAL TOP OF STEEL IS (+0'-0") RELATIVE TO TYP. ELEVATION, UNLESS NOTED OTHERWISE.

1. TYP. ELEVATION: 16'-8" (TOP OF BEAM)
2. TYPICAL TOP OF STEEL IS (+0'-0") RELATIVE TO TYP. ELEVATION, UNLESS NOTED OTHERWISE.

1/4" = 1'-0"

ROOF FRAMING

5/2/17

DRAWING TITLE: ROOF PLAN

ARCHITECT: RYAN LEFEBVRE

BUILDING 21 - CSE
CALIFORNIA POLYTECHNIC STATE UNIVERSITY
SAN LUIS OBISPO, 93401

DRAWN BY:

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SAN LUIS OBISPO, 93401

DRAWN BY:
GUARD RAIL EXTERIOR TYP.

3/4" = 1'-0"
GUARD RAIL INTERIOR TYP.

1/4" = 1'-0"
1. PANEL TO GUARD RAIL - TOP
   1 1/2" = 1'-0"

2. PANEL CONNECTION - TOP
   3" = 1'-0"

3. PANEL TO GUARD RAIL - BOTTOM
   1 1/2" = 1'-0"

4. PANEL CONNECTION - BOTTOM
   3" = 1'-0"
1 PANEL CONNECTION TYP.

2 SIGN CONNECTION

STOP SIGN: GUARDRAIL IN-FILL
L1-1/2x1-1/2x1/8
1/8

STOP SIGN: GUARDRAIL IN-FILL
L1-1/2x1-1/2x1/8
1/4" DIAM. BOLT

1/8 TYP.
GUARD RAIL EXTERIOR 5'-10 3/4"

1"

2' - 8 3/8"

1"

3' - 6"

5' - 10 3/4"

1/4" = 1'-0"

DRAWN BY: RYAN LEFEBVRE

5/2/17

DRAWING TITLE: ATYPICAL GUARD RAILS

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

SHEET NUMBER: S.3.16
DECKING CONNECTION

3" = 1'-0"

JOINT SEALANT
1/2" DIAM. BACKER ROD
4x4 - W2xW2 WWF

1/4"

(N) 18G. VERCO PLB DECKING w/ LW CONC.
1/2" DIAM. SPOT WELD @ 12" OC

(E) L2x2x3/16 w/ 3/4" PLUG WELD @ 2" OC

(E) TS5x3x3/16
MONO-STRINGER STEPS

1/4" THICK PL

HILTI SLEEVE ANCHOR,
HLC-HX 5/16 x 1-5/8,
5/16" DIAM. HOLE, 1.38" DEPTH

3" = 1'-0"
1 STEPS SECTION 1

1 1/2" = 1'-0"

1/8" THICK PL
PL 1/4" x 4" x 1'-1.25"
HSS 5" x 3" x 3/16"

2 STEPS SECTION 2

1 1/2" = 1'-0"

WHERE IN CONTACT

1/8"

1/2"

1 1/4"

PL 1/4" x 4" x 1'-1.25"
TS 5" x 3" x 3/16"
HSS 5" x 3" x 3/16"

3 STEPS SECTION 3

1 1/2" = 1'-0"

HSS 5" x 3" x 3/16"

1/4" THICK PL w/ (2)
3/8" DIAM. HOLES

HILTI SLEEVE ANCHOR,
HLC-HX 5/16" x 1-5/8,
5/16" DIAM. HOLE, 1.38" DEPTH

HILTI SLEEVE ANCHOR,
HLC-HX 5/16" x 1-5/8,
5/16" DIAM. HOLE, 1.38" DEPTH

MODULAR HOUSE
SENIOR PROJECT

DRAWN BY:
RYAN LEFEBVRE
5/2/17

DRAWING TITLE:
STEP DETAILS

5/2/17

ALIFORNIA POLYTEHNIKE STATE UNIVERSITY
1 GRAND AVE.
SAN LUIS OBISPO, 93401

DRAWING NUMBER:
S.3.19

STAMP:

MOD SQUAD

BUILDING 21 - 122E

STAMP:

DRAWN BY:
RYAN LEFEBVRE
5/2/17

DRAWING TITLE:
STEP DETAILS

5/2/17

ALIFORNIA POLYTEHNIKE STATE UNIVERSITY
1 GRAND AVE.
SAN LUIS OBISPO, 93401

DRAWING NUMBER:
S.3.19

STAMP:
Project Description

This project will include the design of a new handrail system, connections between the rails and the existing frame, and a new steel deck with concrete fill. The Modular House will have a new handrail system surrounding every exterior side on both the lower and upper levels. The exact design of this handrail is yet to be determined. We will be incorporating the existing road signs from the south wall of the structure into the design to maintain the unique charm they currently give to the Modular house. The handrail will likely be made of steel for ease of connection to both the signs and the frame, either through welds or bolts. These connections will be designed to ensure adequate strength. Additionally, a steel deck with concrete fill will be designed to replace the existing deck on both floors. A seismic analysis will be performed on the structure to ensure that the proposed solution will be adequate for the canyon. Analysis will also be performed on the existing structure to confirm that the structure is adequate for continuation of proposed design.

Design Criteria

Design Code: IBC 2012
ASCE 7-10
AISC Steel 314
AISC Seismic

Building Type: Construction Type: Type I
No hour fire rating
Occupancy Group: Assembly Area A-5 (Assembly Area for viewing outside activities)

Wind Criteria: N/A, Due to open nature of the structure

Seismic Criteria:
- $S_{00} = 0.789g$
- $S_{01} = 0.450g$

Cs = .2254

Foundation Criteria: Use existing Foundation

Allowable loads:
- Live Loads: Floor ________________________ 100 psf
- Dead Loads: Floor (Fill and Decking) _________ 26.1 psf

Controlling Deflections: Depth of beam shall be great than L/240

GFDR: HSS Tubing (Beam and Column), Steel Decking and Fill

LFIR: HSS Tubing Moment Frames

References System: Project Summary

The existing weight of the Modular House is 25.7 kips. After all modifications and renovations are complete the building is going to weigh only 17 kips. The renovated building will be 34% lighter than the original building.

Force is defined by mass multiplied by the acceleration. The design acceleration will not change. Therefore a decrease of mass by 34% means that the force the building needs to resist will also be decreased by 34%. The original lateral system was strong enough to resist the original forces with a heavier mass so the lateral system will remain unchanged and will be strong enough to resist the smaller forces that it may experience.

In addition, by getting rid of the complexity of the multiple materials and changing the flooring system will no longer have a mass irregularity caused by the change from wood flooring to tile.
### Existing Load Takeoff

<table>
<thead>
<tr>
<th>System</th>
<th>Existing Load Takeoff</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROOF</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STRESSED SKIN PANEL</td>
<td>10 psf</td>
<td></td>
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<tr>
<td>PARTITION</td>
<td>10 psf</td>
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<tr>
<td>TOTAL AREA</td>
<td>427.5 sf</td>
<td></td>
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<tr>
<td>Load</td>
<td>8.55 k</td>
<td></td>
</tr>
<tr>
<td><strong>2ND FLOOR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2&quot; PLYWOOD SHEATHING - FLOOR</td>
<td>1.6 psf</td>
<td></td>
</tr>
<tr>
<td>3/8&quot; PLYWOOD SHEATHING - CEILING</td>
<td>1.2 psf</td>
<td></td>
</tr>
<tr>
<td>CERAMIC TILE - FLOORING</td>
<td>10 psf</td>
<td></td>
</tr>
<tr>
<td>CLADDING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PARTITION</td>
<td>10 psf</td>
<td></td>
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<tr>
<td>TOTAL AREA</td>
<td>153 sf</td>
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<tr>
<td>LOAD</td>
<td>3.5 k</td>
<td></td>
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<tr>
<td><strong>1ST FLOOR</strong></td>
<td></td>
<td></td>
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<tr>
<td>1/2&quot; PLYWOOD SHEATHING - FLOOR</td>
<td>1.6 psf</td>
<td></td>
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<tr>
<td>3/8&quot; PLYWOOD SHEATHING - CEILING</td>
<td>1.2 psf</td>
<td></td>
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<tr>
<td>CERAMIC TILE - FLOORING</td>
<td>10 psf</td>
<td></td>
</tr>
<tr>
<td>CLADDING</td>
<td></td>
<td></td>
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<tr>
<td>PARTITION</td>
<td>10 psf</td>
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<td>TOTAL AREA</td>
<td>479.5 sf</td>
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<td>LOAD</td>
<td>10.9 k</td>
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<td><strong>TUNING</strong></td>
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<tr>
<td>ROOF</td>
<td>1 k</td>
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<tr>
<td>2ND FLOOR RISE</td>
<td>0.22 k</td>
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<tr>
<td>2ND FLOOR</td>
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<tr>
<td>1ST FLOOR RISE</td>
<td>0.22 k</td>
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<tr>
<td>1ST FLOOR</td>
<td>0.71 k</td>
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<tr>
<td>1ST FLOOR DROP</td>
<td>0.22 k</td>
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<tr>
<td>TOTAL</td>
<td>3 k</td>
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</tr>
<tr>
<td>TOTAL BUILDING WEIGHT</td>
<td>25.7 k</td>
<td></td>
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</tbody>
</table>

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### Design Criteria 1

- **Assumptions:**
  - Soil Class: D
  - Risk Category: I/II

- **Output:**
  - Shear: Sx = 1.128 kN
  - Moment: Mx = 1.193 kN
  - Shear: Sy = 0.339 kN
  - Moment: My = 0.450 kN

- **Reinforcement:**
  - Vf = 22.5 kN
  - Vp = 0.01
  - T = 0.01

- **Limit:**
  - TW = 0.00
  - T = 0.01

- **Additional Notes:**
  - The design satisfies all code requirements.
### Design Criteria 2

**References**

<table>
<thead>
<tr>
<th>System: Seismic Analysis</th>
<th>Cont./Decking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decking Requirements</strong></td>
<td></td>
</tr>
<tr>
<td>Minimum Load Grade</td>
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</tr>
<tr>
<td>#</td>
<td>Load</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Limit Weight, No Fire Rating</td>
<td></td>
</tr>
</tbody>
</table>

B Formula

18 Grade B, 3 in. LW Conc.

Single Span 8'-0", No Shading Required

**Assumed Snow Loads**

- **Dead**
  - Concr: 22.2 psf
  - Deck: 2.9 psf
- Live: Assembly/Deck: 100 psf

**Dead Load Take-off**

1st Floor: 22.2 psf

### Design Criteria 3

**References**

<table>
<thead>
<tr>
<th>System: Frame Analysis</th>
</tr>
</thead>
</table>

- **Column Fireproof Capacity**
  - Steel Thickness: 3/4" x 1/4"
  - All Sill:
    - Fl. 1/Thr. 2
      - 2 = 8h^2 = (6-2)(4.64^2) = 76.5
        - 4h = (3-2.7)(2.7/4) = 7.2
        - 7.2 = 2.2
      - 6M0 = 0.7(46 ksi)(2.23 m^3) = 7.64 kN

- **Beam Fireproof Capacity**
  - Fy = 46 ksi, f_y = 77 psi
  - 2 = 8h^2 = (6-2)(4.64^2) = 76.5
    - 4h = (3-2.7)(2.7/4) = 7.2
    - 7.2 = 2.2
  - 6M0 = 0.7(46 ksi)(4.71 m^3) = 16.24 kN

- **Beam Shear Capacity**
  - A_y = 0.6 F_y A_y u
  - F_y = 46 ksi, f_y = 77 psi
  - 2 = 8h^2 = (6-2)(4.64^2) = 76.5
    - 4h = (3-2.7)(2.7/4) = 7.2
    - 7.2 = 2.2
  - 6M0 = 0.7(46 ksi)(4.71 m^3) = 16.24 kN

- **V_a** = 0.6 F_y A_y u
  - A_y = 4.7/6 = 2.7/4
    - 77 ps 1/1.4
  - C_y = 0.7/2.7 = 2.57
  - K_y = 0.7
  - V_a = (3-2.7)(2.7/4) = 7.2
  - 7.2 = 2.2
  - C_y = 0.7
  - 6M0 = 0.7(46 ksi)(4.71 m^3) = 16.24 kN
### Design Criteria 4

#### System: Frame Analysis

**Allowable Beam Deflection**

\[ D+L \rightarrow 6/1240 = 8''/12''/240 = 0.7'' \]

**Column Slender Value**

- Determine \( K \) from Table

\[ K = 0.66 \left( \frac{v}{62} \right)^{0.56} = 58.1 < 200 \]

- Center of Gravity

\[ \frac{I_a}{L_a} = 2.60 \]

- \( K = 0.59 \left( C - A = 7.1 \right) \)

- \( VL = 0.59(8x12)'' = 59.1 < 200 \)

### Design Criteria 5

#### System: Frame Analysis

**Compression Strength Column**

\[ P_a = A_p f_p, A_p = 1.89 \text{ in}^2 \]

\[ \frac{V_f}{A_f} = \frac{561}{46} = \frac{4.31}{2000} = 11.8 \text{ in} \]

\[ F_c = \left( \frac{A_p}{A_f} \right) \left( \frac{61.2}{k} \right) = \left( \frac{40000}{46} \right) = 90.9 \]

\[ F_c = \left( \frac{V_f}{A_f} \right) \left( \frac{61.2}{k} \right) = \frac{37.2}{k} \]

\[ P_a = 1.89 \left( 1.2 \times 4 \right) = 70.3 \text{ k} \]

\[ k = 0.79 \rightarrow \phi = 0.89 \]

**Shear Strength Column**

- In accordance to sec. G2.1 = 1. AU + 1.74

- \( 2.13 \text{ in}^2 \)

- \( k_a = 0.18 \text{ (min. thickness) = 1.74} \)

- \( A_{p} = 1257 \text{ in}^2 \)

- \( k = 0.69 \text{ in}^2 \)

- \( GZ = 0.6 \left( 4.66 \right) = 26.6 \text{ k} \)

- \( \phi = 0.9 \)

- \( V_a = 23 \)
### References

<table>
<thead>
<tr>
<th>System: Frame Analysis</th>
<th>Comments</th>
</tr>
</thead>
</table>

#### Weld Connection

- Black Shear
  - $f_w = 0.35 \times 0.6 \times b_x = 0.76$
  - $F_m = 58kN$
  - $W_{bu} = 10g^2 x 0.6$
  - $W_{bu} = 2.06 + 2.6$
  - $= 3.625$
  - $= 0.75[0.6(58kN)(10(1/2)) + 10(55kN)(2.6)]$
  - $= 65.25kN$

#### Moment Connection

- All Steel
  - $W_5 \times H_5$
  - $N_{f5} = 93$
    - Fully Restrainted Connection
    - $T$-connection
    - $B = 0.6/3 \times 3in \times 3in \times 1.00$
  - $\beta = 0.85$
  - $N_{f5} = 600 (5 - L) (A_{shear})$
  - $D = 12kN$
  - $L_p = 1244 - 0.93(7/8)$
  - $K_5 = 50$
  - $N_{max} = 48(1749) (2 - 0.744) (5 + 6(1749))$
  - $= 1733 kN$
  - $= 11.1 kN$, $= 100$
  - $\beta = 0.85$, $\beta = 1.00$

### Frame Summary

- Column:
  - Flanges: $7.62 kN$
  - Connection: $63.5 kN$
  - Shear: $23 kN$
  - Slenderness Ratio: $< 200$

- Beam:
  - Flanges: $16.34 kN$
  - Shear: $19.5 kN$
  - Deflection: $0.4''$

- Connection:
  - Weld: $55.25$
  - Nuc Conn: $11.1k$

- Stage Plate
  - $N_{p5} = 8''$ (From Modular House)
  - $m = 8'' - 0.7(8'') = 2.8''$
  - Plate thickness $= \frac{1}{2}$
  - Anchor Rod: $\frac{3}{8}''$

- Stage Caming
  - Shear: $V_w$
  - $R = 0.60 F_{P1}$
  - $A_{v1} = 0.57 (3.4'') = 4.4in$
  - $\gamma = 1.00$
  - $R = 0.6 (3.4 kN) (3.4in)$
  - $\gamma = 36.4kN$
## References

<table>
<thead>
<tr>
<th>System: Frame Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Plate Capacity</strong></td>
</tr>
<tr>
<td>Anchor Bolt Capacity</td>
</tr>
<tr>
<td>- Tensile: 46 kips</td>
</tr>
<tr>
<td>- Shear: 27 kips</td>
</tr>
<tr>
<td>Beam: 42 kips</td>
</tr>
<tr>
<td>Ten: 36.8 kip</td>
</tr>
<tr>
<td>Shear: 21.2 kip</td>
</tr>
</tbody>
</table>

**Plate Flexural Capacity**

- \( M_{pl} = \frac{P_{pl} \cdot b \cdot h^2}{4} \)
- \( = 36 \text{ kips} \cdot (0.5 \text{ in})^2 \)
- \( = 18 \text{ kips} \cdot \text{in} \)
- \( = 1.5 \text{ kips} \cdot \text{in} \)
- \( M_{pl} = 1.35 \text{ kip} \cdot \text{in} \)

**Bending Strength on Cond**

- \( f_b = 0.25 \text{ kip} / \text{in} \)
- \( = 4000 \text{ psi} \)
- \( = 0.80 \text{ kip} (4000 \text{ psi}) (0.8 \text{ in}) \)
- \( = 216 \text{ kip} \)

**Base Plate Summary**

- Rate Thrust: 1/16 in
- Bolt #: 5/8
- Plate Shear Capacity: 36 kip
- Pile Thrust: 1.35 kip
- Bolt Tension: 35.8 kip
- Shear: 21.2 kip

---

**FRAME ON GRID**

*Modified from Diagram*

**Design Criteria**

- **RISA Gravity Analysis**

---

**Moment**

\( \phi M_n = \frac{7.69}{8} TS 3 \times 3 \text{ col} \)
\( \phi M_n = \frac{16.2}{8} TS 5 \times 3 \text{ BMS} \)
Frame on Grid

Deflection

RISA Gravity Analysis 2

RISA Gravity Analysis 3
RISA Gravity Analysis 6

Note:
- Max Moment = 8.498 k-ft

Deflected Shape

<table>
<thead>
<tr>
<th>Joint Label</th>
<th>X (in)</th>
<th>Y (in)</th>
<th>Rotation</th>
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<td>N11</td>
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<td>-0.025</td>
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<tr>
<td>N15</td>
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<td>1.299e-3</td>
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<tr>
<td>N16</td>
<td>0.191</td>
<td>-0.025</td>
<td>1.299e-3</td>
</tr>
</tbody>
</table>

RISA Gravity Analysis 7
Dead Load = 26.1 PSF
Live Load = 100 PSF
Total Load (w/ load combo) = 191 PSF

Gridline A - Gravity

Dead Loading

Live Loading

Axial

Shear

Moment

Deflection

RISA Gravity Analysis 10

RISA Gravity Analysis 11
References | System: Grid Line B Gravity Analysis | Comments
--- | --- | ---

**Nodes and Loads**

- N27
- N28
- N29
- N30
- N31
- N32
- N33
- N34

**Axial Force**

- N1: 0.1
- N2: 0.2
- N3: 0.3
- N4: 0.4

**Shear Force**

- Top: 0.2
- Middle: 0.3
- Bottom: 0.4

**Moment**

- Top: 0.5
- Middle: 0.6
- Bottom: 0.7

---

**RISA Gravity Analysis 12**

---

**RISA Gravity Analysis 13**
Max Moment = 6.42 k - ft

--- | --- | --- | ---
N1 | 0 | 0 | -2.342e-3
N2 | 0 | 0 | -4.58e-3
N3 | 0 | 0 | -5.59e-4
N4 | 0.042 | -0.05 | 3.452e-3
N5 | 0.044 | -0.003 | 4.505e-3
N6 | 0 | 0 | -3.957e-3
N7 | 0.071 | -0.002 | 4.318e-3
N8 | 0.07 | -0.004 | 4.663e-4
N9 | 0.07 | -0.005 | 3.352e-3
N10 | 0.055 | -0.004 | 9.74e-4
N11 | 0.055 | -0.004 | 1.008e-4
N12 | 0.055 | -0.002 | 2.216e-4
N13 | 0.055 | -0.002 | 7.066e-5
N14 | 0.055 | -0.004 | 7.498e-5
N15 | 0.055 | -0.004 | 7.809e-5
N16 | 0.055 | -0.005 | 1.977e-5
N17 | 0.055 | -0.002 | 5.546e-5
N18 | 0.056 | -0.002 | 4.114e-5
N19 | 0.056 | -0.005 | 3.438e-5

RISA Gravity Analysis 16

Deflected Shape

RISA Gravity Analysis 17
RISA Analysis - Lateral 1

- References System
- Joint Deflections

### Design Criteria
- Lateral Acceleration: 0.04g
- Module Weight: 2.3 k

### Frame on Gridline (0)

- Lateral Forces
- Beams: HSS 3\(\times\)3\(\times\)\(\frac{3}{4}\)
- Columns: HSS 5\(\times\)5\(\times\)\(\frac{3}{4}\)

### Flexible Diaphragm

### Rigid Diaphragm

---

RISA Analysis - Lateral 2

- Joint Deflections
- Maximum Story Drift: 0.07
- Conservative, since modeled with a pin base
RISA Analysis - Lateral 3

Joint Deflections

Joint Label | X (in) | Y (in) | Rotation (degrees)
---|---|---|---
N1 | 0 | 0 | -4.926e-3
N2 | 0 | 0 | -5.314e-3
N3 | 0 | 0 | -4.775e-3
N4 | 0 | -5.93 | -1.74e-3
N5 | 0 | -5.93 | -9.963e-4
N6 | 0 | -4.975e-3
N7 | 0 | -1.622e-3
N8 | 0 | -1.435e-3
N9 | 0 | -1.232e-3
N10 | 0 | -1.435e-3
N11 | 0 | -9.81e-4
N12 | 0 | -3.168e-4
N13 | 0 | -2.319e-5
N14 | 0 | -2.67e-5
N15 | 0 | -2.106e-4
N16 | 0 | -1.136e-5
N17 | 0 | -2.816e-5
N18 | 0 | 0 | 0

Deflected Shape

RISA Analysis - Lateral 4
Shear:
V_{max} = 0.856k

Moment:
M_{max} = 1.474k-ftk
Shear:
\[ V_{\text{max}} = 0.698k \]

Moment:
\[ M_{\text{max}} = 1.393 \text{k-ft} \]
MODULAR HOUSE SENIOR PROJECT
ARCE 453/460
Building 21-122E. Cal Poly
San Luis Obispo, California 93410

References
System: GRID 4 RISA 2D CHECK

RIGID DIAPHRAGM

Axial
Shear
Moment
Deflection

Max Moment: 2.03 k
Max Shear: 0.74

RISA Analysis - Lateral 13
Equivalent force: $F = 3.73\, \text{kN}$

Center of rigidity:

$$c = \frac{2(0.8\, \text{m})(0.4\, \text{m})}{2(0.8\, \text{m})} = 0.4\, \text{m}$$

Torsional moment:

$$M = 1.11\, \text{kNm} \times 3.73\, \text{kN} = 2.94\, \text{kN} \times \text{m}$$

For $F_1 = 5.0\, \text{kN}$:

$$F_1 \times 1.0\, \text{m}$$

For $F_2 = 2.0\, \text{kN}$:

$$F_2 \times 0.5\, \text{m}$$

For $F_3 = 1.0\, \text{kN}$:

$$F_3 \times 0.25\, \text{m}$$

For $F_4 = 0.5\, \text{kN}$:

$$F_4 \times 0.125\, \text{m}$$

Comments:

- RISA Analysis - Lateral 15
- RISA Analysis - Lateral 16
**Modular House Senior Project**

**Code:**

**Date:**

**Building 21-122E, Cal Poly**
San Luis Obispo, California 93410

**ARCE 453/460**

**System:** Modular House Grid B Rigid Diaphragm Analysis

---

**Moments**

<table>
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<th>RISA Analysis - Lateral 23</th>
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**Axial**

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**Comments**

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**RISA Analysis - Lateral 25**

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<tr>
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<tr>
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<tr>
<td>N19</td>
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</tbody>
</table>

**RISA Analysis - Lateral 26**

Shear: $V_{\text{max}} = 0.374k$

Moment: $M_{\text{max}} = .749k\cdot ft$
Deflected Shape

RISA Analysis - Lateral 27

Shear: Vmax = 0.476k

Moment: Mmax = 0.953k-ft

<table>
<thead>
<tr>
<th>Joint Label</th>
<th>X (in)</th>
<th>Y (in)</th>
<th>Rotation (deg)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0</td>
<td>-2.694e-3</td>
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<td>-1.974e-3</td>
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<tr>
<td>N3</td>
<td>0</td>
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<tr>
<td>N4</td>
<td>0.034</td>
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<td>-5.639e-4</td>
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<td>N6</td>
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<tr>
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<tr>
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**Elevation on Line 1**

**Deformed Shape**

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<th>LEVEL</th>
<th>Displacement (inches)</th>
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<tbody>
<tr>
<td>Roof Rise</td>
<td>0.340</td>
</tr>
<tr>
<td>Roof Framing</td>
<td>0.340</td>
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<tr>
<td>Level 2 Rise</td>
<td>0.331</td>
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<tr>
<td>Level 2 Framing</td>
<td>0.310</td>
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<tr>
<td>Level 1 Rise</td>
<td>0.195</td>
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<tr>
<td>Level 1 Framing</td>
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<tr>
<td>Level 1 Drop</td>
<td>0.000</td>
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**Shear**

<table>
<thead>
<tr>
<th>MAX (+)</th>
<th>MIN (-)</th>
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<tbody>
<tr>
<td>Shear</td>
<td>0.87 kips</td>
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<tr>
<td>Moment</td>
<td>1.18 k-ft  1.25 k-ft</td>
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**ETABS Comparison**

- Lateral 1
- Lateral 2
Elevation of Line 2

<table>
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<th>LEVEL</th>
<th>Displacement (inches)</th>
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<td>0.340</td>
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<td>Roof Framing</td>
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<tr>
<td>Level 2 Rise</td>
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<tr>
<td>Level 2 Framing</td>
<td>0.316</td>
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<tr>
<td>Level 1 Rise</td>
<td>0.195</td>
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<tr>
<td>Level 1 Framing</td>
<td>0.176</td>
</tr>
<tr>
<td>Level 1 Drop</td>
<td>0.000</td>
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</table>

ETABS Comparison - Lateral 3

Roof Rise 0.340
Roof Framing 0.340
Level 2 Rise 0.331
Level 2 Framing 0.316
Level 1 Rise 0.195
Level 1 Framing 0.176
Level 1 Drop 0.000

ETABS Comparison - Lateral 4

Maximum (MAX (+))
- Shear 0.68 kips
- Moment 1.18 k-ft

Minimum (MIN (-))
- Moment 1.18 k-ft
Elevation of Line 3

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<tr>
<td>Roof Framing</td>
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<tr>
<td>Level 2 Framing</td>
<td>0.355</td>
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<tr>
<td>Level 1 Rise</td>
<td>---</td>
</tr>
<tr>
<td>Level 1 Framing</td>
<td>0.168</td>
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<tr>
<td>Level 1 Drop</td>
<td>0.057</td>
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ETABS Comparison - Lateral 5

ETABS Comparison - Lateral 6

Maximum (MAX)  Minimum (MIN)
Shear 1.22 kips  1.70 k-ft
Moment 1.74 k-ft  1.74 k-ft
Elevation of Line 4

**Elevation**

**Deformed Shape**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Displacement (inches)</th>
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<tbody>
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<tr>
<td>Roof Framing</td>
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<td>0.364</td>
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<tr>
<td>Level 2 Framing</td>
<td>0.163</td>
</tr>
<tr>
<td>Level 1 Rise</td>
<td>---</td>
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<tr>
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<td>0.037</td>
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<td>Level 1 Drop</td>
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**ETABS Comparison - Lateral 7**

**ETABS Comparison - Lateral 8**

<table>
<thead>
<tr>
<th>MAX (+)</th>
<th>MIN (-)</th>
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<tbody>
<tr>
<td>Shear</td>
<td>0.83 kips</td>
</tr>
<tr>
<td>Moment</td>
<td>1.03 k-ft</td>
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<tr>
<td></td>
<td>1.04 k-ft</td>
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</table>
Elevation of Line A

Deformed Shape

Level | Displacement (inches)
--- | ---
Roof Rise | 0.412
Roof Framing | 0.411
Level 2 Rise | 0.408
Level 2 Framing | 0.399
Level 1 Rise | 0.232
Level 1 Framing | 0.199
Level 1 Drop | 0

Shear

MAX (+) | MIN (-)
--- | ---
Shear | 1.10 kips
Moment | 1.43 k-ft | -1.49 k-ft
MODULAR HOUSE SENIOR PROJECT
CODE: ETABS
DATE: 04/24/2017
BY: SD SHEET 67 of 81

Building 21-122E, Cal Poly
San Luis Obispo, California 93410

Elevation on Line B

LEVEL Displacement (inches)
---
Roof Rise 0.324
Roof Framing 0.324
Level 2 Rise 0.320
Level 2 Framing 0.310
Level 1 Rise 0.185
Level 1 Framing 0.162
Level 1 Drop 0.042

MAX (+) MIN (-)
Shear 1.10 kips
Moment 1.45 k-ft 1.18 k-ft
Elevation on Line C

Elevation

Deformed Shape

LEVEL  Displacement (inches)
Roof Rise    N/A
Roof Framing 0.226
Level 2 Rise 0.204
Level 1 Rise N/A
Level 1 Framing 0.125
Level 1 Drop 0.039

Shear 1.19 kips
Moment 1.16 k-ft 0.97 k-ft

ETABS Comparison - Lateral 13

ETABS Comparison - Lateral 14
<table>
<thead>
<tr>
<th>References</th>
<th>System: Panel Connections (capacities)</th>
<th>Comments</th>
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<tbody>
<tr>
<td>US5 - a C 3 x 5 x 2': A36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l' = 10&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>min weld = 1/8&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E60 electrode = 60 lb</td>
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<td></td>
</tr>
<tr>
<td>Shear strength, weld metal:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dA = 0.75 (0.696) (60 lb) (707) (1/8&quot;) (10&quot;) = 24 kips =-60V</td>
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<td></td>
</tr>
<tr>
<td>Base metal:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dA = 0.9 (0.696) (707) (1/8&quot;) (10&quot;) = 37.5 kips</td>
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<td></td>
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<tr>
<td>C x 3 x 5 x 2 = L 2 1/2 x 1 1/4 x 1/4:</td>
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<tr>
<td>1/4&quot; of Panel A 225</td>
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<tr>
<td>Bolt shear = Ra = 21</td>
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<tr>
<td>Ra = 0.75 (40 lb) (5/16&quot;) = 8 kips</td>
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<td></td>
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<tr>
<td>Design on plate:</td>
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<td></td>
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<tr>
<td>da = 0.75 [1.2] (0.75) (5/16&quot;) (5000)] = 7.36 kips</td>
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<td></td>
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<tr>
<td>bearing = 0.75 [2.5 x (75/16)] (707) (707) (5000)] = 9.5 kips</td>
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<td></td>
</tr>
<tr>
<td>Shear yield:</td>
<td></td>
<td></td>
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<tr>
<td>Ra = 0.60 Ay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ra = 0.60 (60) (707) (1/4&quot;) (1/4&quot;) = 6 kips</td>
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<td></td>
</tr>
<tr>
<td>Shear rupture:</td>
<td></td>
<td></td>
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<tr>
<td>Ra = 0.60 Fa</td>
<td></td>
<td></td>
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<tr>
<td>fa = 0.75 (0.6 x 60 x 707) (707) (1/4&quot;) = 9.5 kips =-60V</td>
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<td></td>
</tr>
<tr>
<td>Tensile yield:</td>
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<td></td>
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<tr>
<td>Ra = 5 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ra = (0.9) (36 lb) (707) (1/4&quot;) (1/4&quot;) = 12.2 kips</td>
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<tr>
<td>Tensile rupture:</td>
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<td></td>
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<tr>
<td>Ra = Fa</td>
<td></td>
<td></td>
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<tr>
<td>fa = (2 - 2.5) (707) = 0.23&quot;</td>
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<tr>
<td>fa = 0.25 (0.9) = 0.23 (2.5) = 0.23</td>
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<td></td>
</tr>
<tr>
<td>fa = (0.75) (60 x 707) (0.32&quot;) = 13.4 kips</td>
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Guard Rail and Connection Calcs 1

Guard Rail and Connection Calcs 2
## Guard Rail and Connection Calcs 3

### References

<table>
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<th>System:</th>
<th>Guard Rail Deflection</th>
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<tr>
<td>HSS 3 x 2 x 38</td>
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<tr>
<td>$l = 100''$ (max deflection in order)</td>
<td></td>
</tr>
<tr>
<td>$\Delta_{max} = \frac{0.0011''}{186.6}$ or $\Delta_{max} = \frac{0.0021''}{186.6}$</td>
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</tr>
<tr>
<td>$I_x = 1.77''$ (beam braced @ 6 supports along length)</td>
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</tr>
<tr>
<td>$I_y = 6.933''$</td>
<td></td>
</tr>
<tr>
<td>$\Delta_{max} = \frac{(0.01)(2140)(284)}{10(100000000)(1.77)} = 0.0011''$</td>
<td></td>
</tr>
<tr>
<td>$\Delta_{max} = \frac{(0.01)(1)(240)}{384(120000)(1.77)} = 0.05''$</td>
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</tr>
<tr>
<td>$\Delta_{max} = 0.0011'' \times 0.38 = 0.0021''$</td>
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</tr>
<tr>
<td>$\Delta_{max} = 0.05'' \times 0.38 = 0.093''$</td>
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</tr>
</tbody>
</table>

### Comments


## Guard Rail and Connection Calcs 4

### Diagram

- HSS 3 x 2 x 38
- $l = 60''$
- $l = 10''$
- $\Delta = 0.06''$
- $\Delta = 0.05''$
- $R = 0.75(0.86)(X.50)(0.7)\gamma(0.1) = 24.375$ kips
- Base metal:
  - $R = 0.9(1.96)(0.75)(0.1) = 32.5$ kips
**References**

**System:** Frame Analysis

**Comments**

**1st Floor**

**Axial on Column**

- **Floor Area:** 48 sq ft
- **P** = 1.25 k
- **P_C** = 4.8 k
- **P_E** = 2.15 k
- **P_L** = 2.20 k

**Beam & Column Section:**

- **Max. Shear:** 1.5 k (column) < 23 k
- **Max. Moment:** 26 k"
MODULAR HOUSE SENIOR PROJECT  
ARCE 453/460  
Building 21-122E, Cal Poly  
San Luis Obispo, California 93410 (IBC 2012)

References System: Frame Analysis

**Limit States 3**

**Limit States 4**
### Phase 2 Stairs Code Compliance

<table>
<thead>
<tr>
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<tr>
<td>1011.7</td>
<td>Construction</td>
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<tr>
<td></td>
<td>→ Stair shall not be more than a 2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Water shall not accumulate on landing</td>
<td></td>
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<tr>
<td>1011.6</td>
<td>Vertical Rise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Flight shall not be less than the stairs between Floor/ Landing</td>
<td></td>
</tr>
<tr>
<td>1011.3</td>
<td>Landings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Shall not be less than the stairs</td>
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</tr>
<tr>
<td></td>
<td>Where stairway has a straight run the depth need not exceed 48 in</td>
<td></td>
</tr>
<tr>
<td>1011.5.2</td>
<td>Headroom</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Clearance not less than 80 in</td>
<td></td>
</tr>
<tr>
<td>1014.3.2</td>
<td>Riser Height</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ max: 7 in, min: 4 in</td>
<td></td>
</tr>
<tr>
<td>1014.2</td>
<td>Tread Run</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ min: 11 in</td>
<td></td>
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<tr>
<td>1015.2</td>
<td>Handrails</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Section 1014</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Height 34' to 38'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Graspibility: Type 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Continuity: Continuous (no exceptions)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ Required</td>
<td></td>
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</tbody>
</table>

**Construction:**

- 0% SLOPE ON TREAD ✔
- CONTINUITY ✔
- LANDING IS LESS THAN 48" FOR STRAIGHT RUN ✔

---

**References System:**

- **System:**
  - Phase 2 Stairs
  - Code: 1011.7, 1011.6, 1011.3, 1011.5.2, 1014.3.2, 1014.2, 1015.2

---

**Phase 2 Stairs 1**

**Phase 2 Stairs 2**
Phase 2 Stairs 3

- **FLIGHT**: < 12' → 5' 6" < 12'
- **TREAD**: 11" ✓
- **RISE**: 6 1/2" ✓

**References**

- System:

**Comments**

<table>
<thead>
<tr>
<th>References</th>
<th>System:</th>
<th>Comments</th>
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</thead>
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</table>

**LEVEL 2 RISE**

- **10' - 4"**

**ROOF RISE**

- **18' - 8"**

**STAIR LANDING**

- **5' - 6"**

**LEVEL 1 FRAMING**

- **0"**
<table>
<thead>
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<th>ID</th>
<th>Task Mode</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>Modular House</td>
<td>47.88 days</td>
<td>Sun 3/19/17</td>
<td>Tue 6/13/17</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Preconstruction</td>
<td>32.88 days</td>
<td>Sun 3/19/17</td>
<td>Thu 5/18/17</td>
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<td>3</td>
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<td>Permitting</td>
<td>14.38 days</td>
<td>Tue 4/18/17</td>
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<td>4</td>
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<td>Approved Mock-Up</td>
<td>2 days</td>
<td>Tue 4/18/17</td>
<td>Fri 4/21/17</td>
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<tr>
<td>5</td>
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<td>Complete structural analysis and design</td>
<td>5 days</td>
<td>Wed 4/19/17</td>
<td>Sun 4/30/17</td>
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<tr>
<td>6</td>
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<td>Complete Drawing Set to Kevin</td>
<td>1 day</td>
<td>Sun 4/30/17</td>
<td>Thu 5/4/17</td>
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<td>7</td>
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<td>Approved/Reviewed Permits</td>
<td>6 days</td>
<td>Thu 5/4/17</td>
<td>Sat 5/13/17</td>
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<td>Site Investigation</td>
<td>18.88 days</td>
<td>Sun 3/19/17</td>
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<td>Existing conditions survey</td>
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<td>Sun 3/19/17</td>
<td>Sun 3/19/17</td>
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<td>Submit Jobsite Hazard Analysis (JHA)</td>
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<td>Fri 4/7/17</td>
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<td>Complete necessary training for hazards</td>
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<td>Mon 4/10/17</td>
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<td>Supplier Pricing</td>
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<td>Sat 5/6/17</td>
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<td>Secure Funding</td>
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<td>Sun 5/7/17</td>
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<td>Construction &amp; Repairs</td>
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<td>Clean work space (rat droppings,</td>
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<td>scraps, garbage)</td>
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<td>remove damaged and vandalized signs</td>
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<td>Layout</td>
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<td>Install metal decking</td>
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<td>Install Formwork</td>
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<td>place, pour and finish concrete</td>
<td>1 day</td>
<td>Fri 6/2/17</td>
<td>Sat 6/3/17</td>
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<td></td>
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<td>infill 1</td>
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<td>concrete cure time 1</td>
<td>2 days</td>
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<td>infill 2</td>
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<td>34</td>
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<td>Steel</td>
<td>28.5 days</td>
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Project: Modular House Workin
Date: Wed 5/3/17
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<td>Signage Design</td>
<td>5 days</td>
<td>Sun 4/23/17</td>
<td>Tue 5/2/17</td>
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<td>36</td>
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<td>Prefab Steel Guardrails</td>
<td>5 days</td>
<td>Fri 5/19/17</td>
<td>Sat 5/27/17</td>
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<tr>
<td>37</td>
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<td>Reinforce super structure</td>
<td>2 days</td>
<td>Tue 5/23/17</td>
<td>Sat 5/27/17</td>
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<td>38</td>
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<td>Weld Plates at existing structure</td>
<td>2 days</td>
<td>Tue 5/23/17</td>
<td>Sat 5/27/17</td>
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<tr>
<td>39</td>
<td></td>
<td>Erect Steel Guardrails</td>
<td>5 days</td>
<td>Tue 5/30/17</td>
<td>Fri 6/9/17</td>
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<tr>
<td>40</td>
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<td>Make Connections (Bolt / Weld)</td>
<td>3 days</td>
<td>Fri 6/9/17</td>
<td>Tue 6/13/17</td>
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<td>41</td>
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<td>Finishes</td>
<td>3 days</td>
<td>Sat 5/27/17</td>
<td>Fri 6/2/17</td>
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<td>42</td>
<td></td>
<td>Paint layout, tape and surface prep</td>
<td>1 day</td>
<td>Sat 5/27/17</td>
<td>Sun 5/28/17</td>
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<td>43</td>
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<td>Paint</td>
<td>1 day</td>
<td>Sun 5/28/17</td>
<td>Tue 5/30/17</td>
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<td>44</td>
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<td>Paint Finish</td>
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<td>Tue 5/30/17</td>
<td>Fri 6/2/17</td>
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<td>Post Construction</td>
<td>1 day</td>
<td>Thu 6/15/17</td>
<td>Fri 6/16/17</td>
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<tr>
<td>46</td>
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<td>Closeout</td>
<td>1 day</td>
<td>Thu 6/15/17</td>
<td>Fri 6/16/17</td>
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<tr>
<td>47</td>
<td></td>
<td>As-Built Drawings</td>
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<td>Fri 6/16/17</td>
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<td>Project Contact Sheet</td>
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<td>Fri 6/16/17</td>
</tr>
<tr>
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<td></td>
<td>Necessary Inspections</td>
<td>1 day</td>
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<td>Fri 6/16/17</td>
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