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

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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 county 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.
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.

Regular home*
2015 average monthly consumption US= 901 kWh/household/month
Average price= $0.1699/kWh
901kWh/household/month*$0.1699/kWh=$153,08/month

Passive house
monthly consumption Passive house= 6200kWh/household/year (516kWh/household/month)
average price= $0.1699/kWh
516kWh/household/month*$0.1699/kWh = $87.67/month

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

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.

sunlight

Wide shape to be exposed to the sun for passive solar heating. Rotated towards true south for maximum exposure. Windows to heat the more spacious living room taking into consideration solar angle. High R-values mean more heat retention and reduced energy consumption due to heating.

water management

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

site strategy

Slightly grading the exiting topography creates circulation and addresses 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.

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

Heating Systems
HAPPY HOMES
BECK, LEE, LUNDHAL, PICHEL, VERGARA

PARCEL 1: ELEVATION WEST 1/4" - 1'

PARCEL 1: ELEVATION EAST 1/4" - 1'

PARCEL 1: SECTION1 1/4" - 1'

PARCEL 1: SECTION2 1/4" - 1'
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-Sheetsing 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

HAPPY HOMES
BECK, LEE, LUNDAHL, PICHEN, VERGARA
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
- Construction on site
- Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
- Can be assembled and located elsewhere (modular)
- Installation of panelized wall assembly with crane
- airtightness: n/a

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
- Uses similar methods of structural and mechanical systems: brand, sizing, and construction methods
- Can be assembled and located elsewhere (modular)
- Installation of panelized wall assembly with crane
- airtightness: 0.45 ARCH/50

Penalization
dividing the exterior wall into three layers ensures that the gaps differ and attains a seamless airtight envelope

1. Stud-Wall, Insulation OSB
2. second Insulation layer DWD board
3. furring and counter furring fiber cement cladding

1 put panels together
2 nail together
3 apply fluid on OSB seams required to ensure airtight envelope
4 apply second layer panel
5 assemble facade

HAPPY HOMES
BECK, LEE, LUNDHAL, PICHEL, VERGARA

Schedule

Rigging Cost Estimate

Cost of renting a Gradall
Cost to rent for a day $833
Cost to rent for a week $2,500
Cost to rent for a month $7,500

Product Specifications
Year: 2003
Manufacturer: Gradall
Model: XL4300 II
Operating Weight (lbs): 43,580

Summary
Prefabricated wall assembly units 44
Number of days for transportation from SLO to Weed 4 days
Days of buffer 9 days
Estimate of time needed 2 weeks
Cost per week $2,500

Total Cost of rigging prefabricated panels: $5,000

*Estimate obtained from Rentalyard.com
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User-Specified Input

Building Code Reference Document  ASCE 7-10 Standard
(which utilizes USGS hazard data available in 2008)

Site Coordinates  41.42891°N, 122.37939°W

Site Soil Classification  Site Class D – "Stiff Soil"

Risk Category  I/II/III

USGS-Provided Output

\[
\begin{align*}
S_s &= 0.736 \text{ g} & S_{MS} &= 0.891 \text{ g} & S_{DS} &= 0.594 \text{ g} \\
S_t &= 0.328 \text{ g} & S_{M1} &= 0.572 \text{ g} & S_{D1} &= 0.381 \text{ g}
\end{align*}
\]

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_{M1}, T_{U}, C_{RS}, and C_{R1} values, please view the detailed report.
LOAD TAKE OFF

ROOF:

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

6" CLOSED-CELL SPRAY INSULATION
C.R.6 PER INCH THICKNESS
→ (2 psf) (0.5 ft)
1.0 psf

2x10 DF L RAFTERS @ 24" O.C.
→ 35 psf (1.11 ft) (9.28 ft) (1 ft) (12.5 ft)
6.7 psf

1/2" GYPSUM BOARD CEILING
→ (5.5 psf) (0.31 ft)
2.5 psf

MEP + SPRINKLERS
4.5 psf

MISCELLANEOUS
16.7 psf

TOTAL DEMO TO WINDS
20.0 psf

18" EXTERIOR WALL ASSEMBLY
→ (25 psf) (42 ft) (1/4 ft) (8 ft)
19 psf

(4 ft) (23.5 ft)

6" INTERIOR WALL ASSEMBLY
→ (15 psf) (12.8 ft) (1/4 ft) (8 ft)
12.0 psf

(41 ft) (23.5 ft)

SEISMIC LOAD TO ROOF
51 psf

PITCHED ROOF
20 psf

TOTAL LIVE TO ROOF
(REDUCIBLE)
20 psf
FLOOR:

VINYL TIE FLOORING

3/4" O.S.B. SHEATHING

2" x 8" DF-L #2 T19
@ 18" O.C.

→\((35\text{pcf})(1.5\text{in})(225\text{in})\left(\frac{1\text{ft}^2}{4\text{in}^2}\right)\) 2.6 psf

6" CLOSED-CELL SPAN INSULATION, 6 psf per inch thickness

→\((2\text{pcf})(0.5\text{ft})\) 1.0 psf

TOTAL DEAD TO BEAMS

2" x 8" DF-L H2 BEAMS

→\((35\text{pcf})(1.5\text{in})(7.5\text{in})\left(\frac{1\text{ft}^2}{6\text{in}^2}\right)\) 2.6 psf

MEP

→ 2.09 psf 12.6 psf

MISCELLANEOUS

TOTAL DEAD TO WALLS

18" EXTERIOR WALL ASSEMBLY

→\((23\text{pcf})(129\text{ft})\left(\frac{1\text{in}}{14\text{in}}\right)\left(\frac{1\text{ft}^2}{1\text{in}^2}\right)\) (4 ft) (23.5 ft) 22.1 psf

6" INTERIOR WALL ASSEMBLY

→\((15\text{pcf})(128\text{ft})\left(\frac{1\text{in}}{12\text{in}}\right)\left(\frac{1\text{ft}^2}{12\text{in}^2}\right)\) (4 ft) (23.5 ft) 15.0 psf

SEISMIC LOAD TO FLOOR

ONE FAMILY DWELLING
NON-HABITABLE ATTIC W/STORAGE

TOTAL LIVE TO FLOOR

52 psf 20 psf

20 psf
Seismic Loading Criteria

Seismic Weight:

\[
\text{Roof} = (51 \text{ PSF}) \left( \frac{17 \text{ ft}}{4 \text{ ft}} \right) \left( \frac{12 \text{ ft}}{9 \text{ ft}} \right) (23.5 \text{ ft}) = 121.21 \text{ kips}
\]

\[
\text{Floor} = (52 \text{ PSF}) \left( \frac{41 \text{ ft}}{22.5 \text{ ft}} \right) \\
\text{Totals} = 50.10 \text{ kips} \quad 171.31 \text{ kips}
\]

Seismic Response Coefficient:

\[
C_g = \sum \frac{D_i}{R_i} = \frac{0.594}{6.51} = 0.0938
\]

\[
T = C_g W_{\text{total}} = 0.0938 (171.31 \text{ kips}) = 0.145 \leq 16 = T_L \checkmark
\]

Base Shear:

\[
V = C_g W_{\text{total}} = 0.0938 (171.31 \text{ kips}) = 15.65 \text{ kips}
\]

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>
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<tbody>
<tr>
<td>A</td>
<td>8 \text{ ft}</td>
<td>18 \text{ ft}</td>
<td>2.25</td>
<td>21</td>
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<tr>
<td>B</td>
<td>8 \text{ ft}</td>
<td>18 \text{ ft}</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>C</td>
<td>8 \text{ ft}</td>
<td>18 \text{ ft}</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
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<tr>
<td>D</td>
<td>24 \text{ ft}</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
</tbody>
</table>

∴ N-S = 1.0

→ For E-W Direction

<table>
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<tr>
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<th>HEIGHT</th>
<th>H/L</th>
<th>L/&amp;L</th>
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<td>8 \text{ ft}</td>
<td>10 \text{ ft}</td>
<td>0.25</td>
<td>0.2 \leq 0.33</td>
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<tr>
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<td>10 \text{ ft}</td>
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<tr>
<td>5</td>
<td>8 \text{ ft}</td>
<td>10 \text{ ft}</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td>D</td>
<td>40 \text{ ft}</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
</tbody>
</table>

∴ P-E-W = 1.0
VERTICAL DISTRIBUTION OF BASE SHEAR

→ FOR ROOF
\[ C_{vR} = \frac{w \cdot h}{\gamma \cdot w \cdot h} = \frac{(18.2)(121)}{(100)(181)} \text{ kip} = 0.97 \]

→ FOR FLOOR
\[ C_{vF} = \frac{(50, 10 \text{ kip})(1 \text{ ft})}{(1797.04 \text{ kip})} = 0.03 \]

STORY FORCES:
(NEGLECT LOFT AND FLOOR SEISMIC LOADING)

\[ F_x \Rightarrow C_{vF} \cdot V = (1.0)(0.07)(15.5 \text{ kip}) = 15.18 \text{ kip} \]

\[ F_y \Rightarrow (1.0)(0.07)(15.5 \text{ kip}) = 15.18 \text{ kip} \]

HORIZONTAL DISTRIBUTION OF BASE SHEAR

→ FOR ROOF
\[ V_x = \frac{2}{5} F_X = \frac{2}{5}(15.18 \text{ kip}) = 15.18 \text{ kip} \]

\[ V_y = \frac{2}{5} F_y = \frac{2}{5}(15.18 \text{ kip}) = 15.18 \text{ kip} \]

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</th>
<th>LEFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-C</td>
<td>18ft</td>
<td>8ft</td>
<td>2.25&gt;2</td>
<td>2(8ft)/8ft=0.89</td>
<td>0.89(8ft)=7.1ft</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</th>
<th>LEFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-5</td>
<td>10ft</td>
<td>8ft</td>
<td>1.25&gt;2</td>
<td>-</td>
<td>8ft</td>
</tr>
</tbody>
</table>

OUT OF PLANE SEISMIC FORCES

\[ f_p = 0.45, \text{ E-W} = 0.4(0.054)(1.0)(190 \text{ kip}) = 4.57 \text{ kip} \]
WIND LOADING CRITERIA

RISK CATEGORY

BASIC WIND SPEED

EXPOSURE CATEGORY

TOPOGRAPHIC FACTOR, $K_{27}$

WIND PressURES, $P_{net 30}$

ADJUSTMENT FACTOR, $\lambda$

ADJUSTED WIND PressURES

\[
P_{net} = \lambda K_{27} P_{net 30} = (1.21)(1)(20.8 \text{ psf}) = 25.17 \text{ psf}
\]

$P_{net} = 25 \text{ psf} > 4.51 \text{ psf} = \beta_p$

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

SLOPE FACTOR

\[ \text{ROOF SLOPE FACTOR} \]
\[ = 0.9 \text{ (cold)} \]

FORMULA:

\[ P_e = 60 \text{ psf} \]

\[ = 0.7 \text{ (wet)} \]

DESIGN SNOW LOAD

\[ S = 0.7 (60 \text{ psf}) \]

\[ = 0.9 (60 \text{ psf}) \]

\[ = 42 \text{ psf (wet)} \]

\[ = 54 \text{ psf (cold)} \]
TYPICAL 7:12 ROOF RAFTER (WARM ROOF)

\[ D: 20 \text{ psf} \left( \frac{24}{12} \text{ in.} \right) \left( \frac{12.5}{12} \text{ in.} \right) = 45 \text{ plf} \]

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

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

LOAD COMBINATIONS:

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

DEMANDS:

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

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

IBC 2015
T. 1604.3

\[ L.C. = \frac{L}{240}, \quad T.C. = \frac{L}{180} \]

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

HND

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

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

\[ E I = \frac{5wL^3}{384} = 5(130 \text{ plf})(12 \text{ ft})^3(192 \text{ kips})(10 \text{ in.}) = 101 \times 10^6 \text{ in}^2 \]

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

* TRY 2x10 DF-L #2

\[ E = 1.60 \times 10^6 \text{ psi} \]
\[ E_{\text{max}} = 98.93 \text{ kpsi} \]
\[ F_b = 900 \text{ psi} \]
\[ F_v = 180 \text{ psi} \]
\[ F_c = 62.5 \text{ psi} \]
\[ S_x = 21.39 \text{ kips/lin ft} \]
\[ A = 13.88 \text{ in}^2 \]

CAPACITY:

\[ F_b' = F_b \left( C_d C_f C_r \right) = (900 \text{ psi})(1.15)(1.1)(1.15) \]
\[ = 1309.38 \text{ psi} \]

\[ M_{\text{max}} = \frac{M}{S} \rightarrow M_{\text{allow}} = F_b' S = (1309.38 \text{ psi})(21.39 \text{ kips/lin ft}) \]
\[ = 2333.97 \text{ kips-ft} \]

\[ F_v' = F_v (C_d) = (180 \text{ psi})(1.15) \]

\[ \gamma = \frac{VQ}{IT} \rightarrow \gamma_{\text{allow}} = \frac{F_v' A}{1.5} = \frac{(207 \text{ psi})(13.88 \text{ in}^2)}{1.5} \]
\[ = 1915.15 \text{ kips/lin ft} \]

\[ \geq 774 \text{ kips/lin ft} \]

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

\[ \text{D: } 20 \text{ psf} \left( \frac{24}{12 \text{ in}} \right) \left( \frac{11 \text{ ft}}{15 \text{ ft}} \right) = 57 \text{ psf} \]

\[ \text{S: } 54 \text{ psf} \left( \frac{24}{12 \text{ in}} \right) = 108 \text{ psf} \]

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

\[ \text{P: SHEAR FROM RAFTER} = 774 \text{ lbs} \]

SEE PREVIOUS

**LOAD COMBINATION:**

\[ \text{(3) } \text{D+S} = 57 \text{ psf} + 108 \text{ psf} = 165 \text{ psf} \]

**DEMANDS:**

\[ +5 \sum M_{\text{wall}} = 0 = PL + WLx - V_{\text{wall}}l_1 \]

\[ V_{\text{wall}} = \left( \frac{774}{165} \right) \left( \frac{3 \text{ ft}}{12 \text{ ft}} \right) + \left( \frac{165 \text{ psf}}{15 \text{ ft}} \right) \left( \frac{15 \text{ ft}}{2} \right) = 2514 \text{ lbs} \]

\[ +7 \sum F_y = 0 = -P - W + V_{\text{wall}} + V_{\text{wall}} = (774/165) + (165 \text{ psf})(15 \text{ ft}) - 2514 \text{ lbs} = 735 \text{ lbs} \]

\[ D_{LL} = \frac{240}{E} = \frac{12 \text{ ft}}{12 \text{ in}} / 240 = 0.61 \text{ in} \]

\[ D_{TL} = \frac{1180}{E} = \frac{12 \text{ ft}}{12 \text{ in}} / 180 = 0.81 \text{ in} \]
CAPACITY:

TRY 2 x 12 DF-C #2

\[ F_b' = (900 \text{ psi})(1.15)(1.0)(1.15) = 1190 \text{ psi} \]

\[ M = (1190 \text{ psi})(31.64 \text{ in}^3)/12\text{in} = 3188 \text{ ft-lb} \geq 2756 \text{ ft-lb} \]

\[ F_y' = (180 \text{ psi})(1.15) \geq 207 \text{ psi} \]

\[ V = (207 \text{ psi})(16.88 \text{ in}^2)/1.15 = 2329 \text{ psi} \geq 2073 \text{ psi} \]

\[ \Delta_{\text{between}} = \frac{6Lx}{24EI} \]

\[ \frac{(654x1/2\text{in})(7.5\text{ft})(1.0)}{24(16\times10^6 \text{ psi})(178\text{ in}^4)(149\text{ in})} \left[ (144\text{ in})^4 - 2(144\text{ in})(90\text{ in})^2 \right. \\
\left. + (144\text{ in})(90\text{ in})^3 - 2(36\text{ in})^2(90\text{ in})^2 \right] + 2(36\text{ in})^2(90\text{ in})^2 \]

\[ = 0.21\text{ in} \leq 0.81\text{ in} \]

**USE 2 x 12 DF-C #2 AFFTERARS @ 24" O.C. FOR 4/12 ROOF**
**TYPICAL GARAGE ROOF RAFTER (COLD ROOF)**

\[
D = 20 \text{psf} \left( \frac{34.14}{12.10} \right) = 39 \text{plf}
\]

\[
L_n = 20 \text{psf} \left( \frac{34.14}{12.10} \right) = 40 \text{plf}
\]

\[
S = 59 \text{psf} \left( \frac{34.14}{12.10} \right) = 108 \text{plf}
\]

**LOAD COMBINATIONS**

3. \( D + S = 39 \text{plf} + 108 \text{plf} = 147 \text{plf} \)

**DEMANDS:**

- \( M = (147 \text{plf}) (10 \text{ft})^2 / 8 = 1838 \text{ft-lb} \)
- \( V = (147 \text{plf}) (10 \text{ft}) / 2 = 735 \text{lbs} \)
- \( \frac{EI}{384} = 5(147 \text{plf})(12 \text{in}) \int \left[ (10 \text{ft})(12 \text{in})^3 (240) \right] / 384 = 66.15 \times 10^6 \text{in}^2 \)
- \( I_{\text{eq}} = 66.15 \times 10^6 / 1.6 \times 10^6 = 41.34 \text{in}^4 \)

**CAPACITY:**

- **TRY 2 x 10 DF-L #2**
  - \( M = \text{SEE PREVIOUS} \geq 2334 \text{ft-lb} \)
  - \( V = \text{SEE PREVIOUS} \geq 735 \text{lbs} \)

**USE 2 x 10 DF-L #2 RAFTERS @ 24" O.C. FOR GARAGE**
**RIDGE BEAM @ GIANACIE (COLD)**

**LOADING:**

- $A_f = (20\text{ ft})(10\text{ ft}) = 200\text{ ft}^2$
- $D = 20\text{ psf (10 ft)}$
- $L_a = 20\text{ psf (10 ft)}$
- $S = 54\text{ psf (10 ft)}$

**LOAD COMBINATIONS:**

- $D + S = 200\text{ psf} + 54\text{ psf} = 254\text{ psf}$

**DEMands:**

- $M = (740\text{ psf})(20\text{ ft})^2/8 = 37\text{ ft kips}$
- $V = (740\text{ psf})(20\text{ ft})/2 = 7.40\text{ kips}$
- $D = 5[(740\text{ psf/m})(20\text{ ft})(16\text{ in})]^2/(240) = 2664+10^6/16\text{ in}^2$ = $2664+10^6/16\text{ in}^2$
- $T_{req} = \frac{2664+10^6/16\text{ in}^2}{1.8 \times 10^6\text{ psi}} = 1480\text{ in}^2$

* TAB 6 3/4" + 13 1/2" GLULAM
* ASSUME 24F-Y4 DF/DF

- $I_x = 13.84\text{ in}^4$
- $E = E_{min} = 1.8 \times 10^6\text{ psi}$
- $S_x = \frac{20.5}{1.3}\text{ in}^3$
- $A = \frac{91.13\text{ in}^2}{91.13\text{ in}^2}$
CAPACITY:

\[ C_v = \left( \frac{2.1}{2} \right)^{1/4} \left( \frac{12}{d} \right)^{1/4} \left( \frac{5.125}{b} \right)^{1/4} \]

\[ = \left( \frac{2.1}{20} \right)^{1/4} \left( \frac{12}{12.5} \right)^{1/4} \left( \frac{5.125}{8.333} \right)^{1/4} \]

\[ = 0.97 \leq 1.0 \checkmark \]

\[ F_b = (2400 \text{ psi}) (1.15) (0.97) \]

\[ = 2677.2 \text{ psi} \]

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

\[ = 4574 \text{ kip-ft} \geq 37 \text{ ft kips} \checkmark \]

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

\[ = 305 \text{ psi} \]

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

\[ = 18.5 \text{ kips} \geq 7.40 \text{ kips} \checkmark \]

\[ E'I = (1.80 + 106 \text{ psi})(138 \text{ in}^2) \]

\[ = 2491 + 106 \text{ lb/in}^2 \]

*CHECK DEMANDS WITH SELF WEIGHT*

\[ SW = (35 \text{ plf})(91.13 \text{ in}^2)/144 \text{ in}^2 \]

\[ = 22.15 \text{ plf} \]

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

\[ = 1.11 \text{ kip-ft} \]

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

\[ = 0.22 \text{ kips} \]

\[ E'I = 5(22.15 \text{ plf})/12 \times [(20 \text{ ft})(12 \text{ in})]^3/3 \]

\[ = 79.74 \text{ lb/in}^2 \]

**DEMANDS + SELF WEIGHT**

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

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

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

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

\[ E'I_T = 2491 + 106 + 79.74 + 106 \]

\[ = 2570 + 106 + 106 \text{ in}^2 \leq 2664 + 106 \text{ in}^2 \checkmark \]

*USE 6 3/4" x 13 1/2" COLUMN
24" V4 DF/DF RIDGE BEAM*
Load Combinations:

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

Demands:

\[ M(\text{between supports}) = \frac{wL}{2} (E^2 - A^2) \times \frac{L}{2} \]

\[ = \frac{(19 \text{ plf})(6 \text{ ft})}{2} \left[ (18 \text{ ft})^2 - (3 \text{ ft})^2 - (6 \text{ ft})(11 \text{ ft}) \right] = 300 \text{ lb ft} \]

\[ M(\text{catlever}) = \frac{wL}{2} (E - x) = \frac{(46 \text{ plf})(3 \text{ ft} - 1.5 \text{ ft})^2}{2} = 51 \text{ lb ft} \]

\[ V(\text{at support}) = \frac{8mL}{L} = (46 \text{ plf})(15 \text{ ft}) - R_1(12 \text{ ft}) = 925 \text{ plf} \]

\[ E_r = 7(46 \text{ plf})(15 \text{ ft}) + 925 \text{ plf} \times R_1 = 255,112 \]

\[ \Delta(\text{between supports}) = \frac{wL^3}{24EI} \]

\[ = \frac{(19 \text{ plf})(114 \text{ in})(72 \text{ in})}{24 \times 12 \times 114 \text{ in}} \left[ (144 \text{ in})^4 - 2(144 \text{ in})^2 (72 \text{ in})^2 + (144 \text{ in})(72 \text{ in})^3 - 2(36 \text{ in})^3 (144 \text{ in})^2 + 2(36 \text{ in})^5 (12 \text{ in})^2 \right] \]

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

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

\[ I_{aeq} = \frac{12.56 \times 10^6 \text{ in}^4}{114 \times 10^6 \text{ psi}} = \frac{7.85}{\text{in}^4} \]

\[ \theta = 2 \times 6 \text{ plf} \times 4 \text{ ft} \]

\[ S_{aw} = 20.80 \text{ in}^4 \]

\[ S_{aw} = 7.56 \text{ in}^2 \]

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

\[ F_b = (900 \text{ psi}) (1.25) (1.3) (1.15) \]
\[ M_{ma} = (1681.88 \text{ psi}) (7.56 \text{ in}) \]
\[ V_{allow} = (225 \text{ psi}) (8.25 \text{ in}^2) / 1.5 \]

= 1681.88 \text{ psi}

= 10600 \text{ ft-lb}

\geq 300 \text{ ft-lb} \checkmark

= 1238165 \text{ in-lb}

\geq 425165

\% USE 2x6 DF-L #2 @ 18\text{ in OC}.
FOR CANTILEVERED CEILING JOISTS
TYPICAL FLOOR HOIST

D: 14 psf (16 ft) = 195 pcf
L: 20 psf (16 ft) = 276 pcf

LOAD COMBINATIONS

D + L = 46 pcf

DEMANDS

M = \frac{(46 \text{ pcf})(12 \text{ ft})^2}{8} = 828 \text{ ft}^3 \text{ lb}

V = \frac{(46 \text{ pcf})(12 \text{ ft})}{2} = 276 \text{ lb}

E2 = 5 \frac{(46 \text{ pcf})(12 \text{ ft})[12 \text{ ft} - 2(24 \text{ in})]^3}{3 \times 89} = 1,871 \text{ lb}

I_{net} = \frac{1.871 \times 10^3 \text{ in}^4}{1.60 \times 10^6 \text{ psi}} = 1.17 \text{ in}^4

* TAY 2x6 DF-L #2

\begin{align*}
I_{ax} &= 10.80 \text{ in}^4 \\
S_{ax} &= 7.58 \text{ in}^3 \\
N &= 8.25 \text{ in}^2
\end{align*}

F_{th} = \text{ SEE PREVIOUS} = 1682 \text{ psi}

M_{max} = \text{ SEE PREVIOUS} = 1060 \text{ ft} \text{ lb}

V_{max} = \text{ SEE PREVIOUS} = 888 \text{ ft} \text{ lb}

\[\therefore \text{ USE 2x6 DF-L #2} \at \text{ 18 in. o.c. floor twists}\]
**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:**

\[ M = \frac{(408 \text{ plf})(12 \text{ ft})^2}{8} = 7.32 \text{ kip-ft} \]

\[ V = \frac{(408 \text{ plf})(12 \text{ ft})}{2} = 2.5 \text{ kips} \]

\[ EI = 5\left(\frac{408 \text{ plf/ln}}{16 \text{ in}}\right)^2(12 \text{ ft})(12 \text{ ft})^3(240) \]

\[ I_{\text{eq}} = \frac{620 + 106}{16 + 10^6 \text{ psi}} = 387 \text{ in}^4 \]

**Capacity:**

- TA1: 4x12 DF-L #2
  - \( F_{th} = 9^3 \text{ in}^4 
  - \( S_t = 73 \text{ in}^3 
  - \( A = 39.38 \text{ in}^2 \)

\[ F_b = (900 \text{ psi})(1.25)(1.1)(1.15) = 1423 \text{ psi} \]

\[ M = (1423 \text{ psi})(73.15 \text{ in}^2) = 8.68 \text{ kip-ft} \geq 7.3 \text{ kip-ft} \checkmark \]

\[ F_v = (180 \text{ psi})(1.25) = 225 \text{ psi} \]

\[ V = (225 \text{ psi})(39.38 \text{ in}^2)/1.5 = 5.94 \text{ kips} \geq 2.5 \text{ kips} \checkmark \]

**Use 4x12 DF-L #2 Floor Beams**
**CONTINUOUS WALL FOOTING**

- $P_R = 23.1 \text{ psf} (6 \text{ ft}) = 139 \text{ plf}$
- $L_R = 20 \text{ psf} (6 \text{ ft}) = 120 \text{ plf}$
- $D_R = 23.1 \text{ psf} (6 \text{ ft}) = 139 \text{ plf}$
- $L_F = 20 \text{ psf} (6 \text{ ft}) = 120 \text{ plf}$

**DEMANDS:**

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

**ASSUMPTIONS:**
- Sedimentary & foliated rock
- Vertical Foundation Pressure
- Lateral Bearing Pressure
- Coefficient of Friction
- Effective Unit Weight, $\gamma$ = 156 psf (worst case)

**SIZE SELECTION:**

\[ b = \frac{(139 \text{ plf} + 120 \text{ plf})^2}{1500 \text{ psf}} = 0.35 \text{ ft} \]

Use 1 ft wide, 2 ft deep footing

**REBAR**

$A_{min} = 0.008 (12\text{ in})(24\text{ in}) = 0.518 \text{ in}^2$

Use (2) #5 BARS

$A_s = 0.62 \text{ in}^2$
**PAD FOOTING**

\[ A_T = (12 \text{ ft})(12 \text{ ft}) = 144 \text{ ft}^2 \]

\[ P = (35 \text{ psf} + 32 \text{ psf})(144 \text{ ft}^2) = 9638 \text{ psf} \]

**SIZE SELECTION**

\[ A = \frac{P}{p_b} = \frac{9638 \text{ psf}}{1.5 \text{ ksf}} = 6.43 \text{ ft}^2 \]

*Use 2.5 ft x 2.5 ft x 2 ft pad footing*

**REBAR**

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

*Use (2) #8 bars E.W.*

\[ A_s = 1.6 \text{ in}^2 \]

**CHECK** 18C 2015 180(k) + T \(1800k\) minimum requirements

\[ D = 12'' \text{ min} \leq 2 \text{ ft} \checkmark \]

\[ B = 12'' \text{ min} \leq 2\frac{1}{8}'' \checkmark \]

\[ T = 6'' \text{ min} \leq 12'' \checkmark \]
**Lateral Design**

**Exterior Stud Wall Out of Plane Loading**

![Diagram of exterior stud wall with load combinations]

**Load Combinations**

\[
W = 25 \text{ psf}
\]

\[
L = 20 \text{ psf}
\]

\[
D = 23.19 \text{ psi}
\]

\[
S = 54 \text{ psi} \quad \text{(worst case)}
\]

**2x10 Studs @ 24" o.c.**

**Dimensions:**

10'6"

8 ft

**Load Combinations**

\[
D + 0.75L + 0.75S = 2(0.75\times25) + (0.75\times20) + 0.75(54) = 786 \text{ lbs}
\]

\[
0.75(0.6)W = 0.75(0.6)(25)(2) = 22.5 \text{ psi}
\]

**Demands:**

\[
M = (22.5 \text{ pcf})(16.5 \text{ ft})^2 / 8 = 783 \text{ ft} \cdot \text{lbs}
\]

\[
V = (22.5 \text{ pcf})(16.5 \text{ ft})^2 / 2 = 186 \text{ lbs}
\]

\[
P = \text{SEE LOAD COMBO ABOVE} = 786 \text{ lbs}
\]

**Capacity:**

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

\[
F_{ce} = \frac{0.822 \times 1 \text{ in}^2}{\left(\frac{1}{24}\right)^2} = 0.822 \times 10^4 \text{ psi}
\]

\[
= 1041 \text{ psi}
\]
\[ F_0' = 1530 \text{ psi}(1.6)(1.0) = 2376 \text{ psi} \]
\[
F_{ce}' \times F_0' = \frac{1041 \text{ psi}}{2376 \text{ psi}} = 0.443
\]
\[
C_p = \frac{1}{1 - \left(\frac{0.438}{1.6}\right) - \sqrt{\frac{1}{1 - \left(\frac{0.438}{1.6}\right)^2}} - \frac{0.438}{0.8}} = 0.389
\]
\[
F_{c'} = (2376 \text{ psi})(0.389) = 923 \text{ psi}
\]
\[
F_{c'}/F_0' = \frac{56.65 \text{ psi}}{923 \text{ psi}} = 0.061 < 1.0 \checkmark
\]
\[
F_b = \frac{783.1/2 \text{ ft}(12 \text{ in})}{21.56 \text{ psi}} = 436 \text{ psi}
\]
\[
F_{b'} = (700 \text{ psi})(1.6)(1.5)(1.0)(1.15) = 2152.8 \text{ psi}
\]
\[
F_{b'}/F_b = \frac{436 \text{ psi}}{2152.8 \text{ psi}} = 0.20 \neq 1.0 \checkmark
\]

Combined Loading:

\[
\left(\frac{F_c}{F_{c'}}\right)^2 + \frac{F_b}{F_{b'}/F_c} = (0.061)^2 + \frac{436 \text{ psi}}{2152.8 \text{ psi} \left(\frac{1.6}{1041}\right)} = 0.22 < 1.0 \checkmark
\]

2×10 DF-L: 2 & 18/1.0, 18\" OC. MAE ADEQUATE.
**Typical Shear Wall Design**

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

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

\[ W = 25 \text{ psf (41 ft)} = 5.6 \text{ kips} \]

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

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

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

**Load Combinations**

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

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

\[ + 0.75(1230 \text{ plf}) = 1.90 \text{ kips gravity} \]

\[ W = 0.75(0.6)(5.6 \text{ kips}) = 2.52 \text{ kips lateral} \]

**Foa Hold Downs**

\[ +5 \text{ f y} = 0 = -(2.52 \text{ kips})/4 \text{ ft} \]

\[ - (1.90 \text{ kips})(8 \text{ ft})(8 \text{ ft})/2 \]

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

\[ C = 88.52 \text{ kips/ft} = 11.1 \text{ kips (comp)} \]

\[ +1 \text{ f y} = 0 = -(1.90 \text{ kips})(8 \text{ ft}) - T + 11.1 \text{ kips} \]

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

**Use Simpson HDG11 - SDS 2.5**

**T = 11.8 kips**

**Foa Shear Panel**

\[ 2V = 2W/ \text{ length} = 2(2.52 \text{ kips})/41 \text{ ft} \]

\[ = 71.0 \text{ plf} \]

**Use 15/2 Structural I**

\[ W @ 6'0" o.c. \quad (C = 950 \text{ plf}) \]
N-S ROOF DIAGRAM

DEMANDS:

\[ \begin{align*}
V_{kip} & = 5.64 \text{ kip} \\
U_{plf} & = 240 \text{ plf} \\
M_{MIP} & = 57.81 \text{ kips-in} \\
C_{HOPD} & = 246 \text{ kips-in}
\end{align*} \]

\[ \text{Use 10d @ 6/6/12} \]
\[ W \frac{1}{2}'' \text{ SHEATHING} \]
\[ c = 940 \text{ plf} \]
SHEAR FLOW FOR TYPICAL SHEAR WALL (N-S)

- Demand = 355 kLF
- Capacity = 695 kLF
- Spacing = 695 / 2.5 = 195
- Use 2 ft spacing

SHEAR FLOW FOR TYPICAL SHEAR WALL (E-W)

- Demand = 355 kLF
- Capacity = 695 kLF
- Spacing = 695 / 2.5 = 195
- Use 2 ft spacing

SIMPSON 1934 CLIP

SIMPSON HHDA11 - SDS2.5
ANCHOR BOLT DESIGN FOR TARGUE W10-14

\[ V = \frac{W}{g} \text{ Eff} = \frac{2,524 \text{ kips}}{2.1 \text{ ft}} = 355 \text{ kips} \]

* Take 1/2" diameter anchor bolts

\[ B = \frac{650 \text{ lb}}{1.6} = 1040 \text{ lb} \]

\[ S_{p} = \frac{C_{f}}{f_{c}} = \frac{1040 \text{ lb}}{355 \text{ kips}} = 2.93 \text{ ft} \leq 9 \text{ ft} \]

USE 1/2" diameter anchor bolts @ 3 ft O.C.
16. CONCRETE MASONRY UNIT WALLS SHALL BE CONSTRUCTED OF GRADE N TYPE UNITS, CONFORMING TO THE MASONRY SPECIFICATIONS OF THE INTERNATIONAL BUILDING CODE, 2006 EDITION, CHAP. 19. THE MASONRY MATERIALS AND WORKMEN SHALL BE SO QUALIFIED AS TO BE ABLE TO OBTAIN CONSISTENT UNIT STRENGTHS OF 3,000 PSI AT 28 DAYS DRYING. CONCRETE MASONRY UNIT WALLS SHALL BE SUPPORTED BY STEEL FRAMES, WITH MASONRY FIGURES A MINIMUM OF 8" AT SIDES AND CORNERS. THE CONCRETE MASONRY WALLS SHALL CONFORM TO IBC REQUIREMENTS AND ATTAIN A MINIMUM COMPRESSIVE STRENGTH OF 3,000 PSI AT 28 DAYS DRYING. CONCRETE MASONRY WALLS SHALL BE SUPPORTED BY STEEL FRAMES, WITH MASONRY FIGURES A MINIMUM OF 8" AT SIDES AND CORNERS.

17. CONCRETE SHALL BE PLACED AND CURED SUCH THAT THE RISE OF WATER IS NOT EXCEEDED. CONCRETE SHALL BE PLACED ONLY WHEN THE SURFACES TO BE CONCRETE ARE FREE FROM DIRT, DUST, OIL, AND OTHER SUBSTANCES THAT MIGHT PREVENT ADHESION OF THE CONCRETE.

18. ALL CONCRETE SHALL BE USED IN CONJUNCTION WITH ARCHITECTURAL DRAWINGS FOR INDICATION OF GENERAL AND TYPICAL DETAILS OF CONSTRUCTION. WHERE CONDITIONS ARE NOT SPECIFIED IN THE CONTRACT DOCUMENTS, THE CONTRACTOR SHALL PROVIDE ALL REINFORCEMENT REQUIRED TO PRODUCE A SLUMP OF 5" OR LESS.

19. CONCRETE SHALL BE MIXED, PROPORTIONED, CONVEYED, AND PLACED IN ACCORDANCE WITH NCSC 3-2-1(10) AND 3-2-1(11). CONCRETE SHALL MEET OR EXCEED THE REQUIREMENTS OF IBC 1905.3 FOR AIR ENTRAINING AGENT CONFORMING TO ASTM C260, C494M, AND C618. TOTAL AIR CONTENT FOR FROST RESISTANT CONCRETE SHALL BE IN ACCORDANCE WITH TABLE 1904.2.1 OF THE INTERNATIONAL BUILDING CODE.

20. CONCRETE SHALL CONFORM TO ASTM A618, INCLUDING SUPPLEMENTS VI, (GRADE 8); 4, 3, 2, AND 1, AS APPLICABLE. CONCRETE SHALL MEET OR EXCEED THE REQUIREMENTS OF IBC 1905.3 FOR AIR ENTRAINING AGENT CONFORMING TO ASTM C260, C494M, AND C618. TOTAL AIR CONTENT FOR FROST RESISTANT CONCRETE SHALL BE IN ACCORDANCE WITH TABLE 1904.2.1 OF THE INTERNATIONAL BUILDING CODE.

21. CONCRETE SHALL CONFORM TO ASTM A618, INCLUDING SUPPLEMENTS VI, (GRADE 8); 4, 3, 2, AND 1, AS APPLICABLE. CONCRETE SHALL MEET OR EXCEED THE REQUIREMENTS OF IBC 1905.3 FOR AIR ENTRAINING AGENT CONFORMING TO ASTM C260, C494M, AND C618. TOTAL AIR CONTENT FOR FROST RESISTANT CONCRETE SHALL BE IN ACCORDANCE WITH TABLE 1904.2.1 OF THE INTERNATIONAL BUILDING CODE.

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23. CONCRETE SHALL CONFORM TO ASTM A618, INCLUDING SUPPLEMENTS VI, (GRADE 8); 4, 3, 2, AND 1, AS APPLICABLE. CONCRETE SHALL MEET OR EXCEED THE REQUIREMENTS OF IBC 1905.3 FOR AIR ENTRAINING AGENT CONFORMING TO ASTM C260, C494M, AND C618. TOTAL AIR CONTENT FOR FROST RESISTANT CONCRETE SHALL BE IN ACCORDANCE WITH TABLE 1904.2.1 OF THE INTERNATIONAL BUILDING CODE.

24. CONCRETE SHALL CONFORM TO ASTM A618, INCLUDING SUPPLEMENTS VI, (GRADE 8); 4, 3, 2, AND 1, AS APPLICABLE. CONCRETE SHALL MEET OR EXCEED THE REQUIREMENTS OF IBC 1905.3 FOR AIR ENTRAINING AGENT CONFORMING TO ASTM C260, C494M, AND C618. TOTAL AIR CONTENT FOR FROST RESISTANT CONCRETE SHALL BE IN ACCORDANCE WITH TABLE 1904.2.1 OF THE INTERNATIONAL BUILDING CODE.

25. CONCRETE SHALL CONFORM TO ASTM A618, INCLUDING SUPPLEMENTS VI, (GRADE 8); 4, 3, 2, AND 1, AS APPLICABLE. CONCRETE SHALL MEET OR EXCEED THE REQUIREMENTS OF IBC 1905.3 FOR AIR ENTRAINING AGENT CONFORMING TO ASTM C260, C494M, AND C618. TOTAL AIR CONTENT FOR FROST RESISTANT CONCRETE SHALL BE IN ACCORDANCE WITH TABLE 1904.2.1 OF THE INTERNATIONAL BUILDING CODE.
### Wood Fasteners

A. Nail Sizes Specified on Drawings are Based on the Following Specifications:

<table>
<thead>
<tr>
<th>Nail Size</th>
<th>Documented Stark</th>
<th>Minimum Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>8d</td>
<td>1.75&quot;</td>
<td>2&quot;</td>
</tr>
<tr>
<td>10d</td>
<td>2.00&quot;</td>
<td>2.5&quot;</td>
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<td>12d</td>
<td>2.25&quot;</td>
<td>3&quot;</td>
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<tr>
<td>15d</td>
<td>2.50&quot;</td>
<td>3.5&quot;</td>
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</tbody>
</table>

If Contractor proposes the use of alternate nails, they shall submit nail specifications to the Structural Engineer (prior to construction) for review and approval.

B. Studs - The Following Stipulations May Be Substituted for Nailing of Plywood (APA Rated Sheathing):

<table>
<thead>
<tr>
<th>Nail Size</th>
<th>Documented Stark</th>
<th>Minimum Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>8d</td>
<td>0.148&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>10d</td>
<td>0.162&quot;</td>
<td>1.25&quot;</td>
</tr>
<tr>
<td>12d</td>
<td>0.190&quot;</td>
<td>1.5&quot;</td>
</tr>
</tbody>
</table>

If Contractor proposes the use of alternate studs, they shall submit stud specifications to the Structural Engineer (prior to construction) for review and approval.

C. Nails and Stakes - Plywood (APA Rated Sheathing) fasteners to framing shall be driven flat to trace of surface with no countersinking permitted.

### General Notes

- **Tongue and Groove Structural Roof and Floor Decking Shall Be Installed As Follows:**
  - 29' Decking shall be toenailed through the tongue and facenailed with one 16d nail per piece per support.
  - 39' and 48' Decking shall be toenailed with one 16d nail and facenailed with one 8d nail per support. Courses shall be spaced together with 16d nails at 30" O.C. (minimum) and at 12" (Maximum) from each end of each piece. Spikes shall be installed in freerider edge holes.

### Structural Engineer

- TRENT PICHEL
  - GREAT NORTHERN SERVICES
  - 310 Boles St, Weed, CA 96094

### Cost Estimator

- SERGIO VERGARA
  - CONSTRUCTABILITY
  - COST ESTIMATOR

### Architectural Design

- FRANZISKA BECK
  - ARCHITECTURAL DESIGNER
  - PASSIVE HOME DESIGNER

- BRIAN LEEDS
  - ARCHITECTURAL DESIGNER

- MEGAN LUNDHAL
  - ARCHITECTURAL DESIGNER

- SERGIO VERGARA
  - CONSTRUCTABILITY
  - COST ESTIMATOR

### Contractor

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

### General Notes

- S1.1
FOUNDATION NOTES

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 S1.0, GENERAL STRUCCTURAL 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 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.
CEILING FRAMING NOTES

1. THE GENERAL CONDITIONS, SPECIFICATIONS, GENERAL NOTES ON SHEET S.1.0, 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

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

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 ADE TO BE 2X4 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 8'-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.
FOOTING

PROVIDE CORNER BARS SAME SIZE AND AMOUNT AS FOOTING REINFORCEMENT

ALTERNATE BENDS WHERE POSSIBLE

FOOTING REINFORCING AT INTERSECTION

LAP 48d U.N.O (2'-6"

ALTERNATE BENDS WHERE POSSIBLE

FOOTING REINFORCING AT INTERSECTION

LAP 48d U.N.O (2'-6"

CALIFORNIA ROOF SECTION

SHEATHING @ CA. ROOF PER PLAN

RAFTER @ CA. ROOF PER PLAN

2X STUD @ 24" O.C.

2X BLOCKING

CONTINUE SHEAR PANEL TO HOLD DOWNS AS SHOWN

PROVIDE REQUIRED DOUBLE STUDS OR POSTS WHERE HOLD DOWNS OCCUR

2X STUD @ 24" O.C. TYP U.N.O

STUD WALL INTERSECTIONS

MINIMUM PLATE SPLICE

(2) 16d EA. SIDE OF SPLICE - ADD ONE SIDE ONLY

(1) 16d EA. SIDE OF SPLICE ON SIMPSON STUD ONE SIDE ONLY

PROVIDE STUD BELOW SPLICES

CALIFORNIA ROOF SECTION

SHEATHING @ MAIN ROOF PER PLAN

RAFTER @ MAIN-ROOF PER PLAN

2X STUD @ 12" O.C.

2X DOUBLE TOP PLATE

PROVIDE STUDS @ 12" O.C. STAG. TYP

2X PURLIN & KICKER (LIMIT RAFTER SPAN TO 8'-0"

CALIFORNIA ROOF FRAMING

SHEATHING PER PLAN

RAFTER PER PLAN

2X RAIL IN 4 ACROSS LIMIT RAILER SPAN TO 8'-0" MAX

ROOF BEAM PER PLAN

CALIFORNIA ROOF RIDGE FRAMING

SHEATHING PER PLAN

RAFTER PER PLAN

2X STUD @ 16 TO TOP PLATE

2X FLAT @ 32" O.C.

NON-BEARING INTERIOR WALL

SHEATHING PER PLAN

J OISTS PER PLAN

2X STUD PER PLAN

2X FLAT @ 32" O.C. (2) 16D TO TOP PLATE

GREAT NORTHERN SERVICES
310 Boles St, Weed, CA 96094

WEED HOUSING DEVELOPMENT

TYPICAL DETAILS

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