Existing Conditions - March 2017
Phase I Construction - June 2017
Phase II Construction - December 2017
Modular House Project Narrative  
Senior Project - Spring 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>
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.

Notes:

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

ARCE
& CM

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

STAMP:
RYAN LEFEBVRE

DRAWN BY:
RYAN LEFEBVRE

DATE:
5/2/17

DRAWING TITLE:
TYPICAL GUARD RAIL DETAILS

SCALE:
As indicated

SHEET NUMBER:
S.3.13

1. UPPER RAIL TO COLUMN CONNECTION

2. RAIL TO COLUMN - TOP & BOTTOM

3. RAIL TO ANGLED COLUMN - TOP & BOTTOM

(N) C3x5x0'-1.25" (N) HSS3x2x3/16 GUARD RAIL

1 1/2" TYP.

OTHER SIDE WHERE OCCURS

(E) TS3x3x3/16 COLUMN

(N) L1-1/2x1x1/2x1/8

(N) HSS3x2x3/16

1/8

WHERE OCCURS

HSS3x2x3/16

1/2"

(E) TS3x3x3/16

1/8

(N) HSS3x2x3/16

(E) TS3x3x3/16

1/2"

3" = 1'-0"

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

2. SIGN CONNECTION
   3" = 1'-0"

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

1/4" DIAM. BOLT

DRAWN BY: RYAN LEFEBVRE
DATE: 5/2/17
DRAWING TITLE: TYPICAL GUARD RAIL DETAILS
SCALE: 3" = 1'-0"
SHEET NUMBER: S.3.14
GUARD RAIL EXTERIOR 5'-10 3/4"

3/4" = 1'-0"
DECKING CONNECTION

3" = 1'-0"

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

JOINT SEALANT
3" CONCRETE FLOOR
TS5x3x3/16
1/4" THICK PL

1/4" THICK PL
HILTI SLEEVE ANCHOR,
HLC-HX 5/16x1-5/8,
5/16" DIAM. HOLE, 1.38" DEPTH

1/2" PL
1/4" PL
HSS5x3x3/16

3" = 1'-0"

MONO-STRINGER STEPS
3" = 1'-0"
1. STEPS SECTION 1

1 1/2" = 1'-0"

- 1/2" THICK PL
- PL 1/4"x4"x1'-1.25"
- HSS5x3x3/16

2. STEPS SECTION 2

1 1/2" = 1'-0"

- WHERE IN CONTACT
- PL 1/4"x4"x1'-1.25"
- TS5x3x3/16
- HSS5x3x3/16

3. STEPS SECTION 3

1 1/2" = 1'-0"

- 1/4" THICK PL w/(2)
- 3/8" DIAM. HOLES
- HILTI SLEEVE ANCHOR,
  HLC-HX 5/16"x1-5/8,
  5/16" DIAM. HOLE, 1.38" DEPTH
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:**
  - $S_{D0} = 0.789g$
  - $S_{D1} = 0.450g$
  - $C_{S} = 0.2254$

- **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

- **GFRS:**
  - HSS Tubing (Beam and Column), Steel Decking and Fill

- **LFRS:**
  - HSS Tubing Moment Frames

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
<table>
<thead>
<tr>
<th>References</th>
<th>System: Existing Load Takeoff</th>
<th>Comments</th>
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<tbody>
<tr>
<td>ROOF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STRESSED SKIN PANEL</td>
<td>10 psf</td>
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</tr>
<tr>
<td>PARTITION</td>
<td>10 psf</td>
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<td>TOTAL</td>
<td>20 psf</td>
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<tr>
<td>AREA</td>
<td>427.5 sf</td>
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<tr>
<td>LOAD</td>
<td>8.55 k</td>
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<table>
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<tr>
<th></th>
<th>2ND FLOOR</th>
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<tbody>
<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>10 psf</td>
<td></td>
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<tr>
<td>TOTAL</td>
<td>22.8 psf</td>
<td></td>
</tr>
<tr>
<td>AREA</td>
<td>153 sf</td>
<td></td>
</tr>
<tr>
<td>LOAD</td>
<td>3.5 k</td>
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<thead>
<tr>
<th></th>
<th>1ST FLOOR</th>
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<tbody>
<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>10 psf</td>
<td></td>
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<tr>
<td>TOTAL</td>
<td>22.8 psf</td>
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</tr>
<tr>
<td>AREA</td>
<td>479.5 sf</td>
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<tr>
<td>LOAD</td>
<td>10.9 k</td>
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<th>TUNING</th>
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<tbody>
<tr>
<td>ROOF</td>
<td>1 k</td>
<td></td>
</tr>
<tr>
<td>2ND FLOOR RISE</td>
<td>0.22 k</td>
<td></td>
</tr>
<tr>
<td>2ND FLOOR</td>
<td>0.38 k</td>
<td></td>
</tr>
<tr>
<td>1ST FLOOR RISE</td>
<td>0.22 k</td>
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</tr>
<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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<table>
<thead>
<tr>
<th></th>
<th>TOTAL BUILDING WEIGHT</th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>25.7 k</td>
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</tr>
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</table>

**References**

**System:** Existing Load Takeoff

**Comments**

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**References**

**System:** Seismic Analysis

**Comments**

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**References**

**System:** Design Criteria 1

**Comments**
### Design Criteria 2

#### References

<table>
<thead>
<tr>
<th>System</th>
<th>Seismic Analysis Cont / Decking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decking Requirements</td>
<td></td>
</tr>
<tr>
<td>- Minimum 10 Grade</td>
<td></td>
</tr>
<tr>
<td>- Angle Spacing</td>
<td></td>
</tr>
<tr>
<td>- Z-Wall</td>
<td></td>
</tr>
<tr>
<td>- Limit Weight, No Fire Rating</td>
<td></td>
</tr>
<tr>
<td>B Formula: 18 Grade 3 in LW Conc.</td>
<td></td>
</tr>
<tr>
<td>Single Span 8'-0&quot;, No Shocking Req O</td>
<td></td>
</tr>
<tr>
<td>- Assumed Snow Load: 160 psf</td>
<td></td>
</tr>
<tr>
<td>- Dead</td>
<td></td>
</tr>
<tr>
<td>- Concrete: 22.2 psf</td>
<td></td>
</tr>
<tr>
<td>- Deck: 2.9 psf</td>
<td></td>
</tr>
<tr>
<td>- Live</td>
<td></td>
</tr>
<tr>
<td>- Assembly / Deck: 100 psf</td>
<td></td>
</tr>
<tr>
<td>12.6 ft = 14.5 ft</td>
<td></td>
</tr>
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</table>

**Dead Load - Take-off**

2nd Floor: Rise -> Decking: 22.2 psf (12 ft) = 1.63 k

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>2nd Floor Rise</td>
<td>Decking 22.2 psf (12 ft) = 1.63 k</td>
</tr>
<tr>
<td>1st Floor Rise</td>
<td>Decking 22.2 psf (12 ft) = 1.63 k</td>
</tr>
<tr>
<td>1st Floor Deck</td>
<td>Decking 22.2 psf (12 ft) = 1.63 k</td>
</tr>
<tr>
<td>Slab on Grade</td>
<td>Decking 22.2 psf (12 ft) = 1.63 k</td>
</tr>
</tbody>
</table>

#### Comments

- Seismic Weight = 16 k (Tendons) = 1.9 %

\[ V_{d} = 22.54 (17%) = 3.83 k \]

### Design Criteria 3

#### References

<table>
<thead>
<tr>
<th>System</th>
<th>Frame Analysis</th>
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<tbody>
<tr>
<td>Column</td>
<td>Fireproofing Capacity</td>
</tr>
<tr>
<td>Steel</td>
<td>Trough: 3.50 in</td>
</tr>
<tr>
<td>5 1/2 ft</td>
<td>4.6 ft</td>
</tr>
<tr>
<td>Steel</td>
<td>Trough: 3.50 in</td>
</tr>
<tr>
<td>5 1/2 ft</td>
<td>4.6 ft</td>
</tr>
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<td>Trough: 3.50 in</td>
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<tr>
<td>5 1/2 ft</td>
<td>4.6 ft</td>
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</tbody>
</table>

**Beam Fireproofing Capacity**

\[ y_{1} = \frac{y_{2}}{2} \]

\[ y_{2} = \frac{y_{1}}{2} \]

\[ L_{1} = \frac{y_{2}}{2} \]

\[ L_{2} = \frac{y_{1}}{2} \]

**Beam Shear Capacity**

\[ V_{d} = \frac{y_{2}}{2} \]

\[ V_{2} = \frac{y_{1}}{2} \]

\[ V_{1} = \frac{y_{2}}{2} \]

\[ V_{3} = \frac{y_{1}}{2} \]

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\[ V_{77} = \frac{y_{1}}{2} \]

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\[ V_{79} = \frac{y_{1}}{2} \]

\[ V_{80} = \frac{y_{2}}{2} \]

\[ V_{81} = \frac{y_{1}}{2} \]

**Design Criteria 3**
### Design Criteria 4

**References**  
System: Frame Analysis

<table>
<thead>
<tr>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLOWABLE BEAM DEFLECTION</td>
</tr>
<tr>
<td>D+L → L/240 = 8&quot; x L/120 = 1/240 x 1/120</td>
</tr>
</tbody>
</table>

**Column Slaender Value**

- **Determine K**
  - **Calc:** 3k x 5/12 x 15/12 = 1/240 x 1/120
  - **Beam. 5/12 x 15/12 = 1/240 x 1/120
  - **Ga = (Ea / Le) = 120 / 7.5 = 16**
  - **K = 0.86 (Fa / a - 7.1)**

**Design Criteria 5**

**References**  
System: Frame Analysis

<table>
<thead>
<tr>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPRESSION STRENGTH COLUMN</td>
</tr>
<tr>
<td>( P_a = \frac{A_p f_y}{f_m} ), ( A_p = 1.89 \text{ in}^2 )</td>
</tr>
<tr>
<td>( V_a = 56.1 \text{ in}, f_m = 20,000 )</td>
</tr>
<tr>
<td>( \frac{V_a}{A_p f_y} = 0.31 )</td>
</tr>
<tr>
<td>( \phi = 0.65 )</td>
</tr>
<tr>
<td>( P_a = 0.65 (1.89 f_m) = 59.5 )</td>
</tr>
<tr>
<td>( P_m = 0.31 (1.89 f_m) = 37.2 )</td>
</tr>
<tr>
<td>( V_m = 63.3 ) ( \text{lbf} )</td>
</tr>
</tbody>
</table>

**Shear Strength Column**

- In accordance to Sec. 6.2.1 and 6.2.2
- Ts = 3 x 3 in
- h = 2.66 in
- \( C_t = 0.18 \) (min. thickness) x 1.2
- \( A_t = 4.257 \) in²
- \( K_s = 0.5 \)

**G2-1**

- \( V_m = 0.6 \text{lbf} A_p f_y \) x \( C_t \)
- \( V_m = 3.21 \) \( \text{lbf} \)
- \( \phi = 1.0 \)

**G2-2**

- \( V_m = 0.6 \) \( (4 \text{ in})^2 \) x \( f_y \) = 24.6 \( \text{lbf} \)
- \( \phi = 0.9 \)
- \( V_m = 23 \) \( \text{lbf} \)
### Design Criteria 6

#### Welded Connection

- **Black Seam**

  \[ A_{ww} = f \left( 0.6 \times F_{aw} \times \frac{W}{2} \right) \]

- **Fz**

- **Fig 2-4**

#### Moment Connection

- **A3, Steel**

  \[ W = \frac{W_s}{W_s} \times 3 \times 3 = 1.0 \]

- **K3-10**

  \[ \beta > 0.85 \]

  \[ M = F_{a0} \times (6 - 1) \times \text{c hinge} \]

  \[ F_{a0} = 150 \text{ kips} \]

  \[ \beta = 3 \times 3 \times 10 \]

  \[ H_s = 5 \text{ in} \]

  \[ H_{s0} = 5 \text{ in} \]

  \[ H_s = 153 \text{ kips} \]

  \[ H_{s0} = 11.1 \text{ kips} \]

  \[ \beta > 1.00 \]

  \[ \beta = 11.1 \text{ kips} \]

### Design Criteria 7

#### Frame Analysis

- **Column**

  - **Flexural**:
    - 7.64 in
  - **Connection**: 63.3 k
  - **Shear**: 2.5 k
  - **Shear Ratio**: < 2.00

- **Beam**

  - **Moments**:
    - 14.2 k in
  - **Shear**: 11.5 k
  - **Deflection**: 0.4 in

- **Connection**

  - **Weld**: 65.28
  - **Nail Conn**: 1/1x 6-

#### Plate Loading

- **N = 8.0 in** (Framing Member, House)

- **m**: 8.0 - 0.9(8.0) = 2.0

- **Plate Thickness**: 0.12 in

- **Anchor Nails**: 0.375 Dia

- **Plate Camber**

  - **Shear Loading**:
    - 4.8 kips
  - **Ag**: 0.4 in

  \[ 0.6 (3 kips) \times 0.4 \text{ in} = 0.4 \text{ kips} \]

  \[ q = 1.00 \]

  \[ q = 0.6 (3 \text{ kips}) \times 0.4 \text{ in} = 0.4 \text{ kips} \]

  \[ q = 0.4 \text{ kips} \]
References

<table>
<thead>
<tr>
<th>System: Frame Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Plate Details</strong></td>
</tr>
<tr>
<td>Anchor Bolt Capacity</td>
</tr>
<tr>
<td>Assuming A307</td>
</tr>
<tr>
<td>Tensile: 45 ksi</td>
</tr>
<tr>
<td>Shear: 27 ksi</td>
</tr>
<tr>
<td>Width: ( \frac{27}{\sqrt{2}} \times (\frac{1}{2}) \times 0.7854 )</td>
</tr>
<tr>
<td>Tensile: 36.8 kN</td>
</tr>
<tr>
<td>Shear: 21.2 kN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plate Geometry Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. ( P_y = \frac{2 \times \text{in}^3}{h^2} )</td>
</tr>
<tr>
<td>( = 36 \text{ ksi} \times (0.01^3) )</td>
</tr>
<tr>
<td>( = 18 \text{ kips} )</td>
</tr>
<tr>
<td>( = 1.5 \text{ kips} )</td>
</tr>
<tr>
<td>( M_{ax} \times 1.35 )</td>
</tr>
</tbody>
</table>

**Bracing Strength on Concrete**

\( P_y = 0.25 \text{ ft}^3 / \text{A} \); Assuming 4000 psi concrete

\( 0.80 \times (4000 \text{ psi}) \times (8'' \times 8'' - M \frac{3}{\sqrt{2}} (\frac{1}{2})') \)

\( = 216.1 \text{ kN} \)

**Frame on Grid**

*Modelled as a Diaphragm*

\( M_{max} = 4.9 \text{ kips} \)
\( M_{col} = 3.7 \text{ kips} \)

**Design Criteria**

- Base Plate Summary
  - Rate Thickness: 1/2" 
  - Rate Bolt: 3/8" 
  - Rate Shear Capacity: 86 kN 
  - Rate Moment Capacity: 135 kN
  - Bolt Tensile: 30.3 kN 
  - Shear: 21.2 kN 

\( \phi M_n = 7.69^{ \times } T S 3 \times 3 \text{ col} \)
\( \phi M_n = 16.24^{ \times } T S 3 \times 3 \text{ BMS} \)
Maximum Moment = 8.498 k-ft

Note: Moment due to Moment Combining, Amount to Columns is Minimal.
References: GRID 4 RISA 2D CHECK

**GRAVITY**

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: Line "C" RISA Analysis – w/ Gravity Loads

Max Moment = 6.42 k - ft

Moments

RISA Gravity Analysis 16

Deflected Shape

JointLabel X [in] Y [in] Rotation
N1 0 0 -2.342e-3
N2 0 0 -4.509e-3
N3 0 0 -8.598e-4
N4 .042 -.005 3.435e-3
N5 .044 -.003 4.509e-3
N6 0 0 -3.957e-3
N7 .071 -.004 -3.18e-3
N7 .07 -.004 -6.66e-4
N17 .07 -.004 -3.363e-3
N18 .07 -.005 3.362e-3
N19 .07 -.004 -2.221e-3
N20 .055 -.005 -1.058e-4
N12 .055 -.005 -1.058e-4
N13 .055 -.002 -2.21e-4
N14 .055 -.002 -7.06e-5
N15 .055 -.004 -4.509e-5
N16 .055 -.005 1.977e-5
N17A .055 -.002 3.546e-5
N19A .056 -.002 4.114e-5
N19A .056 -.005 3.438e-5

RISA Gravity Analysis 17
Comments

<table>
<thead>
<tr>
<th></th>
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<tr>
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<tr>
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<td>-9.615e-4</td>
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<tr>
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<td>0.414</td>
<td>0.001</td>
<td>-3.836e-4</td>
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<tr>
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<td>N13</td>
<td>0.422</td>
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<td>-2.319e-5</td>
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<td>2.67e-5</td>
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<tr>
<td>N15</td>
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<td>0.001</td>
<td>-2.200e-4</td>
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<tr>
<td>N16</td>
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<td>-1.136e-5</td>
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<tr>
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<td>0.001</td>
<td>-2.816e-5</td>
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<tr>
<td>N18</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

RISA Analysis - Lateral 4

Deflected Shape

RISA Analysis - Lateral 3

Deflected Shape
Shear:
V_{max} = 0.856k

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

Moment:
\[ M_{\text{max}} = 1.393\text{k-ft} \]
**References**

**System:** GRID 4 RISA 2D CHECK

**Comments**

**FLEXIBLE DIAPHRAGM**

### Axial

### Shear

### Moment

### Deflection

Max Moment: 1.6k
Max Shear: 0.6k

---

**RISA Analysis - Lateral 11**

---

**RISA Analysis - Lateral 12**
MODULAR HOUSE SENIOR PROJECT
ARCE 453/460
Building 21-122E. Cal Poly
San Luis Obispo, California 93410

References System: GRID 4 RISA 2D CHECK
Comments

RIGID DIAPHRAGM

Axial

Shear

Deflection

Moment

Max Moment: 2.034
Max Shear: 0.74

RISA Analysis - Lateral 13
<table>
<thead>
<tr>
<th>References</th>
<th>System:</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**RISA Analysis - Lateral 15**

```
Equivalent force = \( 8 + 3 = 11 \) k

\[
x = \left( \frac{3.5 \times 8.4}{11} \right) \approx 2.32\text{ ft}
\]

Center of rigidity:

\[
x_c = 2(3.5 \times 8.4) - 3(6)(0) = 14.7\text{ ft}
\]

torsional moment = 1.11k \((3.75 - 3.47)\) \(\approx 2.9\) k-ft

\[
F_x = \frac{11k}{5\text{ columns}} \approx 2.2\text{ k/ft}
\]

\[
F_y = \frac{29k}{3.47} \approx 8.4\text{ k/ft}
\]

\[
F_z = \frac{29k}{2(3.47)} = 5.28\text{ k/ft}
\]

gridline A: \( F_x = 2.2\text{ k} \)

gridline B: \( F_x = 1.97\text{ k} \)

```
**Gridline A - Flexible Diaphragm**

- **Axial**
- **Moment**
- **Shear**
- **Deflected Shape**

**Joint Deflections**

<table>
<thead>
<tr>
<th>Joint Label</th>
<th>X (in)</th>
<th>Y (in)</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N2</td>
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<td>0.001</td>
<td>-4.11e-4</td>
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<tr>
<td>N3</td>
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<td>0</td>
</tr>
<tr>
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<td>1.184</td>
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</tr>
<tr>
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<td>N8</td>
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</table>

**RISA Analysis - Lateral 17**

---

**Gridline A - Rigid Diaphragm**

- **Axial**
- **Moment**
- **Shear**
- **Deflected Shape**

**Joint Deflections**

<table>
<thead>
<tr>
<th>Joint Label</th>
<th>X (in)</th>
<th>Y (in)</th>
<th>Rotation</th>
</tr>
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<tbody>
<tr>
<td>N1</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>N2</td>
<td>1.217</td>
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<td>N3</td>
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<td>0</td>
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<tr>
<td>N4</td>
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<tr>
<td>N6</td>
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<td>N19</td>
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<td>-2.022e-3</td>
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</tbody>
</table>

**RISA Analysis - Lateral 18**
**System: Modular House Grid B Rigid Diaphragm**

**Moments**

-2.6 kN

**Shear**

RISA Analysis - Lateral 23

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

**Axial**

RISA Analysis - Lateral 24
Deflected Shape

Joint Label | X [in] | Y [in] | Rotation
--- | --- | --- | ---
N1 | 0 | 0 | -2.129e-3
N2 | 0 | 0 | -1.654e-3
N3 | 0 | 0 | -1.67e-3
N4 | 0.28 | 0 | -4.788e-4
N5 | 0.29 | 0 | -5.56e-4
N6 | 0 | 0 | -2.265e-3
N7 | 0.4 | 0 | -6.327e-4
N8 | 0.4 | 0 | -3.555e-4
N9 | 0.4 | 0 | -1.699e-4
N10 | 0.56 | 0 | -4.592e-6
N11 | 0.6 | 0 | -1.177e-5
N12 | 0.6 | 0 | -1.918e-5
N13 | 0.6 | 0 | -1.743e-5
N14 | 0.6 | 0 | -3.31e-6
N15 | 0.6 | 0 | -3.15e-7
N16 | 0.6 | 0 | -1.814e-7
N17A | 0.6 | 0 | -1.535e-7
N18A | 0.6 | 0 | -6.127e-7
N19A | 0.6 | 0 | -4.216e-7

Shear: Vmax = 0.374k
Moment: Mmax = 0.749k-ft
### Deflected Shape

#### Model

![Model Image]

#### Joint Label | X (in) | Y (in) | Rotation (deg)
--- | --- | --- | ---
N1 | 0 | 0 | -2.694e-3
N2 | 0 | 0 | -1.974e-3
N3 | 0 | 0 | -1.92e-3
N4 | 0.034 | 0 | -5.639e-4
N5 | 0.034 | 0 | -7.155e-4
N6 | 0 | 0 | -2.057e-3
N17 | 0.05 | 0 | -8.028e-4
N18 | 0.05 | 0 | -4.533e-4
N19 | 0.051 | 0 | -2.689e-4
N20 | 0.076 | 0 | -0.514e-5
N11 | 0.076 | 0 | -6.66e-5
N12 | 0.075 | 0 | -1.59e-5
N13 | 0.075 | 0 | -3.034e-5
N14 | 0.075 | 0 | -4.492e-6
N15 | 0.075 | 0 | -4.799e-7
N16 | 0.076 | 0 | -1.933e-7
N17A | 0.075 | 0 | -1.933e-7
N18A | 0.075 | 0 | -1.98e-6

### Shear

**Vmax = 0.476k**

### Moment

**Mmax = 0.953k-ft**
### Elevation on Line 1

<table>
<thead>
<tr>
<th>Level</th>
<th>Displacement (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Rise</td>
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</tr>
<tr>
<td>Roof Framing</td>
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<tr>
<td>Level 2 Rise</td>
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<tr>
<td>Level 2 Framing</td>
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<tr>
<td>Level 1 Framing</td>
<td>0.176</td>
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<tr>
<td>Level 1 Drop</td>
<td>0.000</td>
</tr>
</tbody>
</table>

### Shear

- **MAX (+)**: 0.87 kips
- **MIN (-)**: 1.25 k-ft

### Moment

- **1.18 k-ft**
- **1.25 k-ft**
Elevation of Line 2

LEVEL | Displacement (inches)
--- | ---
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

Shear

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

ETABS Comparison - Lateral 3
### Elevation of Line 3

**LEVEL** | **Displacement (inches)**
--- | ---
Roof Rise | ---
Roof Framing | 0.367
Level 2 Rise | ---
Level 2 Framing | 0.355
Level 1 Rise | ---
Level 1 Framing | 0.188
Level 1 Drop | 0.057

**ETABS Comparison - Lateral 5**

**Max (+) | Min (-)**
--- | ---
Shear | 1.22 kips
Moment | 1.70 k-ft

**ETABS Comparison - Lateral 6**
Elevation of Line 4

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Displacement (inches)</th>
</tr>
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<tbody>
<tr>
<td>Roof Rise</td>
<td>---</td>
</tr>
<tr>
<td>Roof Framing</td>
<td>0.378</td>
</tr>
<tr>
<td>Level 2 Rise</td>
<td>---</td>
</tr>
<tr>
<td>Level 2 Framing</td>
<td>0.364</td>
</tr>
<tr>
<td>Level 1 Rise</td>
<td>---</td>
</tr>
<tr>
<td>Level 1 Framing</td>
<td>0.163</td>
</tr>
<tr>
<td>Level 1 Drop</td>
<td>0.037</td>
</tr>
</tbody>
</table>

ETABS Comparison - Lateral 7

Shear

MAX (+) MIN (-)
Shear 0.83 kips
Moment 1.03 k-ft 1.04 k-ft

ETABS Comparison - Lateral 8
### Level Displacement (inches)

<table>
<thead>
<tr>
<th>Level</th>
<th>Displacement</th>
</tr>
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<tbody>
<tr>
<td>Roof Rise</td>
<td>0.324</td>
</tr>
<tr>
<td>Roof Framing</td>
<td>0.324</td>
</tr>
<tr>
<td>Level 2 Rise</td>
<td>0.320</td>
</tr>
<tr>
<td>Level 2 Framing</td>
<td>0.310</td>
</tr>
<tr>
<td>Level 1 Rise</td>
<td>0.185</td>
</tr>
<tr>
<td>Level 1 Framing</td>
<td>0.162</td>
</tr>
<tr>
<td>Level 1 Drop</td>
<td>0.042</td>
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**ETABS Comparison - Lateral 11**

MAX (+) MIN (-)

<table>
<thead>
<tr>
<th>Shear</th>
<th>1.10 kips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment</td>
<td>1.45 k-ft</td>
</tr>
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**ETABS Comparison - Lateral 12**
## References

<table>
<thead>
<tr>
<th>System: Panel Connections (capacities)</th>
<th>Comments</th>
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<tbody>
<tr>
<td><strong>(3-2)</strong></td>
<td>$C_{3.5} = 10''$</td>
</tr>
<tr>
<td></td>
<td>$\min \text{ weld} = 1 / 8''$</td>
</tr>
<tr>
<td></td>
<td>E60 electrode $\rightarrow$ 60 ksi</td>
</tr>
<tr>
<td></td>
<td>$p_{Rn} = 0.75(0.8)(60\text{ksi})(0.707)(0.5)(10') = 24 \text{kips} \rightarrow \text{GOV}$</td>
</tr>
<tr>
<td></td>
<td>Base metal: $p_{Rn} = 0.9(0.8)(60\text{ksi})(0.5)(10') = 37.5 \text{kips}$</td>
</tr>
<tr>
<td></td>
<td>$C_{3.5} = 1.25 \times 1.25 \times 3/8''$</td>
</tr>
<tr>
<td></td>
<td>$\frac{1}{2}''\text{ thick} + A_{225}$</td>
</tr>
<tr>
<td></td>
<td>$\text{Panel shear} = R_n - F_u$</td>
</tr>
<tr>
<td><strong>(3-1)</strong></td>
<td>$R_n = (0.75)(0.5)(1.16)^2 = 6 \text{kips}$</td>
</tr>
<tr>
<td></td>
<td>Density on plate: $\bar{R}_n = \frac{1}{1.2} R_n = 5.24 \text{ kips}$</td>
</tr>
<tr>
<td></td>
<td>$\text{tensile} = 0.75[1.2(0.75)(3/8'')(500\text{ksi})] = 7.34 \text{kips}$</td>
</tr>
<tr>
<td></td>
<td>$\text{bearing} = 0.3(2,4)(1/8')(0.5)(58\text{ksi}) = 9.9 \text{kips}$</td>
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<tr>
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<td>$\text{shear yielding: } R_n = 0.05 F_u A_{yw}$</td>
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<tr>
<td><strong>(3-3)</strong></td>
<td>$R_n = 0.05(60)(0.3'')(0.75) = 6 \text{kips}$</td>
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<td>$\text{shear rupture: } R_n = 0.60 F_u A_{yw}$</td>
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<tr>
<td><strong>(3-4)</strong></td>
<td>$R_n = 0.75(0.60)(36\text{ksi})(1.5)(2.5''') = 9.5 \text{kips} \rightarrow \text{GOV}$</td>
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<tr>
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<td>$\text{tensile yielding: } R_n = 5.5 \text{ksi}$</td>
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<tr>
<td><strong>(3-5)</strong></td>
<td>$R_n = 0.9(36\text{ksi})(2.5''') = 12.2 \text{kips}$</td>
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<tr>
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<td>$\text{tensile rupture: } R_n = F_u A_{t}$</td>
</tr>
<tr>
<td><strong>(4-2)</strong></td>
<td>$R_n = (2.5)(3/8'') = 0.23 \text{ksi}$</td>
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<tr>
<td></td>
<td>$A_{t} = \frac{R_n}{2} = 0.23 \text{ksi}$</td>
</tr>
<tr>
<td></td>
<td>$p_{Rn} = 0.75(0.3'')(0.32''') = 13.4 \text{kips}$</td>
</tr>
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</table>
**References**

System: Guard Rail Deflection

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>( \Delta_{\text{max}} = \frac{Pd^2}{4EI} ) or ( \Delta_{\text{max}} = \frac{5wL^4}{384EI} )</td>
</tr>
<tr>
<td>( I_x = 1.77 \text{ in}^2 ) beam braced at 6 supports along length</td>
</tr>
<tr>
<td>( I_y = 6.932 \text{ in}^2 )</td>
</tr>
<tr>
<td>( \Delta_{\text{max}} = \frac{1}{384} \left( \frac{2000000}{0.001} \right)(0.77) = 0.0011'' )</td>
</tr>
<tr>
<td>( \Delta_{\text{max}} = \frac{(0.75)(24^3)(0)}{384(2000000)(1.77)} = 0.05'' )</td>
</tr>
<tr>
<td>( \Delta_{\text{max}} = \frac{0.0011'' \times 1.77}{0.932} = 0.0021'' )</td>
</tr>
<tr>
<td>( \Delta_{\text{max}} = 0.05'' \times 1.77 \times 0.932 = 0.086'' )</td>
</tr>
</tbody>
</table>

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**References**

System: Guard Rail Connections

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>( A_{\text{N}} = 0.75(0.6)(60)(0.707)(10)(10) = 24 \text{ kips} )</td>
</tr>
<tr>
<td>( A_{\text{N}} = 0.9(0.4)(36)(0.707)(10)(10) = 32.5 \text{ kips} )</td>
</tr>
</tbody>
</table>
References | System: Frame Analysis | Comments
--- | --- | ---

**1st Floor**

- **Axial on Column**
  - **Axial**:
    - $A_t = 3(4\times4) = 48\,\text{in}^2$
    - $P_t = 125\,\text{kN}$
    - $P_L = 4.8\,\text{kN}$
    - $P_D = 2.15\,\text{kN}$
    - $P_L = 8.20\,\text{kN}$
  - **Beam Loading** (Dead & Live House Case)
    - 1st Floor - Beam $B$
    - $W_o = 261.5\,\text{lf} (\text{lf}) = 211\,\text{kN}$
    - $W_L = 100\,\text{cf} (\text{lf}) = 8\,\text{kN}$
    - $M_o = 101.2\,\text{kN} \cdot \text{lf}$
    - $M_L = 8.3\,\text{kN} \cdot \text{lf}$
  - $V = W_L / 2 = 4\,\text{kN}$
  - $V_o = 3.4\,\text{kN}$
  - $V_L = 3.2\,\text{kN}$

**Load Combos (Beams)**

- **Share**:
  - 1.20+1.60, Earthquake, Minimum, $V = 6.12\,\text{kN}$
  - $6.12 < 17.35\,\text{kN}(\text{beam})$  
  - $< 61\,\text{kN}(\text{column})$  

**Columns**

- **Axial**:
  - $0.90 \times 1.08 \times 0.9215 \times 1.0 (1.0) = 2.93\,\text{kN}$
  - $1.20 \times 1.08 \times 0.875 \times 0.7751 \times 1.0 + 0.1(1.0) = 7.06\,\text{kN}$
  - $15.78\,\text{kN} > 86.9\,\text{kN}$  
  - $< 63.3\,\text{kN}$  

**Beam Lateral**

- **Max Shear** = 1.8\,\text{kN}
- **Max Moment** = 26\,\text{kN} \cdot \text{lf}

**Limit States 1**

---

**2nd Floor**

- **Axial on Columns**
  - Largest Bearing @ B-2
  - $A_t = 4(4\times4) = 16\,\text{in}^2$
  - $P_t = 76.1\,\text{psf}$
  - $P_L = 4.1\,\text{psf}$
  - $P_D = 0.417\,\text{kN}$
  - $P_L = 1.6\,\text{kN}$

**Beam Loading**

- 2nd Floor - Beam $B$
- $W_o = 261.5\,\text{lf} (\text{lf}) = 194.7\,\text{kN}$
- $W_L = 100\,\text{cf} (\text{lf}) = 75\,\text{kN}$
- $V_o = P_w \times \frac{b}{2}$
- $V_L = 0.653\,\text{kN}$
  - $V_o = P_w = 0.653\,\text{kN}$
  - $b = 2\,\text{lf}$
  - $P_w = 0.417\,\text{kN}$
  - $P_L = 1.6\,\text{kN}$

**2nd Flow Floor**

- **Share**:
  - 2nd Floor Rise
  - $P_o = 0.417\,\text{kN}$
  - $P_L = 1.6\,\text{kN}$

**Limit States 2**
MODULAR HOUSE SENIOR PROJECT
ARCE 453/460
Building 21-122E, Cal Poly
San Luis Obispo, California 93410 (IBC 2012)

References

<table>
<thead>
<tr>
<th>System</th>
<th>Frame Analysis</th>
</tr>
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<tbody>
<tr>
<td>Moments Diagrams</td>
<td></td>
</tr>
<tr>
<td>Points of Interest</td>
<td></td>
</tr>
<tr>
<td>Elevation of Line B</td>
<td></td>
</tr>
<tr>
<td>M = \text{Moment}</td>
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</tr>
</tbody>
</table>

Moment Diagrams

- Level 1 Roof

- Points of Interest

- Elevation of Line B

References

- System: Frame Analysis
- Limit States 3

References

- System: Frame Analysis
- Limit States 4
Phase 2 Stairs 1

References | System: Phase 2 Stairs Code Compliancy | Comments
--- | --- | ---
1011.7 | Construction
→ Stair shall not be more than a 2%
→ Water shall not accumulate on landing |  
1011.6 | Vertical Rise
→ Flight shall not be less than the stairs between Floor/ Landing |  
1011.3 | Landings
→ Shall not be less than the stairs
→ Where stairway has a straight run the depth need not exceed 48 in |  
1011.5.2 | Headroom
→ Clearance not less than 80 in |  
1014.3.2 | Riser Height
→ max: 7 in, min: 4 in |  
1014.2 | Tread Run
→ min: 11 in |  
Handrails
→ Section 1014
→ Height 34" to 38"
→ Graspability: Type 2 |  
1015.2 | Continuity: Continuous (no exceptions)
Guards
→ Required |  

Phase 2 Stairs 2

References | System: | Comments
--- | --- | ---

Construction → 0% SLOPE ON TREAD ✓
CONTINUITY → ✓
LANDING IS LESS THAN 48' FOR STRAIGHT RUN ✓
LEVEL 2 RISE
10' - 4"

STAIR LANDING
5' - 6"

LEVEL 1 FRAMING
0"

FLIGHT < 12' ⇒ 5' 6" < 12' ✓
TREAD = 11' ✓
RISE = 6 1/2' ✓
<table>
<thead>
<tr>
<th>ID</th>
<th>Task Mode</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
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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>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Permitting</td>
<td>14.38 days</td>
<td>Tue 4/18/17</td>
<td>Sat 5/13/17</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Approved Mock-Up</td>
<td>2 days</td>
<td>Tue 4/18/17</td>
<td>Fri 4/21/17</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Complete structural analysis and design</td>
<td>5 days</td>
<td>Wed 4/19/17</td>
<td>Sun 4/30/17</td>
</tr>
<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>Tue 5/4/17</td>
<td>Sat 5/13/17</td>
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<td>8</td>
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<td>Site Investigation</td>
<td>18.88 days</td>
<td>Sun 3/19/17</td>
<td>Sat 4/22/17</td>
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<td>9</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>
<td>1 day</td>
<td>Fri 4/7/17</td>
<td>Fri 4/7/17</td>
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<td>Complete necessary training for hazards</td>
<td>3 days</td>
<td>Tue 4/18/17</td>
<td>Sat 4/22/17</td>
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<td>Preconstruction Management</td>
<td>21.25 days?</td>
<td>Sun 4/9/17</td>
<td>Thu 5/18/17</td>
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<td>13</td>
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<td>Material QTO</td>
<td>2 days</td>
<td>Sun 4/9/17</td>
<td>Mon 4/10/17</td>
</tr>
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<td>14</td>
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<td>1 day?</td>
<td>Fri 4/21/17</td>
<td>Sat 4/22/17</td>
</tr>
<tr>
<td>15</td>
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<td>Supplier Pricing</td>
<td>2 days</td>
<td>Sun 4/30/17</td>
<td>Fri 5/5/17</td>
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<td>16</td>
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<td>1 day</td>
<td>Fri 5/5/17</td>
<td>Sat 5/6/17</td>
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<tr>
<td>17</td>
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<td>1 day</td>
<td>Sat 5/6/17</td>
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<td>Material Purchasing</td>
<td>5 days</td>
<td>Sun 5/7/17</td>
<td>Thu 5/18/17</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>Construction &amp; Repairs</td>
<td>28.5 days</td>
<td>Sun 4/23/17</td>
<td>Tue 6/13/17</td>
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<tr>
<td>20</td>
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<td>11 days</td>
<td>Thu 5/4/17</td>
<td>Sun 5/21/17</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>Clean work space (rat droppings, scraps, garbage)</td>
<td>1 day</td>
<td>Thu 5/4/17</td>
<td>Fri 5/5/17</td>
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<tr>
<td>22</td>
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<td>remove damaged and vandalized signs</td>
<td>1 day</td>
<td>Fri 5/5/17</td>
<td>Sat 5/6/17</td>
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<td>4 days</td>
<td>Sat 5/13/17</td>
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<td>24</td>
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<td>Prep structure for repairs and additions</td>
<td>1 day</td>
<td>Sun 5/21/17</td>
<td>Sun 5/21/17</td>
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<tr>
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<td>Deep clean</td>
<td>1 day</td>
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<td>Tue 5/23/17</td>
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<td>Layout</td>
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<td>Tue 5/23/17</td>
<td>Sat 5/27/17</td>
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<tr>
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<td>Install metal deckling</td>
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<td>Sat 5/27/17</td>
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<td>Tue 5/30/17</td>
<td>Fri 6/2/17</td>
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<td>place, pour and finish concrete infill 1</td>
<td>1 day</td>
<td>Fri 6/2/17</td>
<td>Sat 6/3/17</td>
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<tr>
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<td>concrete cure time 1</td>
<td>2 days</td>
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<td>place, pour and finish concrete infill 2</td>
<td>1 day</td>
<td>Fri 6/2/17</td>
<td>Sat 6/3/17</td>
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<td>33</td>
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<td>2 days</td>
<td>Sat 6/3/17</td>
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<td>Sun 4/23/17</td>
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<td>PreFab Steel Guardrails</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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<td>Erect Steel Guardrails</td>
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<td>Tue 5/30/17</td>
<td>Fri 6/9/17</td>
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<td>Make Connections (Bolt / Weld)</td>
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<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>
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<td>Paint layout, tape and surface prep</td>
<td>1 day</td>
<td>Sat 5/27/17</td>
<td>Sun 5/28/17</td>
</tr>
<tr>
<td>43</td>
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<td>Paint</td>
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<td>Tue 5/30/17</td>
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<td>Paint Finish</td>
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<td>45</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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<td>Closeout</td>
<td>1 day</td>
<td>Thu 6/15/17</td>
<td>Fri 6/16/17</td>
</tr>
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<td>47</td>
<td></td>
<td>As-Built Drawings</td>
<td>1 day</td>
<td>Thu 6/15/17</td>
<td>Fri 6/16/17</td>
</tr>
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<td>48</td>
<td></td>
<td>Project Contact Sheet</td>
<td>1 day</td>
<td>Thu 6/15/17</td>
<td>Fri 6/16/17</td>
</tr>
<tr>
<td>49</td>
<td></td>
<td>Necessary Inspections</td>
<td>1 day</td>
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