Weed, CA Housing Project

A Senior Project
Presented to the Architectural Engineering Department,
California Polytechnic State University, San Luis Obispo

In partial fulfillment of requirements for the
Degree of the Bachelor of Science

By Trenton Jay Pichel
December 1, 2017

© Trenton Jay Pichel
Project Description

The following provides background information of the overall purpose for this project as well as
supporting architectural documents to aid the structural design.

History: In September of 2014, Siskiyou country and the City of Weed, CA was struck by a
violent wild fire that burned through the town, destroying several office buildings and
neighborhoods, along with two churches and caused damage to the local elementary school.
High winds blow through Weed, which are particularly high during the late summer months, and
spread the fire faster than what fire fighters could manage. In short, the City of Weed lost
numerous amount of buildings due to the Boles fire and families were uprooted in its wake. Two
years later, Cal Poly San Luis Obispo became involved in the cities rebuild.

Who: The following structural calculations and drawings were created for Great Northern
Services (GNS) in the city of Weed, California. GNS is a non-profit organization dedicated to
servicing its community by invigorating the cultural, environmental, social, and economical
aspects of Siskiyou County. Alongside GNS, this project was developed for the College of
Siskiyou, which is a community college servicing the same region GNS influences and is a
secondary shareholder to this project.

What: The following content is the structural design for a 1000 square feet, single story, and
single family residential home located in northern California, which is subjected to large snow
and wind loads. With this in mind, the design intent was to provide a well-insulated space for the
future homeowners through Passive House design aspects.

Why: Prefabricated passive housing was the focus of the design so that the future occupants
could live comfortably in their home during all seasons of the year, especially in the winter since
Weed can endure snowfall of up to six feet during the colder months. Passive housing not only
provides a superior comfort of living, but the monthly energy savings on heating and cooling are
extremely significant as well, providing up to a 75 percent reducing in monthly bills. Natural gas
was not an option when determining the heating needs for the client and therefore electricity
and diesel fuel are the primary means of energy for the area. The project team determined early
on that diesel fuel was likely to be an inefficient design in terms of sustainability and
maintenance costs, leaving electricity as the only viable option and furthering support for a
passive concept.
Spatial efficient
- High ratio of usable area to gross built area
  - Open floorplan and circulation arrangement of the rooms minimizes hallways and dead space
  - The Shelf, a raised shelf system provides additional storage and allows more usable floor space below

Energy efficient
- Building shape
  - Aiming an A/V-ratio below 0.7 reduces surfaces through which heat can be lost
- Site strategy
  - Wall assembly and thermal envelope
    - A well insulated wall assembly and continuous insulating envelope reduces heatloss through the surfaces/walls
    - Airtightness
      - Reducing the air change rate leads to a lower exchange of hot and cold air

Building to the Passive House Standard reduces our buildings’ operational energy demand to an optimized extent through passive measures and components such as insulation, airtightness, heat recovery, solar heat gains, solar shading and incidental internal heat gains. Passive House reliably delivers up to approximately a 90% reduction in heating and cooling demand and up to a 75% reduction in overall primary energy demand when compared to our existing building stock.

Affordable
- Simple but sophisticated floorplans reduces the amount of walls and constructive elements
- The investment in higher quality building components is mitigated by the elimination of expensive heating and cooling systems.

Energy efficient
- Building shape
  - Aiming an A/V-ratio below 0.7 reduces surfaces through which heat can be lost
- Site strategy
  - Wall assembly and thermal envelope
    - A well insulated wall assembly and continuous insulating envelope reduces heatloss through the surfaces/walls
    - Airtightness
      - Reducing the air change rate leads to a lower exchange of hot and cold air

Regular home*
- 2015 average monthly consumption US = 901 kWh / household / month
- Average price = $0.1699 / kWh
- 901 kWh monthly * $0.1699 / kWh = $153.08 / month

Passive house
- Monthly consumption Passive house = 6200 kWh / household / year
- Average price = $0.1699 / kWh
- 516 kWh monthly * $0.1699 / kWh = $87.67 / month

Savings
- $153.08 / month - $87.67 / month = $65.41 / month
- $65.41 / month = $784.92 / year

Passive House Principles
- Building to the Passive House Standard reduces our buildings’ operational energy demand to an optimized extent through passive measures and components such as insulation, airtightness, heat recovery, solar heat gains, solar shading and incidental internal heat gains. Passive House reliably delivers up to approximately a 90% reduction in heating and cooling demand and up to a 75% reduction in overall primary energy demand when compared to our existing building stock.
- Passive Houses are uniquely raising our expectations of what sustainable high-performance buildings can be and should be.
Roof structure angled to take on high wind loads predominantly from the south and partially from the north while preserving the look of the neighborhood.

Roof shape and material choice to effectively shed snow and direct water downhill.

Water Management

Heat Pump Water Heater
- Water is taken from the water line along the west side of the property into the technical room where the heater is located
- Water is then heated as needed based on homeowners' heating needs
- One plumbing wall is needed
- Waste water is then sent to the sewage pipe which will connect to the sewer line in parcel 2

Heating Systems

Primary Heating Source
- A technical room, located at an exterior wall allows immediate heating and less connection for the systems
- The Heat Pump is located in the garage
- Ductless Mini-Split Heat Pumps
- Modulated heating based on temperature
- One outdoor unit and three indoor units focused mainly on heating
- Indoor units capable of 8,900 BTU/hr
- Outdoor unit capable of 28,600 BTU/hr
- Electricity and power will be provided by the line

Water Management

Heat Pump Water Heater
- Water is taken from the water line along the west side of the property into the technical room where the heater is located
- Water is then heated as needed based on homeowners' heating needs
- One plumbing wall is needed
- Waste water is then sent to the sewage pipe which will connect to the sewer line in parcel 2

Heating Systems

Primary Heating Source
- A technical room, located at an exterior wall allows immediate heating and less connection for the systems
- The Heat Pump is located in the garage
- Ductless Mini-Split Heat Pumps
- Modulated heating based on temperature
- One outdoor unit and three indoor units focused mainly on heating
- Indoor units capable of 8,900 BTU/hr
- Outdoor unit capable of 28,600 BTU/hr
- Electricity and power will be provided by the line

site strategy

Slightly grading the exiting topography creates circulation and adresses several issues; The building orientation and roof shape not only maximizes solar exposure and provides thermal comfort but also protects the site of high wind from north and south.

Also, the grading creates a downward flow for water management and irrigation.
ROOF R-62.66
- Corrugated metal R-0
- 3/4" battens R-1
- 3/4" counter battens R-1
- Waterproofing membrane R-0
- 3/8" Wood fibreboard (open to diffusion) R-0.74
- 2" XPS R-10
- 2" Insulated Sheeting R-12.4
- 9.25" Cellulose fibre insulation / timer joists R-35.15
- 1.5" Insulated Sheeting R-12.4
- 5/8" OSB board, interior finishing R-0.45

WALL ASSEMBLY R-66.266
- 5/8" Drywall/Gypsum R-0.45
- 5.5" High Density Cellulose R-20.9
- 2x6" StudWall
- 5/8" OSB, fluid applied at seams R-0.74
- 9.25" High Density Cellulose R-35.15
- 2" XPS Board R-10
- 2" DWD - vapor permeable sheathing R-0.14
- 3/4" Furring and air space R-1
- 5/16" fibre cement R-0.15

FLOOR ASSEMBLY R-61.436
- 3/8" Linoleum resilient flooring R-0.4
- 3/8" OSB-Sheathing R-0.74
- 7.25" Cellulose and Joists R-27.55
- 2" Insulated Sheeting R-12.4
- 2" Insulated Sheeting R-12.4
- 2" Diffusion Board R-12.4
- Waterproofing Membrane R-0
Examples for Fabrication of Passive Houses

Knox House by EcoCor
- Similar environmental design conditions: snow, wind, heating and cooling, forest
- Hybrid Double Wall System
  - airtightness: 28 ACH/50 and dropping

17 Carol Street by Michael Trolle
- Similar environmental design conditions: snow, wind, heating and cooling, forest
- Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
  - Construction on site
  - airtightness: 0.45 ARCH/50

R. House by Rus Design Architects
- Can be assembled and located elsewhere (modular)
  - Installation of panelized wall assembly with crane
  - airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*

---

**Examples for Fabrication of Passive Houses**

- Knox House by EcoCor
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Hybrid Double Wall System
    - Airtightness: 28 ACH/50 and dropping

- 17 Carol Street by Michael Trolle
  - Similar environmental design conditions: snow, wind, heating and cooling, forest
  - Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
    - Construction on site
    - Airtightness: 0.45 ARCH/50

- R. House by Rus Design Architects
  - Can be assembled and located elsewhere (modular)
    - Installation of panelized wall assembly with crane
    - Airtightness: nil

*The lower the grade of prefabrication the airtight is the building envelope*
# Table of Contents

## Loading
- Load Take Off ................................................................. L-1
- Seismic Loading .............................................................. L-3
- Wind Loading ................................................................. L-5
- Snow Loading ................................................................. L-6

## Gravity Design
- Rafters ............................................................................. G-1
- Ceiling Joists ................................................................. G-8
- Floor Joists ................................................................. G-10

## Foundation Design
- Continuous Footing .......................................................... F-1
- Pad Footing ......................................................................... F-2

## Lateral Design
- Exterior Stud Wall .......................................................... LT-1
- Shear Wall ........................................................................ LT-2

## Diaphragm Design
- N-S Diaphragm ................................................................. D-1

## Connection Design
- Shear Flow ........................................................................ C-1
- Anchor Bolts ........................................................................ C-2
USGS–Provided Output

\[ S_s = 0.736 \text{ g} \quad S_{ms} = 0.891 \text{ g} \quad S_{ds} = 0.594 \text{ g} \]
\[ S_t = 0.328 \text{ g} \quad S_{mt} = 0.572 \text{ g} \quad S_{dt} = 0.381 \text{ g} \]

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the “2009 NEHRP” building code reference document.

For PGA_m, T_u, C_{RS}, and C_{RI} values, please view the detailed report.

Through this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.
LOAD TAKE OFF

ROOF:

1 1/4" VERCO HCB - 36
GALVANIZED ROOF DECK, 20 GAUGE
2.2 psf

6" CLOSED-CELL SPANX INSULATION,
C.R.6 per inch thickness
→ (2 psf)(0.5" ft)
1.0 psf

2x10 DF. L RAFTERS @ 24" O.C.
→ 35 psf (1.15")[9.284(144/12)]/121
6.7 psf

1/2" GYPSUM BOHAD CEILING
→ (5.0 psf)/(0.37"
4.5 psf

MEP + SPRINKLERS
16.9 psf

MISCELLANEOUS
3.1 psf

TOTAL LOAD TO ROOF
20.0 psf

18" EXTERIOR WALL ASSEMBLY
→ (23 psf)(129 ft)(12/12) (8 ft)
(41 ft)(23.5 ft)
19 psf

6" INTERIOR WALL ASSEMBLY
→ (15 psf)(128 ft)(12/12) (8 ft)
(41 ft)(23.5 ft)
12.0 psf

SEISMIC LOAD TO ROOF
51 psf

PITCHED ROOF
20 psf

TOTAL LIVE TO ROOF
(REDUCIBLE
20 psf
FLOOR:

VINYL TILE FLOORING
3/4" OSB SHEATHING
2x8 DF-L #2 R15
@ 18" O.C.
→ (35pcf)(1.5") (2.5') (1'ft²)

6" CLOSED-CELL SPANCELL INSULATION,
@ 6" PER 1"LCH THICKNESS
→ (2pcf) (0.5'²)

TOTAL DEAD TO BEAMS
2x8 DF-LH2 BEAMS
→ (35pcf)(1.5") (7.5") (1'ft²)

MEP

MISCELLANEOUS

TOTAL DEAD TO WALLS
18" EXTERIOR WALL ASSEMBLY
→ (23pcf)(129'ft²)(12") (1'ft²)
(4') (23.5')

6" INTERIOR WALL ASSEMBLY
→ (15pcf)(128'ft²)(12") (1'ft²)
(4') (23.5')

SEISMIC LOAD TO FLOOR

ONE FAMILY DWELLING,
NON HABITABLE ATTIC W/STORAGE

TOTAL LIVE TO FLOOR

1.4 psf
3.0 psf
2.6 psf
1.0 psf
8.0 psf
2.6 psf
2.0 psf
12.6 psf
1.4 psf
14.0 psf
23.1 psf
15.0 psf
52 psf
20 psf
20 psf
Seismic Loading Criteria

Seismic Weight:

\[
\text{Roof} = (51 \text{ psf})(17.5 \text{ ft} + 12 \text{ ft}) \left( \frac{1}{2} \text{ ft} \right) (23.5 \text{ ft}) = 121.2 \text{ kips}
\]

\[
\text{Floor} = (52 \text{ psf})(4 \text{ ft})(23.5 \text{ ft})
\]

\[
\text{Total} = 50.10 \text{ kips}
\]

\[
171.31 \text{ kips}
\]

Seismic Response Coefficient:

\[
C_0 = \frac{S.D.S.}{R/I} = \frac{0.594}{6.5/1} = 0.09138
\]

\[
T = (0.02)(14 \text{ ft}) = 0.275
\]

\[
0.145 \leq 16 = T_L \quad \checkmark
\]

Base Shear:

\[
V = C_0 W_{\text{Total}} = (0.09138)(171.31 \text{ kips}) = 15.65 \text{ kips}
\]

Redundancy Factor:

→ For N-S Direction

<table>
<thead>
<tr>
<th>WALL</th>
<th>LENGTH</th>
<th>HEIGHT</th>
<th>H/L</th>
<th>L/&amp;L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8 FT</td>
<td>18 FT</td>
<td>2.25</td>
<td>\text{8 FT/24 FT} \leq 0.33</td>
</tr>
<tr>
<td>B</td>
<td>8 FT</td>
<td>18 FT</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>C</td>
<td>8 FT</td>
<td>18 FT</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>D</td>
<td>24 FT</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

\[ \therefore N-S = 1.0 \]

→ For E-W Direction

<table>
<thead>
<tr>
<th>WALL</th>
<th>LENGTH</th>
<th>HEIGHT</th>
<th>H/L</th>
<th>L/&amp;L</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 FT</td>
<td>10 FT</td>
<td>0.25</td>
<td>0.2 \leq 0.33</td>
</tr>
<tr>
<td>2</td>
<td>8 FT</td>
<td>10 FT</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>3</td>
<td>8 FT</td>
<td>10 FT</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>4</td>
<td>8 FT</td>
<td>10 FT</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>5</td>
<td>8 FT</td>
<td>10 FT</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>D</td>
<td>40 FT</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

\[ \therefore P_{E-W} = 1.0 \]
VERTICAL DISTRIBUTION OF BASE SHEAR

→ For Roof
\[ C_Y = \frac{w_h h^2}{121.2 \text{kip} \times 1 \text{ft}} = \frac{(18.21 \text{kip})(14 \text{ft})}{(121.2 \text{kip})(14 \text{ft}) + (50.10 \text{kip})(1 \text{ft})} = 0.97 \]

\[ \text{For Floor} \]
\[ C_Y = \frac{(50.10 \text{kip})(1 \text{ft})}{1747.04 \text{kip} \times 4 \text{ft}} = 0.03 \]

\[ = 1.00 \checkmark \]

STORY FORCES:
(NEGLECT ROOF AND FLOOR SEISMIC LOADING)

\[ F_{x \text{roof}} = \sum C_Y V = (1.0)(0.97)(15.65 \text{kip}) = 15.18 \text{kip} \]

\[ F_{x \text{roof}} = (1.0)(0.97)(15.65 \text{kip}) = 15.18 \text{kip} \]

HORIZONTAL DISTRIBUTION OF BASE SHEAR

→ For Roof
\[ V_x = \frac{2}{3} F_x \]

\[ V_x = \frac{2}{3} (15.18 \text{kip}) = 15.18 \text{kip} \]

\[ E-W \]

\[ V_x = \frac{2}{3} F_x \]

\[ = 15.18 \text{kip} \]

EFFECTIVE LENGTHS

→ For N-S Direction

<table>
<thead>
<tr>
<th>WALL</th>
<th>HEIGHT</th>
<th>LENGTH</th>
<th>H/L</th>
<th>REDUCED CAPACITY L \text{eff}</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-C</td>
<td>18 ft</td>
<td>8 ft</td>
<td>2.25</td>
<td>2.0 18 ft 2(8 ft)=0.00 089 (8 ft)=7.1 ft</td>
</tr>
</tbody>
</table>

→ For E-W Direction

<table>
<thead>
<tr>
<th>WALL</th>
<th>HEIGHT</th>
<th>LENGTH</th>
<th>H/L</th>
<th>REDUCED CAPACITY L \text{eff}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>10 ft</td>
<td>8 ft</td>
<td>1.25</td>
<td>2.0 8 ft</td>
</tr>
</tbody>
</table>

OUT OF PLANE SEISMIC FORCES

\[ f_p = 0.45 \text{sec}^2 \varepsilon w = 0.4(0.594)(1.0)(90 \text{psf}) = 4.57 \text{psf} \]
WIND LOADING, CATEGORIES

RISK CATEGORY

BASIC WIND SPEED

EXPOSURE CATEGORY

TOPOGRAPHIC FACTOR, $K_{zT}

WIND PRESSURES, $P_{net,30}$

ADJUSTMENT FACTOR, $\lambda$

ADJUSTED WIND PRESSURES

$$P_{net} = \lambda K_{zT} P_{net,30} = (1.21)(1)(20.8 \text{ psf}) = 25.17 \text{ psf}$$

$$P_{net} = 25.17 \text{ psf} > 4.51 \text{ psf} = \gamma_p$$

*: WIND GOVERNS FOR OUT OF PLANE FORCES
SNOW LOADING CRITERIA

SNOW LOAD, $p_s$

= 60 psf

ROOF SLOPE FACTOR, $C_s$

W/ METAL DECKING, $C_s$

= 0.7 (w/mam) = 0.9 (cold)

DESIGN SNOW LOAD

$S = 0.7 (60 \text{ psf})$

= 42 psf (w/mam)

= 54 psf (cold)
Typical 7:12 Roof Rafter (Warm Roof)

\[ D: 20 \text{ psf} \left( \frac{24 \text{ in}}{12 \text{ in}} \right) \left( \frac{12 \text{ ft}}{12 \text{ in}} \right) = 45 \text{ plf} \]

\[ L_a: 20 \text{ psf} \left( \frac{24 \text{ in}}{12 \text{ in}} \right) = 40 \text{ plf} \]

\[ S: 42 \text{ psf} \left( \frac{24 \text{ in}}{12 \text{ in}} \right) = 84 \text{ plf} \]

Load Combinations:

\[ D + S = 45 \text{ plf} + 84 \text{ plf} = 129 \text{ plf} \]

Demands:

\[ M = \frac{wL^2}{8} = \frac{(129 \text{ plf}) (12 \text{ ft})^2}{8} = 2322 \text{ ft kips} \]

\[ V = \frac{wL}{2} = \frac{(129 \text{ plf}) (12 \text{ ft})}{2} = 774 \text{ kips} \]

L.L. = \frac{L}{240}, T.L. = \frac{L}{180}

\[ \Rightarrow L.L. = \frac{180}{240} = 0.75 \]

\[ T.L. = \frac{180}{180} = 1.00 \]

\[ HND \]

\[ \frac{L.L. \times (60 \text{ psf} + 20 \text{ psf})}{T.L. \left[ (60 \text{ psf} + 20 \text{ psf}) \times 12 \text{ in} \times 10 \text{ in} \right]} = 0.76 \geq 0.75 \quad \text{USE} \frac{L}{240} \]

\[ \Delta = \frac{5wL^4}{384EI} = \frac{L}{240} \]

\[ \varepsilon = \frac{5wL^3}{384} \left( \frac{240}{240} \right) = \frac{5(130 \text{ plf} \times 12 \text{ in}) \left( \frac{1 \text{ ft}}{12 \text{ in}} \times 10 \text{ in} \right)}{384} \approx 101 \times 10^6 \text{ in}^2 \]

\[ \frac{V_{req}}{E'} = \frac{101 \times 10^6 \text{ in}^2}{1.60 \times 10^8 \text{ psi}} = 63.18 \text{ in}^4 \]
SIZE SELECTION:

* TRY 2x10 DF-L #2

\[ E = 1.60 \times 10^6 \text{ psi} \]
\[ F_b = 900 \text{ psi} \]
\[ F_v = 180 \text{ psi} \]
\[ F_c = 625 \text{ psi} \]
\[ I_{xx} = 98.93 \text{ in}^4 \]
\[ S_x = 21.39 \text{ in}^3 \]
\[ A = 13.88 \text{ in}^2 \]

CAPACITY:

\[ F_b' = F_b \left( C_d C_r C_p \right) = (900 \text{ psi})(1.15)(1/1.15)(1.15) = 1309.38 \text{ psi} \]
\[ \sigma_{max} = \frac{M}{S} \Rightarrow M_{allow} = F_b'S = (1309.38 \text{ psi})(21.39 \text{ in}^3) = 2333.97 \text{ ft kips} \]
\[ F_v' = F_v \left( C_d \right) = (180 \text{ psi})(1.15) = 207.00 \text{ psi} \]
\[ \gamma = \frac{VQ}{IT} \Rightarrow V_{allow} = \frac{F_v'A}{1.5} = \frac{(207 \text{ psi})(13.88 \text{ in}^2)}{1.5} = 1915 \text{ ksf} \]
\[ \geq 774 \text{ ksf} \]

* USE 2x10 DF-L #2 RACERAS @ 24" O.C. FOR 7/12 ROOF
TYPICAL 3:12 ROOF RAFTER (COLD ROOF)

\[ D = 20 \text{psf} \left( \frac{24 \text{in}}{12 \text{in}} \right) \left( \frac{1}{15 \text{ft}} \right) = 57 \text{pcf} \]
\[ S = 54 \text{psf} \left( \frac{24 \text{in}}{12 \text{in}} \right) = 108 \text{pcf} \]
\[ L = 20 \text{psf} \left( \frac{24 \text{in}}{12 \text{in}} \right) = 40 \text{pcf} \]
\[ P = \text{SHEAR FROM Rafter} = 774 \text{lbs} \]

SEE PREVIOUS

LOAD COMBINATION:

(1) \[ D + S = 57 \text{pcf} + 108 \text{pcf} = 165 \text{pcf} \]

DEMANDS:

\[ \sum S_M = 0 = P \cdot x + w \cdot x - V \cdot \ell \]
\[ V_{wall} = \frac{\left( 774/2 \right) \left( 3 \text{ft} \right) + \left( 165 \text{pcf} \right) \left( 15 \text{ft} \right) \left( 15 \text{ft} / 2 \right)}{12 \text{ft}} = 2514 \text{lbs} \]

\[ \sum S_Y = 0 = -P - w \cdot x + V_{wall} + V_{wall} = 735 \text{lbs} \]

\[ V \text{ lbs} \]

\[ D_L = \frac{w}{240} = \frac{12 \text{ft} \cdot (12 \text{in})}{240} = 0.61 \text{ in} \]
\[ D_{LL} = \frac{w}{180} = \frac{12 \text{ft} \cdot (18 \text{in})}{180} = 0.81 \text{ in} \]
CAPACITY:

*TRY 2x12 DF-6 #2

\[ f_{xh} = 178.0 \text{ kN} \]
\[ s_{xh} = 31.64 \text{ kN}^2 \]
\[ A = 16.88 \text{ m}^2 \]

\[ F_x = (900 \text{ psi})(1.15)(1.0)(1.15) = 1190 \text{ ps} \]
\[ M = (1190 \text{ psi})(31.64 \text{ in}^3)/12 \text{ in} = 3138 \text{ ft lb} \]
\[ F_y = (180 \text{ psi})(1.15) = 207.1 \text{ lbs} \]
\[ V = (207.1 \text{ lbs})(16.88 \text{ in}^2)/1.5 = 2329 \text{ lbs} \]

\[ \Delta_{	ext{between}} = \frac{GJ}{24EI} \]

\[ = \frac{(165 \text{ psi})(12 \text{ in})}{24(16 \times 10^6 \text{ psi})(178 \text{ in}^4)(144 \text{ in})} \left[ (144 \text{ in})^4 - 2(144 \text{ in})^2(36 \text{ in})^2 + 2(36 \text{ in})^4 \right] \]

\[ = 0.21 \text{ in} \]

\[ \leq 0.8 \text{ in} \]

"USE 2x12 DF-6 #2 AFTER
@ 24" O.C. FOR 4/12 ROOF"
Typical Garage Roof Rafter (Cold Roof)

D: 20 psf (241/2 in) / (11.62 ft) = 39 plf

Lx = 20 psf (241/2 in) = 40 plf

Sy = 54 psf (241/2 in) = 108 plf

Load Combinations

③ D + S = 39 plf + 108 plf = 147 plf

Demands:

\[ M = (147 \text{ plf})(10 \text{ ft})^2 / 8 \]

\[ V = (147 \text{ plf})(10 \text{ ft}) / 2 \]

\[ EI = \frac{5(147 \text{ plf})(12 \text{ in})^4(10 \text{ ft})(12 \text{ in})^3}{384} \]

\[ I_{\text{eq}} = \frac{66.15 \times 10^{-6} \text{ in}^4}{1.6 \times 10^6 \text{ psi}} \]

Capacity:

* Try 2 x 10 DF-L #2

\[ M = \text{ SEE PREVIOUS} \]

\[ V = \text{ SEE PREVIOUS} \]

Use 2 x 10 DF-L #2 rafters
© 24" O.C. for garage
RIDGE BEAM @ GABLE END

**LOADING:**

- **\( A_f = (20 \text{ ft})(10 \text{ ft}) = 200 \text{ ft}^2 \)**
  - % NO LIVE LOAD REDUCTION
  - \( = 200 \text{ psf} \)

- **D**: 20 psf (10 ft)
  - \( = 200 \text{ psf} \)

- **\( L_A = 20 \text{ psf} (10 \text{ ft}) \)**
  - \( = 200 \text{ psf} \)

- **\( S = 54 \text{ psf} (10 \text{ ft}) \)**
  - \( = 540 \text{ psf} \)

**LOAD COMBINATIONS:**

(3) \( D + S = 200 \text{ psf} + 540 \text{ psf} = 740 \text{ psf} \)

**DEMANDS:**

- \( M = (740 \text{ psf})(20 \text{ ft})^2 / 8 \)
  - \( = 37 \text{ ft kips} \)

- \( V = (740 \text{ psf})(20 \text{ ft}) / 2 \)
  - \( = 7400 \text{ kips} \)

- \( \Delta = 5(740 \text{ psf}/\text{lin}) [(20 \text{ ft})(3 \text{ in})]^2 (240) \)
  - \( = 2664 \text{ in} \times 10^6 \text{ in} \cdot \text{ft} \)

- \( I_{req} = \frac{(2664 \times 10^6 \text{ in}^2)}{1.8 \times 10^8 \text{ psi}} \)
  - \( = 1480 \text{ in}^4 \)

- **TAB 6 3/4" + 13 ½" GLULAM
  - Assume 24F-Y4 DF/DF**

  - \( I_{xx} = 1.84 \times 10^3 \text{ in}^2 \)
  - \( E = E_{min} = 1.8 \times 10^6 \text{ psi} \)
  - \( S_x = 205 \text{ M3} \)
  - \( A = 91.13 \text{ in}^3 \)
CAPACITY:

\[ C_v = \left(\frac{12}{2}\right)^{1/2} \left(\frac{12}{12}\right)^{1/2} \left(\frac{5.125}{5.125}\right) \]

\[ = \left(\frac{12}{20\text{ft}}\right)^{1/2} \left(\frac{12}{13.8\text{in}}\right)^{1/2} \left(\frac{5.125}{5.125}\right) \]

\[ = 0.97 \leq 1.0 \checkmark \]

\[ F_v = (2670 \text{ psi}) (1.15) (0.97) \]

\[ = 2677.2 \text{ psi} \]

\[ M = (26772 \text{ psi}) (205 \text{ in}^2) \]

\[ = 457.7 \text{ kips ft} \geq 37 \text{ ft kips} \checkmark \]

\[ F_v' = (265 \text{ psi}) (1.15) \]

\[ = 305 \text{ psi} \]

\[ V = (305 \text{ psi}) (96.13 \text{ in}^3) / 1.5 \]

\[ = 18.5 \text{ kips} \geq 18.90 \text{ kips} \checkmark \]

\[ E'\ell = (1.80 \times 10^6 \text{ psi}) (138 \text{ in} \times 4) \]

\[ = 2491 \times 10^6 \text{ in}^2 \]

\[ \times \text{ CHECK DEMANDS WITH SELF WEIGHT} \]

\[ SW = (35 \text{ kft}) (91.3 \text{ in}^2) / 144 \text{ in}^2 \]

\[ = 22.15 \text{ kips} \]

\[ M = (22.15 \text{ kips}) (20 \text{ ft})^2 / 8 \]

\[ = 1.11 \text{ kips ft} \]

\[ V = (22.15 \text{ kips}) (20 \text{ ft}) / 2 \]

\[ = 0.22 \text{ kips} \]

\[ E2 = 5 (22.15 \text{ kips}) / 12 \times \frac{[20 \text{ ft} (12 \text{ in})]^{3/2}}{384} \]

\[ = 79.79 \text{ in}^2 \]

\[ \text{DEMANDS + SELF WEIGHT} \]

\[ M_T = 37 \text{ kip ft} + 1.11 \text{ kip ft} \]

\[ = 38.1 \text{ kip ft} \checkmark \]

\[ V_T = 7.40 \text{ kips} + 0.22 \text{ kips} \]

\[ = 7.62 \text{ kips} \leq 18.5 \text{ kips} \checkmark \]

\[ EI_T = 2491 \times 10^6 + 79.74 + 10^6 \]

\[ = 2570 \times 10^6 \text{ in}^2 \leq 2664 \times 10^6 \text{ in}^2 \checkmark \]

"USE 6 3/4" x 13 3/4" COLUMN 2Y - V4 DF/DF RIDGE BEAM"
**TYPICAL CEILING JOIST**

\[ D: 14 \text{ psf} \left( \frac{1.10}{16} \right) = 19 \text{ psf} \]

\[ L: 20 \text{ psf} \left( \frac{1.0}{16} \right) = 27 \text{ psf} \]

**LOAD COMBINATIONS:**

\[ D + L = 19 \text{ psf} + 27 \text{ psf} = 46 \text{ psf} \]

**DEMANDS:**

\[ M (\text{BETWEEN SUPPORTS}) = \frac{wL}{2} \left( \frac{L^2 - a^2xL}{2} \right) \]

\[ = \frac{19 \text{ psf} \times 16 \text{ ft} \times (16 \text{ ft}^2 - 2 \times 0 \times 16 \text{ ft})}{2} \]

\[ = 300 \text{ lb ft} \]

\[ M (\text{CATICLEVER}) = \frac{wL}{2} \left( a - x \right)^2 \]

\[ = \frac{46 \text{ psf} \times 16 \text{ ft} \times (16 \text{ ft} - 1.5 \text{ ft})^2}{2} \]

\[ = 51 \text{ lb ft} \]

\[ V (\text{AT SUPPORTS}) = 8L \times a_0 = 8 \times 46 \text{ psf} \times 15 \text{ ft} \times (15 \text{ ft} - 12 \text{ ft}) = 925 \text{ lb} \]

\[ \varepsilon_f = 0.07 \times 46 \text{ psf} \times 15 \text{ ft} + 925 \text{ lb} = 255 \text{ in} \]

\[ A (\text{BETWEEN SUPPORTS}) = \frac{wL}{24EI} \left( \frac{L^4 - a^2x^3 + 2a^2xL^2 + 2a^4}{2} \right) \]

\[ = \left( \frac{19 \text{ psf} \times 16 \text{ ft} \times (144 \text{ in}^4 + 2(144 \text{ in}^4)(72 \text{ in})^2}{24 \times 144 \text{ in}^4} \right) \]

\[ + \left( 144 \text{ in}^4 \right. \left. (72 \text{ in})^2 \right) \left. - 2(36 \text{ in}^4)(144 \text{ in}^2) \right) \]

\[ + 2(36 \text{ in}^4)(72 \text{ in})^2 \]

\[ = 7.5 \times 10^6 \frac{\text{ ft}}{240} \]

\[ \Rightarrow EI = \frac{(7.5 \times 10^6)(240)}{(144 \text{ in}^4)} = 12.56 \times 10^6 \text{ in}^2 \]

\[ I_{AEQ} = \frac{12.56 \times 10^6 \text{ in}^2}{1.60 \times 10^6 \text{ psi}^2} = 7.85 \text{ in}^4 \]

**734 2 x 6 DF-L H2**

\[ I_{AA} = 70.80 \text{ in}^4 \]

\[ S_{xx} = 7.58 \text{ in}^2 \]

\[ A = 8.25 \text{ in}^2 \]
CAPACITY:

\[ F_b' = (900 \text{ psi}) (125)(1.3)(1.15) = 1681.88 \text{ psi} \]

\[ M_{max} = (1681.88 \text{ psi}) (7.56 \text{ ft}) = 10600 \text{ ft} \text{ lb} \]

\[ V_{allow} = (225 \text{ psi})(8.25 \text{ in}^2)/1.5 = 1238 \text{ in} \text{ lb} \]

\[ \geq 425 \text{ in} \text{ lb} \]

% USE 2x6 DF-C 1/2 @ 18 in OC. FOR CANTILEVERED CEILING JOISTS.
**TYPICAL FLOOR JOIST**

\[
\begin{align*}
D: 14 \text{ psf} \left( \frac{16 \text{ in}}{12 \text{ ft}} \right) &= 19 \text{ plf} \\
L: 20 \text{ psf} \left( \frac{16 \text{ in}}{12 \text{ ft}} \right) &= 27 \text{ plf} \\
\end{align*}
\]

**LOAD COMBINATIONS**

\[
\begin{align*}
\sigma D + L &= 19 \text{ plf} + 27 \text{ plf} = 46 \text{ plf} \\
\end{align*}
\]

**DEMANDS**

\[
\begin{align*}
M &= \frac{(46 \text{ plf})(12 \text{ ft})^2}{8} = 828 \text{ kips} \\
V &= \frac{(46 \text{ plf})(12 \text{ ft})}{2} = 276 \text{ kips} \\
E2 &= \frac{5(46 \text{ plf})(12 \text{ in})(12 \text{ in})(9.2 \text{ in})^2}{3 \times 89} = 1.87 \times 10^6 \text{ in}^2 \\
I_{\text{req}} &= \frac{1.87 \times 10^6 / 16 \text{ in}^2}{1.60 \times 10^6 \text{ psi}} = 1.17 \text{ in}^4 \\
\end{align*}
\]

* TAY 2x6 DF-L #2

\[
\begin{align*}
I_{2x6} &= 20.80 \text{ in}^4 \\
S_{2x6} &= 7.58 \text{ in}^3 \\
A &= 8.25 \text{ in}^2 \\
\end{align*}
\]

\[
\begin{align*}
F_{4} &= \text{ SEE PREVIOUS} \\
M_{\text{max}} &= \text{ SEE PREVIOUS} \\
V_{\text{max}} &= \text{ SEE PREVIOUS} \\
\end{align*}
\]

\[
\begin{align*}
\therefore \text{ USE 2x6 DF-L #2} \\
@ 16'' o.c. \text{ FLOOR JOISTS} \\
\end{align*}
\]
**FLOOR BEAM**

\[ A_t = (15 \text{ft})(12 \text{ft}) = 180 \text{ ft}^2 \]
\[ D = (14 \text{psf})(12 \text{ft}) = 168 \text{ plf} \]
\[ L = (20 \text{psf})(12 \text{ft}) = 240 \text{ plf} \]

**Load Combinations**

\[ D + L = 168 \text{ plf} + 240 \text{ plf} = 408 \text{ plf} \]

**Demands:**

\[ M = (408 \text{ plf})(12 \text{ft})^2/8 = 7.3 \text{ kip} \cdot \text{ft} \]
\[ V = (408 \text{ plf})(12 \text{ft})/2 = 2.5 \text{ kips} \]
\[ EI = 5\left(408 \text{ plf} / \text{lin. ft}\right)\left(12 \text{ ft}\right)^2/(240) = 620 + 106.16 \text{ in}^2 \]
\[ I_{\text{eq}} = \frac{620 + 106.16 \text{ in}^2}{16 \times 10^6 \text{ psi}} = 387 \text{ in}^2 \]

**Capacity:**

- **TA 1** 4x12 DF-L No.
  - \[ F_{\text{net}} = 415.3 \text{ in}^2 \]
  - \[ S_t = 73.15 \text{ in}^2 \]
  - \[ A = 39.38 \text{ in}^2 \]
  - \[ F_b = (900 \text{ psi})(1.125)(1.1)(1.15) = 1423 \text{ psi} \]
  - \[ M = (1423 \text{ psi})(73.15 \text{ in}^2) = 8.68 \text{ kip} \cdot \text{ft} \geq 7.3 \text{ kip} \cdot \text{ft} \]
  - \[ F_v = (180)(1.25) = 225 \text{ psi} \]
  - \[ V = (225 \text{ psi})(39.38 \text{ in}^2)/1.5 = 5.92 \text{ kips} \geq 2.5 \text{ kips} \]

- Use 4x12 DF-L No. **2** 

- **Floor Beams**
CONTINUOUS WALL FOOTING

\[ D_R = 23.1 \text{ psf} (6 \text{ ft}) = 139 \text{ plf} \]
\[ L = 20 \text{ psf} (6 \text{ ft}) = 120 \text{ plf} \]
\[ D_F = 23.1 \text{ psf} (6 \text{ ft}) = 139 \text{ plf} \]
\[ L_F = 20 \text{ psf} (6 \text{ ft}) = 120 \text{ plf} \]

DEMANDS:
\[ W = 139 \text{ plf} + 120 \text{ plf} = 259 \text{ plf} \]

ASSUMPTIONS: SEDIMENTARY + FOLIATED ROCK
VERTICAL FOUNDATION PRESSURE
\[ = 1500 \text{ psf} \]
LATERAL BEARING PRESSURE
\[ = 100 \text{ psf} \text{ ft below grade} \]
COEFFICIENT OF FACTION
\[ = 0.25 \]
EFFECTIVE UNIT WEIGHT, \( \gamma \)
\[ = 156 \text{ pcf (worst case)} \]
SIZE SELECTION:
\[ b = \frac{(139 \text{ pcf} + 120 \text{ pcf})^2}{1500 \text{ psf}} = 0.35 \text{ ft} \]

USE 1 FT WIDE, 2 FT DEEP FOOTING

REBAR
\[ A_{5_{\text{min}}} = 0.0018 (12 \text{ in}) (24 \text{ in}) = 0.518 \text{ in}^2 \]

USE (2) #5 BARS
\[ A_S = 0.62 \text{ in}^2 \]
**PAD FOOTING**

\[ A_T = (12 \text{ ft})(12 \text{ ft}) = 144 \text{ ft}^2 \]
\[ P = (35 \text{ psf} + 32 \text{ psf}) \times 144 = 9,654 \text{ psf} \]

**SIZE SELECTION**

\[ A = \frac{P}{f_b} = \frac{9,654 \text{ kips}}{1,500 \text{ ksf}} = 6.43 \text{ ft}^2 \]

**USE** 2.5 ft x 2.5 ft x 2 ft

**REBAR**

\[ A_{5min} = 0.0018 (720 \text{ in}^2) = 1.30 \text{ in}^2 \]

**USE (2) #8 BARS E/W, \( A_s = 1.61 \text{ in}^2 \)**

**CHECK** 18C2015 (180 ksf + 7,150 ksf)

Minimum Requirements:

- \( D = 12" \text{ min} \leq 2 \text{ ft} \) \( \checkmark \)
- \( B = 12" \text{ min} \leq 2' - 6" \) \( \checkmark \)
- \( T = 6" \text{ min} \leq 12" \) \( \checkmark \)
LOAD COMBINATIONS

\[ D + 0.75L + 0.25S \]
\[ = (25 \text{ psf}) \left( (23.1 \text{ psf}) + (0.75)(20 \text{ psf}) + 0.25(54 \text{ psf}) \right) = 786 \text{ lb} \]
\[ 0.75(0.6)W = 0.75(0.6)(25 \text{ psf})(2 \text{ ft}) = 22.5 \text{ plf} \]

DEMANDS:

\[ M = \frac{(22.5 \text{ plf})(16.5 \text{ ft})^2}{8} = 783.16 \text{ ft} \]
\[ V = \frac{(22.5 \text{ plf})(16.5 \text{ ft})^2}{2} = 186 \text{ lb} \]
\[ P = \text{ SEE LOAD COMBO ABOVE} = 786 \text{ lb} \]

CAPACITY:

* TAF: 2x10 DF-L H2 @ 24” o.c.

\[ F_c = \frac{P}{A} = \frac{786 \text{ lb}}{13.875 \text{ in}^2} = 56.65 \text{ psi} \]

\[ F_{ce} = \frac{0.822 \times 1.220}{(2)^2} = \frac{0.822(0.58 \times 10^6 \text{ psi})}{(1.220 \times 1.220)^2} = 1041 \text{ psi} \]
\[ F_0' = 1350 \text{ psi} \cdot (1.6) (1.1) = 2376 \text{ psi} \]

\[ \frac{F_{c1}}{F_0} = \frac{1041 \text{ psi}}{2376 \text{ psi}} = 0.438 \]

\[ C_p = \frac{1 + (0.438)}{1.6} - \sqrt{\left(1 + (0.438) \right)^2 - \frac{(0.438)^2}{0.8}} = 0.389 \]

\[ F_c' = (2376 \text{ psi})(0.389) = 923 \text{ psi} \]

\[ \frac{F_c}{F_{c1}} = \frac{56.65 \text{ psi}}{923 \text{ psi}} = 0.061 \leq 1.0 \checkmark \]

\[ F_b = \frac{783 \frac{1}{2} \text{ ft}(16 \text{ in})}{21.56 \text{ in}^3} = 436 \text{ psi} \]

\[ F_b' = (920 \text{ psi})(1.6)(1.3)(1.0)(1.15) = 2152.8 \text{ psi} \]

\[ \frac{F_b}{F_{b1}} = \frac{436 \text{ psi}}{2152.8 \text{ psi}} = 0.20 \neq 1.0 \checkmark \]

**Combined Loading:**

\[ \left( \frac{F_c}{F_{c1}} \right)^2 + \frac{F_b}{F_{b1}}(1 - \frac{F_c}{F_{c1}}) = (0.061)^2 + \frac{(436 \text{ psi})}{2152.8 \text{ psi}}(1 - \frac{56.65}{1041}) = 0.22 \leq 1.0 \checkmark \]

2x10 DF-L #2 @ 16” O.C.
MAE ADEQUATE
**Lateral Design**

**Typical Shear Wall Design**

---

**Shear Wall Calculations**

**Note:** N-S walls are worst case

\[ \omega = 23.1 \text{psf (11 ft)} = 254.1 \text{plf} \]

\[ W = 25 \text{psf (11 ft)(11 ft)} = 5.6 \text{kips} \]

\[ D = 20 \text{psf (41")} = 410 \text{plf} \]

\[ S = 60 \text{psf (41")} = 1230 \text{plf} \]

\[ L = 20 \text{psf (41")} = 410 \text{plf} \]

---

**Load Combinations**

\[ (0.6) W + 0.75 L + 0.75 (0.6 W) + 0.75 S \]

\[ \therefore W = 254.1 \text{plf} + 410 \text{plf} + 0.75(410 \text{plf}) + 0.75(1230 \text{plf}) \]

\[ \therefore W = 254.1 \text{plf} + 410 \text{plf} + 307.5 \text{plf} + 922.5 \text{plf} \]

\[ \therefore W = 1994.6 \text{plf} \]

\[ = 2.52 \text{kips lateral} \]

---

**→ FOA Hold Downs**

\[ + \sigma_E = 0 = (2.52 \text{kips})(11 \text{ft}) \]

\[ + (1.0) 400 \text{plf}(8 \text{ft})(8 \text{ft})/2 \]

\[ + C (8 \text{ft}) \]

\[ C = 88.52 \text{kips } / 8 \text{ft} \]

\[ = 11.1 \text{kips (comp)} \]

\[ + \sigma_F = 0 = (1.90 \text{kips})(8 \text{ft}) - T + 11.1 \text{kips} \]

\[ = 4.1 \text{kips (tension)} \]

---

\[ \text{Use Simpson HHDG11-SDS2.5} \]

\[ T = 11.8 \text{kips} \]

---

**→ FOA Shear Panel**

\[ 2V = 2W/lef = 2(254.1 \text{plf})/71 \text{ft} \]

\[ = 710 \text{plf} \]

---

\[ \text{Use 15/2 Structural I} \]

\[ W/10d @ 6'0" \text{c. (c=950 plf)} \]
**N-S Roof Diaphragm**

**DEMANDS:**

\[V_{kip} = 5.64\]
\[V_{plf} = 2.40\]
\[M_{kip} = 5.781\]
\[C_{kip} = 2.46\]

--- FOR DIAPHRAGM SMOOTHING

**CASE 1 + CASE 2**

\[V = 705 \text{ plf}\]

**USE 10d @ 6/6/12**

\[W \frac{1}{2}'' SHEATHING \]
\[C = 910 \text{ plf}\]
Connection Design

Shear flow for typical shear wall (N-S)

- Demand = 355 plf
- Capacity = 695 plf
- Spacing = 695/355 = 1.95
  Use 2 ft spacing

Simpson 1934 Clip

Simpson HHDA11-5DS2.5
ANCHOR BOLT DESIGN FOR TYPICAL WALL

\[ \tau = \frac{W}{A_{\text{eff}}} = \frac{2,524 \text{lb}}{7.1 \text{in}^2} = 355 \text{psi} \]

* Tak \( \frac{1}{2} \) in. ANCHOR BOLTS

\[ E_1 = 650 \text{ksi} (1.6) \]

\[ k_{\text{nut}} = \frac{G}{F} = \frac{1040 \text{ksi}}{355 \text{psi}} \]

\[ = 2.93 \text{ ft} \leq 4 \text{ ft} \]

Use \( \frac{1}{2} \) in. ANCHOR BOLTS @ 3 ft O.C.
201. CONCRETE SHALL BE MIXED, PROPORTIONED, CONVEYED, AND PLACED IN ACCORDANCE WITH ACI 307, 308, 310, AND 305. CONCRETE SHALL BE SEASONED AND CURTURED IN ACCORDANCE WITH ACI 301. CONCRETE MASONRY UNITS TO BE FULLY GROUTED.

21. SCALE INDICATING ANCHORAGE.

22. CONCRETE MASONRY UNITS TO BE FULLY GROUTED.

23. SCALE INDICATING ANCHORAGE.

24. CONCRETE MASONRY UNITS TO BE FULLY GROUTED.

25. SCALE INDICATING ANCHORAGE.

26. CONCRETE MASONRY UNITS TO BE FULLY GROUTED.

27. SCALE INDICATING ANCHORAGE.

28. CONCRETE MASONRY UNITS TO BE FULLY GROUTED.

29. SCALE INDICATING ANCHORAGE.

30. CONCRETE MASONRY UNITS TO BE FULLY GROUTED.

31. SCALE INDICATING ANCHORAGE.

32. CONCRETE MASONRY UNITS TO BE FULLY GROUTED.

33. SCALE INDICATING ANCHORAGE.
**WOOD FASTENERS**

A. **NAIL SIZES SPECIFIED ON DRAWINGS ARE BASED ON THE FOLLOWING SPECIFICATIONS:**

<table>
<thead>
<tr>
<th>NAIL SIZE</th>
<th>DOCUMENT STAPLE</th>
<th>MINIMUM LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>6d</td>
<td>10d</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>8d</td>
<td>12d</td>
<td>1&quot;</td>
</tr>
<tr>
<td>10d</td>
<td>15d</td>
<td>1 1/2&quot;</td>
</tr>
</tbody>
</table>

B. **IF CONTRACTOR PROPOSES THE USE OF ALTERNATE NAILS, THEY SHALL SUBMIT NAIL SPECIFICATIONS TO THE STRUCTURAL ENGINEER PRIOR TO CONSTRUCTION FOR REVIEW AND APPROVAL.**

C. **HAILS AND STAPLES - PLYWOOD (APA RATED SHEATHING) FASTENERS TO FRAME SHALL BE DRIVEN FROM TOP OF SHEATHING WITH NO COUNTERSINKING PERMITTED.**

D. **THE FOLLOWING APPLIES UNLESS OTHERWISE SHOWN ON THE PLANS:**

- **ALL WOOD FRAMING DETAILS NOT SHOWN OTHERWISE SHALL BE CONSTRUCTED TO THE MINIMUM STANDARDS OF THE UNIFORM BUILDING CODE. UNLESS OTHERWISE NOTED, SHEATHING MUST CONFORM TO TABLE 2009 J1.1 OF THE INTERNATIONAL BUILDING CODE. UNLESS NOTED OTHERWISE, ALL NAILS SHALL AS SPECIFIED ABOVE. COORDINATE THE SIZE AND LOCATION OF ALL OPENINGS WITH MECHANICAL AND ARCHITECTURAL DRAWINGS. PROVIDE WASHERS UNDER THE HEADS AND NUTS OF ALL BOLTS AND LAG SCREWS BEARING ON WOOD.**

- **IF CONTRACTOR PROPOSES THE USE OF ALTERNATE STAPLES, THEY SHALL SUBMIT STAPLE SPECIFICATIONS TO THE STRUCTURAL ENGINEER PRIOR TO CONSTRUCTION FOR REVIEW AND APPROVAL.**

**GENERAL NOTES**

- **WOOD FRAMING NOTES**
  - **ALL STUD WALLS SHOULD HAVE A SINGLE BOTTOM PLATE AND A DOUBLE TOP PLATE. END NAIL TOP PLATE TO EACH SUPPORT. PROVIDE APPROVED PLYWOOD EDGE CLIPS CENTERED BETWEEN JOISTS/TRUSSES AT EQUIVALENT STAPLE 0.148" FLUSH TO FACE OF SHEATHING WITH NO COUNTERSINKING PERMITTED. O.C. UNLESS OTHER METAL CONNECTIONS ARE PROVIDED.**

- **WALL FRAMING**
  - **ALL STUD WALLS SHOWN AND NOT OTHERWISE NOTED SHALL BE 16" O.C. TWO STUD MINIMUM SHALL BE PROVIDED AT THE END OF ALL WALLS AND AT EACH SIDE OF ALL OPENINGS IN WALLS. PROVIDE THREE 3X3X3/4" DECKING SHALL BE TOENAILED THROUGH THE TONGUE AND FACENAILED WITH ONE 16d NAIL PER PIECE PER SUPPORT.**

- **FLOOR AND ROOF FRAMING**
  - **Provided double joists under all parallel partitions that extend over more than half the joist length and exceed all opening in floors or roofs unless otherwise specified. Provide solid blocking at all bearing points.**

- **TONGUE AND GROOVE JOINTS**
  - **Tongue and groove joints shall be supported with Simpson metal joist hangers in accordance with notes above. Nails all multi joist beams together with 16d (2") staples. Stragglers attach hangers to bearing lines with the same material.**

- **UNLESS OTHERWISE NOTED (UNLESS METAL CONNECTIONS ARE PROVIDED)**

- **UNLESS OTHERWISE NOTED (UNLESS MECHANICAL AND ARCHITECTURAL DRAWINGS PROVIDE WASHERS UNDER THE HEADS AND NUTS OF ALL BOLTS AND LAG SCREWS BEARING ON WOOD).**

- **MUTUAL MISCELLANEOUS**

- **GENERAL NOTES**

- **WEED HOUSING DEVELOPMENT**

- **FRANZISKA BECK**
  - **ARCHITECTURAL DESIGNER**

- **TRENT PICHOL**
  - **STRUCTURAL DESIGNER**

- **BRAIN LEE**
  - **ARCHITECTURAL DESIGNER**

- **MEGAN LUNDHAL**
  - **CONSTRUCTABILITY**

- **WEED HOUSING DEVELOPMENT**

- **GREAT NORTHERN SERVICES**

- **ARCHITECTURAL DESIGNER**

- **ARCHITECTURAL DESIGNER**
1. It is the contractors responsibility to verify all dimensions with the architectural floor plan and notify the architect and engineer of any discrepancies prior to starting work.

2. The general conditions, specifications, general notes on sheet 1.0, general structural details and the following apply to the work of the foundation.

3. Sub-grade preparations will conform to the requirements of the soils report and will be performed under the supervision of the soils engineer.

4. Footings are to be examined and certified in writing by the project soils engineer prior to placement of concrete.

5. All slab reinforcement should be supported on chairs to provide placement at mid depth of slab.

6. Foundation system will be based upon the requirements of the soils report. The engineer of record must be notified of any discrepancies or updates of the soil information.

7. An approved water and vapor proof barrier must be installed under the concrete foundation system so that water and vapor cannot enter into the structure. Refer to the architects or owners document and geotechnical engineers recommendation for detailed requirements.

LEGEND

- SHEAR WALL
- HIDDEN LINE
- GRID LINE
- P.T.D.F. PRESSURE TREATED DOUGLAS FIR
- TYP. TYPICAL MEMBER
- E.W. EACH WAY
- S.O.G. SLAB ON GRADE
- O.C. ON CENTER
1. The general conditions, specifications, general notes on sheet S1.0, general structural details and the following apply to the work of the floor framing notes.

2. The contractor will check floor framing dimensions against the architectural plan and notify the architect and engineer of record of any omissions and discrepancies before starting work.

3. All walls at the floor framing level are to be 2x6 studs @ 16" O.C. and 2x10 studs @ 24" O.C. for inside and outside walls, respectively.

4. See architectural plans for locations of plumbing walls.

5. Bearing headers spanning 6'-0" or more shall have at least (2) 2x trimmers continuous to the sill plate, unless noted otherwise.

6. All shear connectors and blocking must be installed prior to the installation of floor sheathing.

7. Use Simpson hangers for floor joist to flush beam connections, unless otherwise noted.

8. Carry all multiple studs or posts from second floor down to first floor or beam below. Provide 4x solid blocking @ floor level.

9. Shear panels may be install on either side of the wall.

**LEGEND**

- P.T.D.F.: Pressure Treated Douglas Fir
- TYP.: Typical Member
- E.W.: Each Way
- S.O.G.: Slab On Grade
- O.C.: On Center

---

**GREAT NORTHERN SERVICES**
310 Boles St, Weed, CA 96094

**WEED HOUSING DEVELOPMENT**

**FLOOR FRAMING PLAN**

Project Number: S2.1

As indicated
1. THE GENERAL CONDITIONS, SPECIFICATIONS, GENERAL NOTES ON SHEET S1.0, GENERAL STRUCTURAL DETAILS AND THE FOLLOWING APPLY TO THE WORK OF THE FLOOR FRAMING NOTES.

2. THE CONTRACTOR WILL CHECK FLOOR FRAMING DIMENSIONS AGAINST THE ARCHITECTURAL PLAN AND NOTIFY THE ARCHITECT AND ENGINEER OF RECORD OF ANY OMISSIONS AND DISCREPANCIES BEFORE STARTING WORK.

3. ALL WALLS AT THE FLOOR FRAMING LEVEL ARE TO BE 2X6 STUDS @ 16" O.C. AND 2X10 STUDS @ 24" O.C. FOR INSIDE AND OUTSIDE WALLS, RESPECTIVELY.

4. SEE ARCHITECTURAL PLANS FOR LOCATIONS OF PLUMBING WALLS.

5. BEARING HEADERS SPANNING 6'-0" OR MORE SHALL HAVE AT LEAST (2) 2X TRIMMER CONTINUOUS TO THE SILL PLATE, UNLESS NOTED OTHERWISE.

6. ALL SHEAR CONNECTORS AND BLOCKING MUST BE INSTALLED PRIOR TO THE INSTALLATION OF FLOOR SHEATHING.

7. USE SIMPSON HANGERS FOR FLOOR JOIST TO FLUSH BEAM CONNECTIONS, UNLESS OTHERWISE NOTED.

8. CARRY ALL MULTIPLE STUDS OR POSTS FROM SECOND FLOOR DOWN TO FIRST FLOOR OR BEAM BELOW. PROVIDE 4X SOLID BLOCKING @ FLOOR LEVEL.

9. SHEAR PANELS MAY BE INSTALL ON EITHER SIDE OF THE WALL.

---

**LEGEND**

- **P.T.D.F.** PRESSURE TREATED DOUGLAS FIR
- **TYP.** TYPICAL MEMBER
- **E.W.** EACH WAY
- **S.O.G.** SLAB ON GRADE
- **O.C.** ON CENTER
- **HIDDEN LINE**
- **GRID LINE**
- **DETAILED CALL OUT**

---

**GREAT NORTHERN SERVICES**
310 Boles St, Weed, CA 96094

**WEED HOUSING DEVELOPMENT**

---

**CEILING FRAMING PLAN**

**FRANZISKA BECK**
ARCHITECTURAL DESIGNER

**BRAIN LEE**
ARCHITECTURAL DESIGNER

**MEGAN LUNDAHL**
ARCHITECTURAL DESIGNER

**TRENT PICHELL**
STRUCTURAL DESIGNER

**SERGIO VERGARA**
CONSTRUCTABILITY

---

**Project Number:**

**Drawn By:**

**Checked By:**

**As indicated**
1. THE GENERAL CONDITIONS, SPECIFICATIONS, GENERAL NOTES ON SHEET S1.0, GENERAL STRUCTURAL DETAILS AND THE FOLLOWING APPLY TO THE WORK OF THE ROOF FRAMING NOTES.

2. THE CONTRACTOR WILL CHECK ROOF FRAMING DIMENSIONS AGAINST THE ARCHITECTURAL PLAN AND NOTIFY THE ARCHITECT AND ENGINEER OF RECORD OF ANY OMISSIONS AND DISCREPANCIES BEFORE STARTING WORK.

3. ALL WALLS ASE TO BE 2X6 STUDS @ 16" O.C. AND 2X10 STUDS @ 24" O.C. FOR INSIDE AND OUTSIDE WALLS, RESPECTIVELY.

4. HEADERS SUPPORTING ROOF LOADS SHALL HAVE AT LEAST ONE 2X TRIMMER CONTINUOUS TO THE SILL PLATE, UNLESS OTHERWISE NOTED.

5. HEADERS SPANNING 6'-0" OR MORE SHALL HAVE AT LEAST (2) 2X TRIMMERS CONTINUOUS TO THE SILL PLATE AND (2) 2X KING STUDS, UNLESS OTHERWISE NOTED.

6. ALL SHEAR CONNECTORS AND BLOCKING MUST BE INSTALLED PRIOR TO THE INSTALLATION OF ROOF SHEATHING.

7. INTERIOR NON-BEARING WALL TOP PLATE MAY BE 1X4 OVER 2X4 MEMBERS.

8. SEE DETAIL ON SHEET S4.1 FOR CALIFORNIA FRAMING REQUIREMENTS.

9. SHEAR PANELS MAY BE INSTALLED ON EITHER SIDE OF THE WALL.

LEGEND

- DETAIL CALL OUT
- SHEAR WALL
- HIDDEN LINE
- GRID LINE
- P.T.D.F. PRESSURE TREATED DOUGLAS FIR
- TYP. TYPICAL MEMBER
- E.W. EACH WAY
- S.O.G. SLAB ON GRADE
- O.C. ON CENTER

Project Number: S2.3

WEED HOUSING DEVELOPMENT
310 Boles St, Weed, CA 96094

As indicated

FRANZISKA BECK
- ARCHITECTURAL DESIGNER
- PASSIVE HOME DESIGNER

BRAIN LEE
- ARCHITECTURAL DESIGNER

MEGAN LUNDHAL
- ARCHITECTURAL DESIGNER

TRENT PICHEL
- STRUCTURAL DESIGNER
- ADMINISTRATION

SERGIO VERGARA
- CONSTRUCTABILITY
- COST ESTIMATOR
FOOTING

PROVIDE CORNER BARS SAME SIZE AND AMOUNT AS FOOTING REINFORCEMENT

ALTERNATE BENDS WHERE POSSIBLE

LAP ANCHOR (7 - 4" MIN.)

FOOTING REINFORCING AT INTERSECTION

INTENTIONALLY LEFT BLANK

2X STUDT WALL INTERSECTIONS

STUD WALL INTERSECTIONS

MINIMUM PLATE SPLICE

PROVIDE STUD BELOW SPLICES

CALIFORNIA ROOF FRAMING

SHEATHING PER PLAN

Rafter @ Main Roof Framing Per Plan

2X STUD @ 24" O.C. TYP

CONTINUE SHEAR PANEL TO HOLD DOWNS AS SHOWN

PROVIDE REQUIRED DOUBLE STUDS OR POSTS WHERE HOLD-DOWNS OCCUR

CALIFORNIA ROOF SECTION

Rafter @ CA. Roof Per Plan

2X ROOF Rafter @ Main Roof Framing Per Plan

CALIFORNIA ROOF FRAMING

SHEATHING @ CA. ROOF PER PLAN

2X STUD @ 32" O.C.

CONTINUE SHEAR PANEL TO HOLD DOWNS AS SHOWN

PROVIDE REQUIRED DOUBLE STUDS OR POSTS WHERE HOLD-DOWNS OCCUR

SHEATHING @ MAIN ROOF PER PLAN

2X STUD @ 24" O.C.

CONTINUE SHEAR PANEL TO HOLD DOWNS AS SHOWN

PROVIDE REQUIRED DOUBLE STUDS OR POSTS WHERE HOLD-DOWNS OCCUR