BTL
ENGINEERING

19011 Wood-Sno Road NE, Suite 100
Woodinville, WA 98072-4436
Phone: (425) 814-8448
Fax: (425) 821-2120

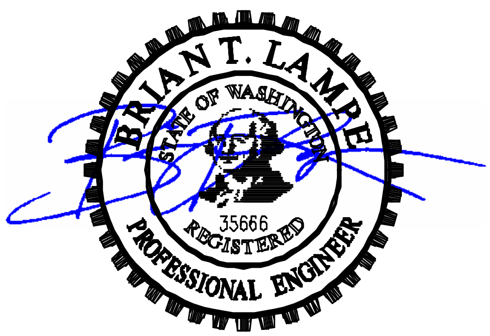
# Structural Calculations

For

# Munson Residence

## 4628 Forest Avenue SE

April 15, 2019




Prepared by

Brian Lampe

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# Criteria

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| | |
|---|---|
| **Project:** | Munson Residence |
| **Project Number:** | 4628 Forest Avenue SE |

| | | | |
|---|---|---|---|
| **Code:** | IBC 2015 | | |
| | Occupancy Category | II | |
| **Earthquake:** | Site Class | D | |
| | $I_e$ = | 1.00 | R = 6.5 |
| | $S_S$ = | 1.430 | $\Omega_0$ = 3.0 |
| | $S_1$ = | 0.549 | $C_d$ = 4.0 |
| | $\rho$ = | 1.00 | |
| **Wind:** | Ultimate Design Wind Speed, $V_{ult}$ | 110 MPH | |
| | Exposure | C | |
| | Topographic Factor $K_{ZT}$ = | 1.00 | |
| **Soil Bearing:** | 2000-psf Allowable Soil Bearing Pressure | | |
| **Concrete:** | 2500-psi Concrete Strength | | |
| | Higher strength may be used, but special inspection and testing reports not req'd | | |
| **Nails:** | Sheathing | 8d common (2½" x 0.131") | |
| | Framing | 12d box (3¼" x 0.131") | |

| | | | |
|---|---|---|---|
| **Roof Framing:** | | | |
| *Snow Load* | Ground Snow, Pg | | 25 psf |
| | | Exposure factor, Ce | 1.0 |
| | | Thermal Factor, Ct | 1.1 |
| | Flat Roof Snow, Pf (0.7 Ce Ct I Pg) | | 19 psf |
| | Use Snow Load | | **25 psf** |
| | Attic (where accessible) | | 10 psf |
| *Dead Load* | Roofing - Composition Shingles | | 4.0 psf |
| | Sheathing - 7/16 OSB | | 2.2 psf |
| | Framing - Trusses @ 24"oc | | 2.5 psf |
| | Insulation - Batt. | | 1.0 psf |
| | Ceiling - 5/8 GWB | | 2.8 psf |
| | Misc. | | 2.5 psf |
| | | **Total** | **15 psf** |
| *Deflection* | L/360 Live Load, L/240 Total Load | | |
| **Floor Framing:** | | | |
| *Live Load* | Residential | | 40 psf |
| | Decks | | 60 psf |
| *Dead Load* | Finish Floor - Allowance | | 5.0 psf |
| | Sheathing - 3/4 Plywood/Edge Gold | | 2.5 psf |
| | Framing - I-Joists @ 16"oc | | 2.7 psf |
| | Ceiling - 5/8 GWB | | 2.8 psf |
| | Misc. | | 2.0 psf |
| | | **Total** | **15 psf** |
| *Deflection* | L/480 Live Load, L/240 Total Load | | |
| **Wall Framing:** | | | |
| *Dead Load* | Exterior 2x Stud Walls | | 10 psf |
| | Interior 2x Stud Walls | | 8 psf |

# King County iMap


The information included on this map has been compiled by King County staff from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a survey product. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of King County.

Date: 1/25/2019 Notes:

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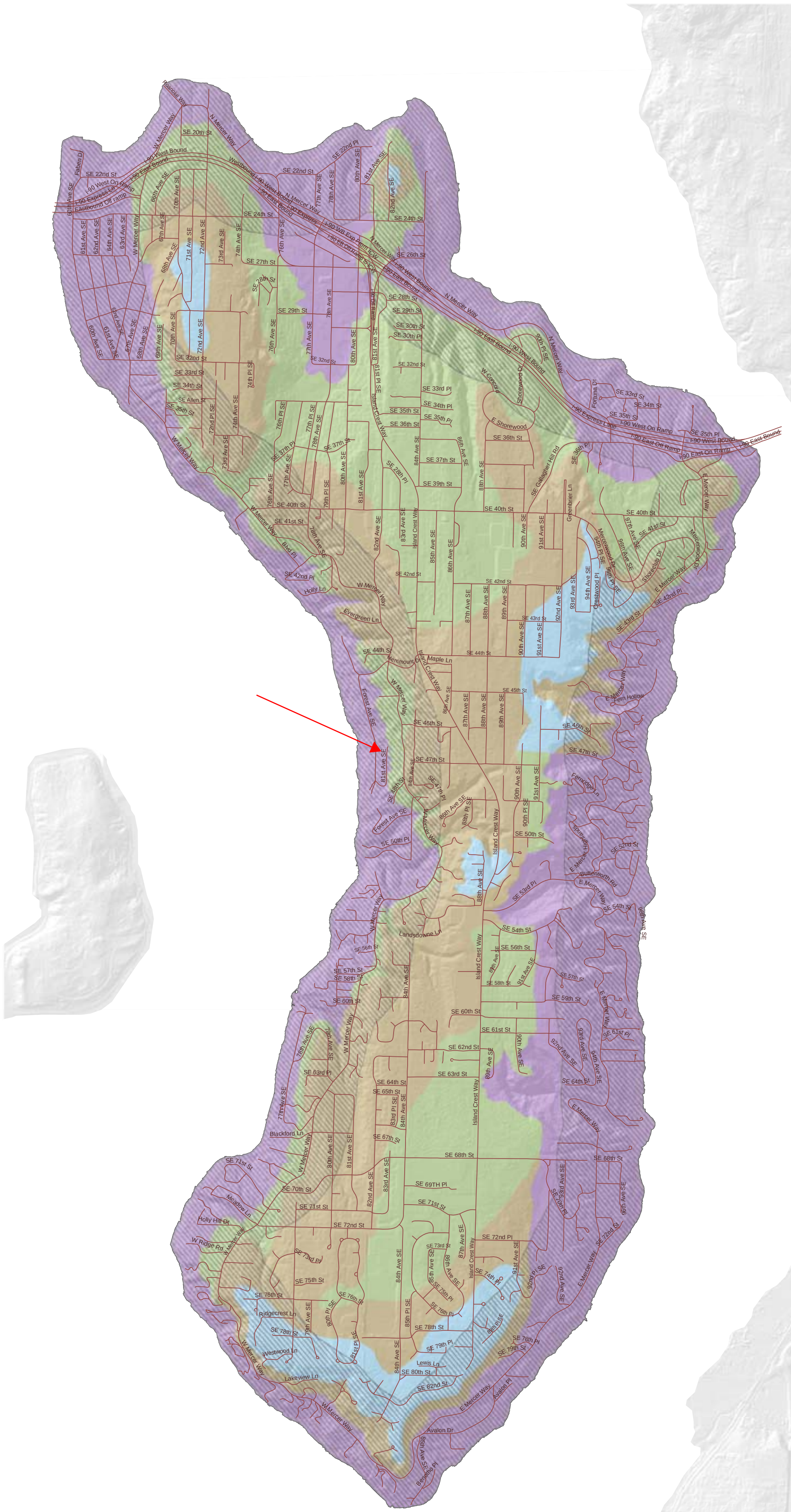
King County

C1.2

# Mercer Island Wind Exposure and Wind Speed-Up (Topographic Effect)

by Development Services Group (DSG), City of Mercer Island
April 2009

0 0.5 1 Kilometers
1:12,000
0 0.5 1 Miles
TN



WIND EXPOSURE CATEGORIES & WIND SPEED-UP FACTORS
(ICC Section 1609 & ASCE 7-05 Chapter 6)

It is the responsibility of the Owner (or their Design Professional) to review site conditions and determine the Kzt factor to be utilized for each specific project. The Kzt factors and wind exposure categories indicated on this map are the minimum values accepted by the City of Mercer Island without requiring the design professional to submit additional calculations and supporting topographic documentation (to verify the values utilized in their wind load determination).

Please note – The Kzt values indicated on this map are approximations based upon periodic calculations of representative samplings around Mercer Island. These values are intended for City of Mercer Island's plan review purposes only.

**WIND EXPOSURE CATEGORIES:**

| Wind Exposure Category | |
|---|---|
| | **Exposure 'C' (1500 feet from Lake)** |
| | **Exposure 'B' (all other areas)** |

**WIND SPEED-UP (TOPOGRAPHIC EFFECT) - $K_z t$ Factor :**

| $K_z t$ Factor | |
|---|---|
| | **$K_z t$ = 1.0** |
| | **$K_z t$ = 1.3** |
| | **$K_z t$ = 1.6** |
| | **$K_z t$ = 1.9** |

**GENERAL NOTES FOR WIND EXPOSURE AND WIND SPEED-UP MAP**

This map is the Wind Exposure Category and Wind Speed-up (Topographic Effects) Map for the City of Mercer island. This map shows the minimum wind exposure category and the minimum wind speed-up, "$K_z t$" factor, which will be accepted without site specific documentation and calculation.

Other wind speed phenomena may occur on Mercer Island that is not specifically indentified on this map. It is the responsibility of the Owner (or their Design Professional) to review site conditions and determine the appropriate design wind speed and exposure category for their specific project and location.

This map is for the sole use of the staff of the City of Mercer Island's Development Services Group (DSG) for the purposes of permit application evaluation. This map provides DSG staff a general assessment of Wind Exposure Category and Wind Speed-up (Topographic Effects). All areas have not been specifically evaluated and there may be locations that are not correctly represented on this map. It is the responsibility of individual property owners and map users to evaluate risk associated with their proposed development. No site-specific assessment of risk is implied or otherwise indicated by the City of Mercer Island with this map.

Information about data used for the map, references, and data limitation are all described the associated "Read Me" document. The digital version of this map is accompanied by a meta data file containing pertinent information about map construction. This data map is available on the City of Mercer Island website.

The City of Mercer Island is using guidance provided within ICC Section 1609 & ASCE 7-05 Chapter 6 regarding definitions used when creating this map.

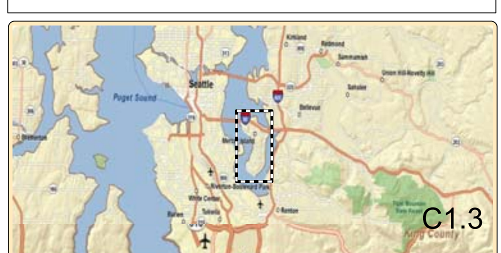
**DEFINITIONS:**

$K_z t$ factor: The topographic effect of wind speed-up at isolated hills, ridges, and escarpments constituting abrupt changes in the general topography, located in any exposure category, that meet all of the conditions noted in ASCE 7-05 Minimum Design Loads for Buildings and Other Structures, Section 6.5.7.

Exposure B: The wind exposure category that applies where the site in question is located a minimum of 1500 feet from the shoreline and the mean roof height is less than or equal to 30 feet per IBC 2006 section 1609.4.3.

Exposure C: The wind exposure category that applies where the site in question is located within 1500 feet from the shoreline per IBC 2006 section 1609.4.3.

Wind Speed: Minimum 85 mph 3-second gust per IRC Figure R301.2(4)




C1.3

# 4628 Forest Ave SE, Mercer Island, WA 98040, USA

**Latitude, Longitude: 47.56280719999999, -122.22948080000003**


| | |
|---|---|
| **Date** | 1/25/2019, 10:07:25 AM |
| **Design Code Reference Document** | ASCE7-10 |
| **Risk Category** | II |
| **Site Class** | D - Stiff Soil |

| Type | Value | Description |
|---|---|---|
| $S_S$ | 1.43 | $MCE_R$ ground motion. (for 0.2 second period) |
| $S_1$ | 0.549 | $MCE_R$ ground motion. (for 1.0s period) |
| $S_{MS}$ | 1.43 | Site-modified spectral acceleration value |
| $S_{M1}$ | 0.824 | Site-modified spectral acceleration value |
| $S_{DS}$ | 0.953 | Numeric seismic design value at 0.2 second SA |
| $S_{D1}$ | 0.549 | Numeric seismic design value at 1.0 second SA |

| Type | Value | Description |
|---|---|---|
| SDC | D | Seismic design category |
| $F_a$ | 1 | Site amplification factor at 0.2 second |
| $F_v$ | 1.5 | Site amplification factor at 1.0 second |
| PGA | 0.592 | $MCE_G$ peak ground acceleration |
| $F_{PGA}$ | 1 | Site amplification factor at PGA |
| $PGA_M$ | 0.592 | Site modified peak ground acceleration |
| $T_L$ | 6 | Long-period transition period in seconds |
| SsRT | 1.43 | Probabilistic risk-targeted ground motion. (0.2 second) |
| SsUH | 1.501 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration |
| SsD | 3.374 | Factored deterministic acceleration value. (0.2 second) |
| S1RT | 0.549 | Probabilistic risk-targeted ground motion. (1.0 second) |
| S1UH | 0.591 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration. |
| S1D | 1.307 | Factored deterministic acceleration value. (1.0 second) |
| PGAd | 1.307 | Factored deterministic acceleration value. (Peak Ground Acceleration) |
| $C_{RS}$ | 0.952 | Mapped value of the risk coefficient at short periods |
| $C_{R1}$ | 0.93 | Mapped value of the risk coefficient at a period of 1 s |

C1.4

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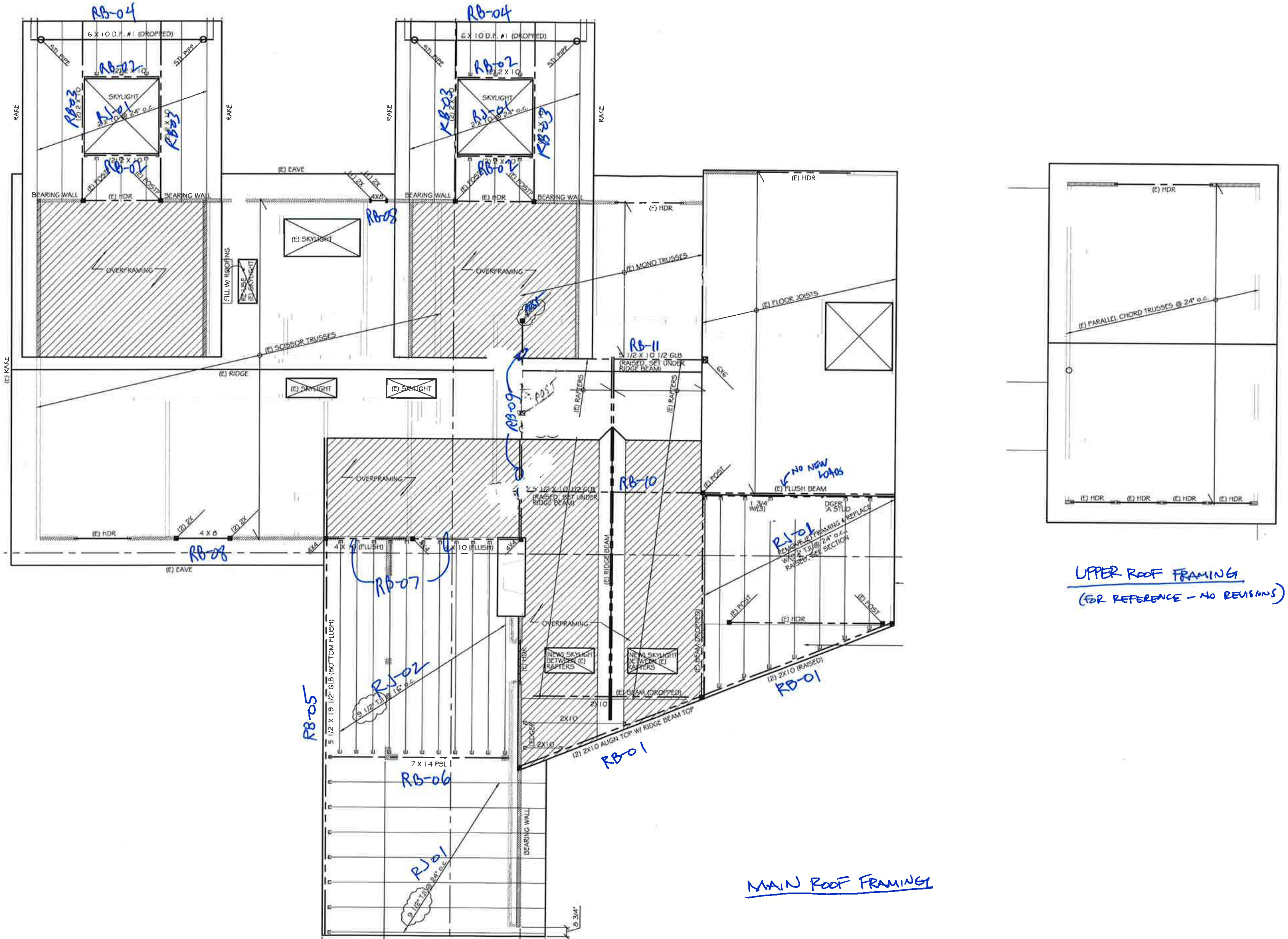
# Gravity

Roof Framing

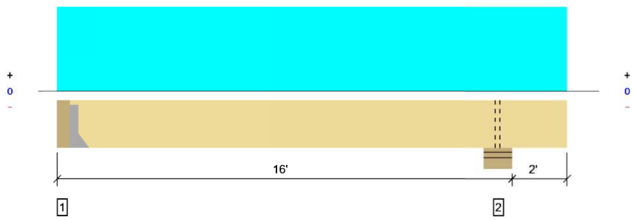


MAIN ROOF FRAMING
UPPER ROOF FRAMING
(FOR REFERENCE – NO REVISIONS)
RB-04
6 X 10 D.F. #1 (DROPPED)
SKYLIGHT
RB-02
RB-03
RJ-01
RB-01
BEARING WALL
(E) HDR
(E) EAVE
OVERFRAMING
(E) SKYLIGHT
RB-08
(E) MONO TRUSSES
(E) FLOOR JOISTS
(E) SCISSOR TRUSSES
(E) RIDGE
RB-11
RB-09
RB-10
NO NEW LOADS
(E) FLUSH BEAM
RB-07
7 X 14 PSL
RB-06
RB-05
RJ-02
(2) 2X10 (RAISED)
(2) 2X10 ALIGN TOP W/ RIDGE BEAM TOP
BEARING WALL
(E) PARALLEL CHORD TRUSSES @ 24" o.c.
RAKE

**FORTE** MEMBER REPORT *2nd Floor/Main Roof, RJ-01 (dimensional)* **PASSED**

## 1 piece(s) 2 x 10 Hem-Fir No. 2 @ 24" OC

Overall Length: 18'




All locations are measured from the outside face of left support (or left cantilever end).All dimensions are horizontal.;Drawing is Conceptual

| Design Results | Actual @ Location | Allowed | Result | LDF | Load: Combination (Pattern) |
|---|---|---|---|---|---|
| Member Reaction (lbs) | 590 @ 5 1/2" | 911 (1.50") | Passed (65%) | -- | 1.0 D + 1.0 S (Alt Spans) |
| Shear (lbs) | 529 @ 1' 2 3/4" | 1596 | Passed (33%) | 1.15 | 1.0 D + 1.0 S (Alt Spans) |
| Moment (Ft-lbs) | 2177 @ 7' 10 1/16" | 2204 | Passed (99%) | 1.15 | 1.0 D + 1.0 S (Alt Spans) |
| Live Load Defl. (in) | 0.433 @ 7' 11 5/16" | 0.501 | Passed (L/417) | -- | 1.0 D + 1.0 S (Alt Spans) |
| Total Load Defl. (in) | 0.684 @ 7' 11 3/16" | 0.752 | Passed (L/264) | -- | 1.0 D + 1.0 S (Alt Spans) |

System : Roof
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD
Member Pitch: 0/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Overhang deflection criteria: LL (2L/360) and TL (2L/240).
- Top Edge Bracing (Lu): Top compression edge must be braced at 1' o/c unless detailed otherwise.
- Bottom Edge Bracing (Lu): Bottom compression edge must be braced at 17' 7" o/c unless detailed otherwise.
- A 15% increase in the moment capacity has been added to account for repetitive member usage.
- Upward deflection on right cantilever exceeds overhang deflection criteria.
- Applicable calculations are based on NDS.

| | Bearing | | | Loads to Supports (lbs) | | | |
|---|---|---|---|---|---|---|---|
| **Supports** | Total | Available | Required | Dead | Snow | Total | Accessories |
| 1 - Hanger on 9 1/4" GLB beam | 5.50" | Hanger[1] | 1.50" | 233 | 394 | 627 | See note [1] |
| 2 - Stud wall - SPF | 12.00" | 12.00" | 1.50" | 307 | 511 | 818 | Blocking |

- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.
- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- [1] See Connector grid below for additional information and/or requirements.

**Connector: Simpson Strong-Tie Connectors**

| Support | Model | Seat Length | Top Nails | Face Nails | Member Nails | Accessories |
|---|---|---|---|---|---|---|
| 1 - Face Mount Hanger | Connector not found | N/A | N/A | N/A | N/A | |

| Loads | Location (Side) | Spacing | Dead (0.90) | Snow (1.15) | Comments |
|---|---|---|---|---|---|
| 1 - Uniform (PSF) | 0 to 18' | 24" | 15.0 | 25.0 | Roof |

**Weyerhaeuser Notes**



| Forte Software Operator | Job Notes |
|---|---|
| Brian Lampe<br>BTL Engineering, P.S.<br>(425) 814-8448<br>brian.lampe@btleng.net | |

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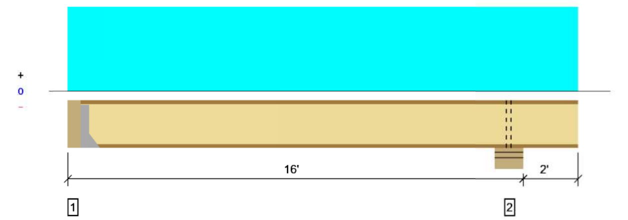
**FORTE** MEMBER REPORT *2nd Floor/Main Roof, RJ-01 (TJIs)* **PASSED**

## 1 piece(s) 9 1/2" TJI® 110 @ 24" OC

Overall Length: 18'




All locations are measured from the outside face of left support (or left cantilever end).All dimensions are horizontal.;Drawing is Conceptual

| Design Results | Actual @ Location | Allowed | Result | LDF | Load: Combination (Pattern) |
|---|---|---|---|---|---|
| Member Reaction (lbs) | 590 @ 5 1/2" | 1047 (1.75") | Passed (56%) | 1.15 | 1.0 D + 1.0 S (Alt Spans) |
| Shear (lbs) | 590 @ 5 1/2" | 1403 | Passed (42%) | 1.15 | 1.0 D + 1.0 S (Alt Spans) |
| Moment (Ft-lbs) | 2177 @ 7' 10 1/16" | 2875 | Passed (76%) | 1.15 | 1.0 D + 1.0 S (Alt Spans) |
| Live Load Defl. (in) | 0.386 @ 7' 11 5/16" | 0.501 | Passed (L/467) | -- | 1.0 D + 1.0 S (Alt Spans) |
| Total Load Defl. (in) | 0.611 @ 7' 11 3/16" | 0.752 | Passed (L/295) | -- | 1.0 D + 1.0 S (Alt Spans) |

System : Roof
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD
Member Pitch: 0/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Overhang deflection criteria: LL (2L/360) and TL (2L/240).
- Top Edge Bracing (Lu): Top compression edge must be braced at 3' 4" o/c unless detailed otherwise.
- Bottom Edge Bracing (Lu): Bottom compression edge must be braced at 7' 4" o/c unless detailed otherwise.
- Upward deflection on right cantilever exceeds overhang deflection criteria.

| | Bearing | | | Loads to Supports (lbs) | | | |
|---|---|---|---|---|---|---|---|
| **Supports** | Total | Available | Required | Dead | Snow | Total | Accessories |
| 1 - Hanger on 9 1/2" GLB beam | 5.50" | Hanger[1] | 1.75" / - [2] | 233 | 394 | 627 | See note [1] |
| 2 - Stud wall - SPF | 12.00" | 12.00" | 3.50" | 307 | 511 | 818 | Blocking |

- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.
- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- [1] See Connector grid below for additional information and/or requirements.
- [2] Required Bearing Length / Required Bearing Length with Web Stiffeners

**Connector: Simpson Strong-Tie Connectors**

| Support | Model | Seat Length | Top Nails | Face Nails | Member Nails | Accessories |
|---|---|---|---|---|---|---|
| 1 - Face Mount Hanger | IUS1.81/9.5 | 2.00" | N/A | 8-10d | 2-Strong-Grip | None |

| Loads | Location (Side) | Spacing | Dead (0.90) | Snow (1.15) | Comments |
|---|---|---|---|---|---|
| 1 - Uniform (PSF) | 0 to 18' | 24" | 15.0 | 25.0 | Roof |

**Weyerhaeuser Notes**



| Forte Software Operator | Job Notes |
|---|---|
| Brian Lampe<br>BTL Engineering, P.S.<br>(425) 814-8448<br>brian.lampe@btleng.net | |

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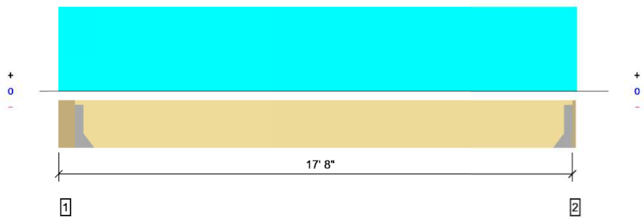
Forte v5.4, Design Engine: V7.1.1.3
*Munson.4te*

FORTE® MEMBER REPORT *2nd Floor/Main Roof, RJ-02 (dimensional)*

**PASSED**

**1 piece(s) 2 x 10 Hem-Fir No. 2 @ 16" OC**

Overall Length: 17' 9 1/2"




All locations are measured from the outside face of left support (or left cantilever end).All dimensions are horizontal.;Drawing is Conceptual

| Design Results | Actual @ Location | Allowed | Result | LDF | Load: Combination (Pattern) |
|---|---|---|---|---|---|
| Member Reaction (lbs) | 456 @ 7" | 911 (1.50") | Passed (50%) | -- | 1.0 D + 1.0 S (All Spans) |
| Shear (lbs) | 414 @ 1' 4 1/4" | 1596 | Passed (26%) | 1.15 | 1.0 D + 1.0 S (All Spans) |
| Moment (Ft-lbs) | 1946 @ 9' 1 1/2" | 2204 | Passed (88%) | 1.15 | 1.0 D + 1.0 S (All Spans) |
| Live Load Defl. (in) | 0.497 @ 9' 1 1/2" | 0.569 | Passed (L/413) | -- | 1.0 D + 1.0 S (All Spans) |
| Total Load Defl. (in) | 0.795 @ 9' 1 1/2" | 0.854 | Passed (L/258) | -- | 1.0 D + 1.0 S (All Spans) |

System : Roof
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD
Member Pitch: 0/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Top Edge Bracing (Lu): Top compression edge must be braced at 4' 1" o/c unless detailed otherwise.
- Bottom Edge Bracing (Lu): Bottom compression edge must be braced at 17' 1" o/c unless detailed otherwise.
- A 15% increase in the moment capacity has been added to account for repetitive member usage.
- Applicable calculations are based on NDS.

| Supports | Bearing | | | Loads to Supports (lbs) | | | Accessories |
|---|---|---|---|---|---|---|---|
| | Total | Available | Required | Dead | Snow | Total | |
| 1 - Hanger on 9 1/4" PSL beam | 7.00" | Hanger[1] | 1.50" | 183 | 304 | 487 | See note [1] |
| 2 - Hanger on 9 1/4" SPF beam | 1.50" | Hanger[1] | 1.50" | 173 | 289 | 462 | See note [1] |

- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- [1] See Connector grid below for additional information and/or requirements.

**Connector: Simpson Strong-Tie Connectors**

| Support | Model | Seat Length | Top Nails | Face Nails | Member Nails | Accessories |
|---|---|---|---|---|---|---|
| 1 - Face Mount Hanger | Connector not found | N/A | N/A | N/A | N/A | |
| 2 - Face Mount Hanger | Connector not found | N/A | N/A | N/A | N/A | |

| Loads | Location (Side) | Spacing | Dead (0.90) | Snow (1.15) | Comments |
|---|---|---|---|---|---|
| 1 - Uniform (PSF) | 0 to 17' 9 1/2" | 16" | 15.0 | 25.0 | Roof |

**Weyerhaeuser Notes**

SUSTAINABLE FORESTRY INITIATIVE

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The product application, input design loads, dimensions and support information have been provided by Forte Software Operator

| Forte Software Operator | Job Notes |
|---|---|
| Brian Lampe<br>BTL Engineering, P.S.<br>(425) 814-8448<br>brian.lampe@btleng.net | |

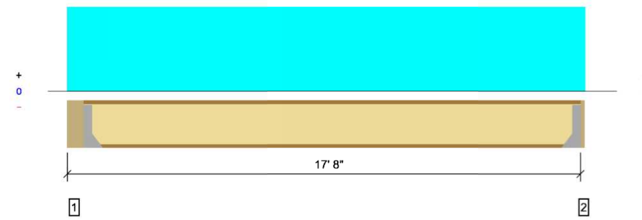


FORTE® MEMBER REPORT *2nd Floor/Main Roof, RJ-02 (TJIs)*

**PASSED**

**1 piece(s) 9 1/2" TJI® 110 @ 16" OC**

Overall Length: 17' 9 3/4"




All locations are measured from the outside face of left support (or left cantilever end).All dimensions are horizontal.;Drawing is Conceptual

| Design Results | Actual @ Location | Allowed | Result | LDF | Load: Combination (Pattern) |
|---|---|---|---|---|---|
| Member Reaction (lbs) | 456 @ 7" | 1047 (1.75") | Passed (44%) | 1.15 | 1.0 D + 1.0 S (All Spans) |
| Shear (lbs) | 456 @ 7" | 1403 | Passed (32%) | 1.15 | 1.0 D + 1.0 S (All Spans) |
| Moment (Ft-lbs) | 1946 @ 9' 1 1/2" | 2875 | Passed (68%) | 1.15 | 1.0 D + 1.0 S (All Spans) |
| Live Load Defl. (in) | 0.434 @ 9' 1 1/2" | 0.569 | Passed (L/472) | -- | 1.0 D + 1.0 S (All Spans) |
| Total Load Defl. (in) | 0.695 @ 9' 1 1/2" | 0.854 | Passed (L/295) | -- | 1.0 D + 1.0 S (All Spans) |

System : Roof
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD
Member Pitch: 0/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Top Edge Bracing (Lu): Top compression edge must be braced at 3' 6" o/c unless detailed otherwise.
- Bottom Edge Bracing (Lu): Bottom compression edge must be braced at 17' 1" o/c unless detailed otherwise.

| Supports | Bearing | | | Loads to Supports (lbs) | | | Accessories |
|---|---|---|---|---|---|---|---|
| | Total | Available | Required | Dead | Snow | Total | |
| 1 - Hanger on 9 1/2" PSL beam | 7.00" | Hanger[1] | 1.75" / - [2] | 183 | 304 | 487 | See note [1] |
| 2 - Hanger on 9 1/2" LSL beam | 1.75" | Hanger[1] | 1.75" / - [2] | 174 | 290 | 464 | See note [1] |

- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- [1] See Connector grid below for additional information and/or requirements.
- [2] Required Bearing Length / Required Bearing Length with Web Stiffeners

**Connector: Simpson Strong-Tie Connectors**

| Support | Model | Seat Length | Top Nails | Face Nails | Member Nails | Accessories |
|---|---|---|---|---|---|---|
| 1 - Face Mount Hanger | IUS1.81/9.5 | 2.00" | N/A | 8-10d | 2-Strong-Grip | None |
| 2 - Face Mount Hanger | IUS1.81/9.5 | 2.00" | N/A | 8-10dx1.5 | 2-Strong-Grip | None |

| Loads | Location (Side) | Spacing | Dead (0.90) | Snow (1.15) | Comments |
|---|---|---|---|---|---|
| 1 - Uniform (PSF) | 0 to 17' 9 3/4" | 16" | 15.0 | 25.0 | Roof |

**Weyerhaeuser Notes**

SUSTAINABLE FORESTRY INITIATIVE


Weyerhaeuser warrants that the sizing of its products will be in accordance with Weyerhaeuser product design criteria and published design values. Weyerhaeuser expressly disclaims any other warranties related to the software. Use of this software is not intended to circumvent the need for a design professional as determined by the authority having jurisdiction. The designer of record, builder or framer is responsible to assure that this calculation is compatible with the overall project. Accessories (Rim Board, Blocking Panels and Squash Blocks) are not designed by this software. Products manufactured at Weyerhaeuser facilities are third-party certified to sustainable forestry standards. Weyerhaeuser Engineered Lumber Products have been evaluated by ICC ES under technical reports ESR-1153 and ESR-1387 and/or tested in accordance with applicable ASTM standards. For current code evaluation reports, Weyerhaeuser product literature and installation details refer to www.weyerhaeuser.com/woodproducts/document-library.

The product application, input design loads, dimensions and support information have been provided by Forte Software Operator


| Forte Software Operator | Job Notes |
|---|---|
| Brian Lampe<br>BTL Engineering, P.S.<br>(425) 814-8448<br>brian.lampe@btleng.net | |

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## RB- 01

M = 2.10 k.ft

V =

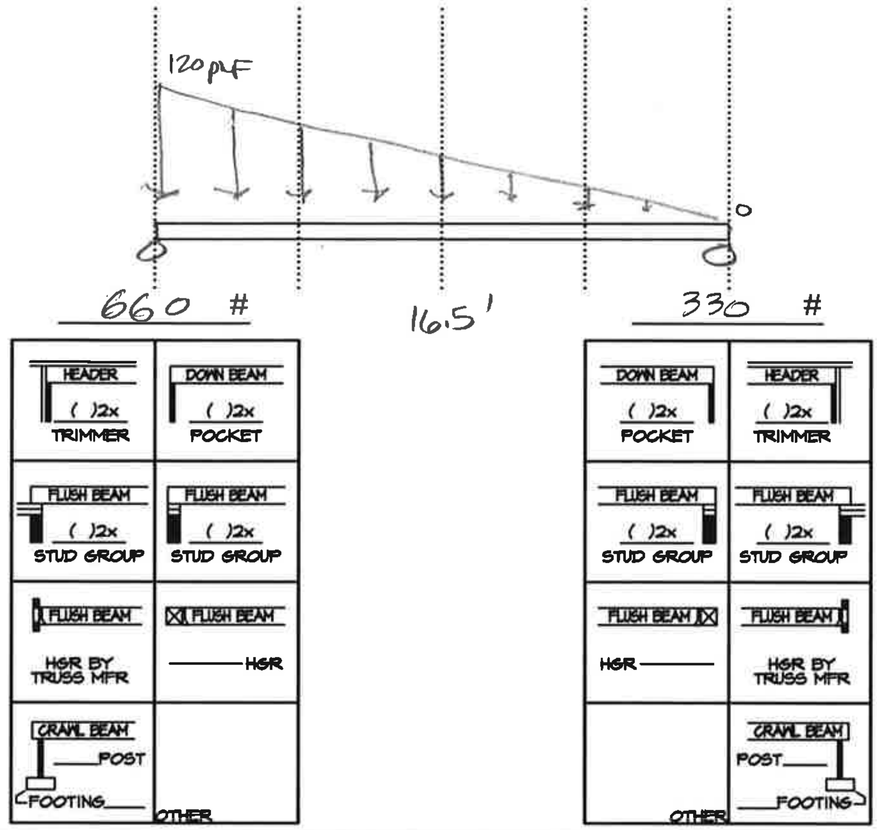
L/360 = 0.55" (LL)

L/240 = 0.83" (TL)

$EI_{req'd}$ = 83 $\times 10^6$ lb.in$^2$

(2) 2x10

OR 1 3/4 x 9 1/2 LSL




## RB- 02

M = 0.90 k.ft

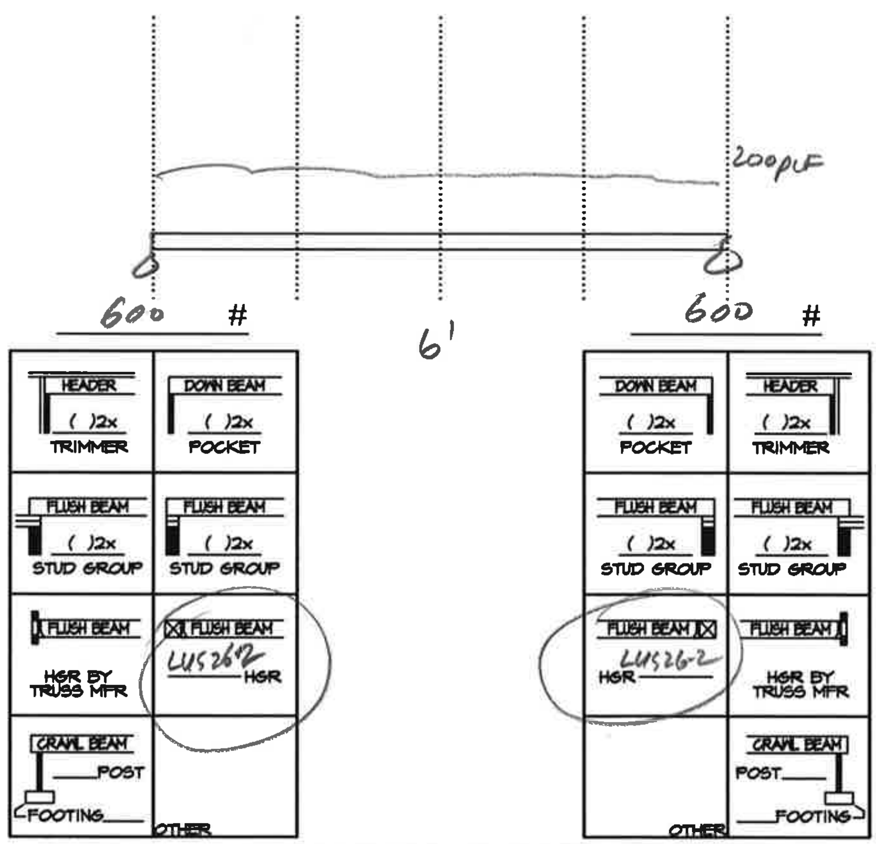
V =

L/360 = 0.20" (LL)

L/240 = 0.30" (TL)

$EI_{req'd}$ = 19 $\times 10^6$ lb.in$^2$

(2) 2x10

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Project Number:  Client:  Scale:  Page: R2.3

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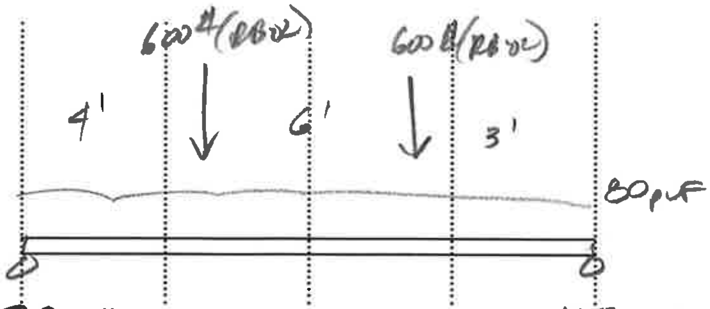
## RB-03

M = 3.80 k.ft

V =




1070 #

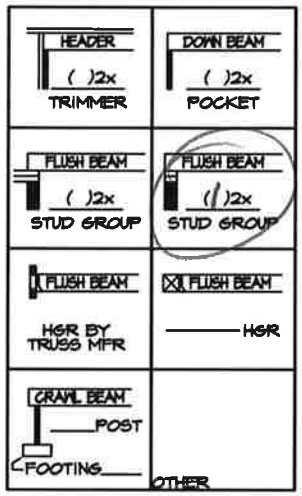
13'

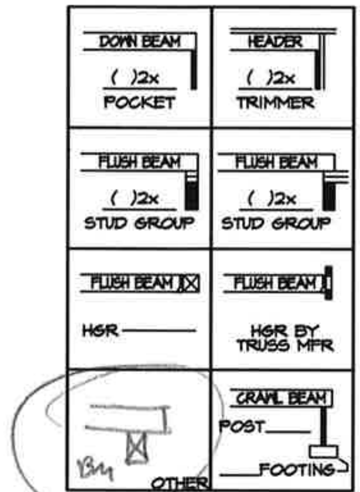
1170 #

L/360 = 0.43" (LL)

L/240 = 0.65" (TL)

$EI_{req'd}$ = 185 $\times 10^6$ lb.in$^2$



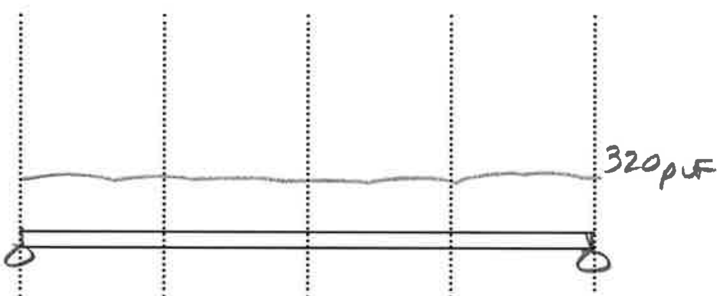




(2) 2x10

## RB-04

M = 6.76 k.ft

V =




2080 #

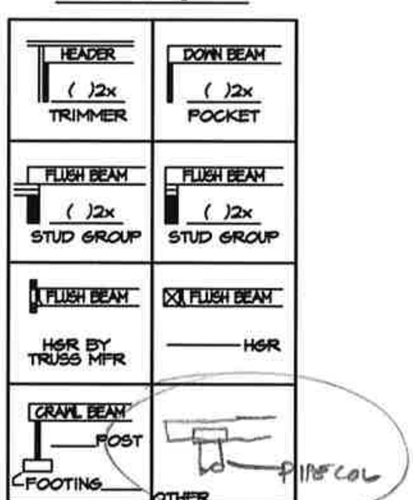
13'

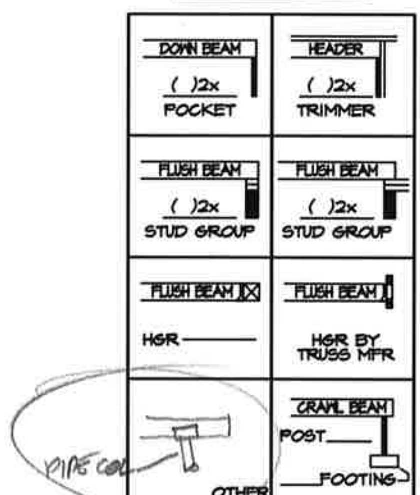
2080 #

L/360 = 0.43" (LL)

L/240 = 0.65" (TL)

$EI_{req'd}$ = 316 $\times 10^6$ lb.in$^2$




6x10 DF#2

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## RB-05

M = 29.40 k.ft

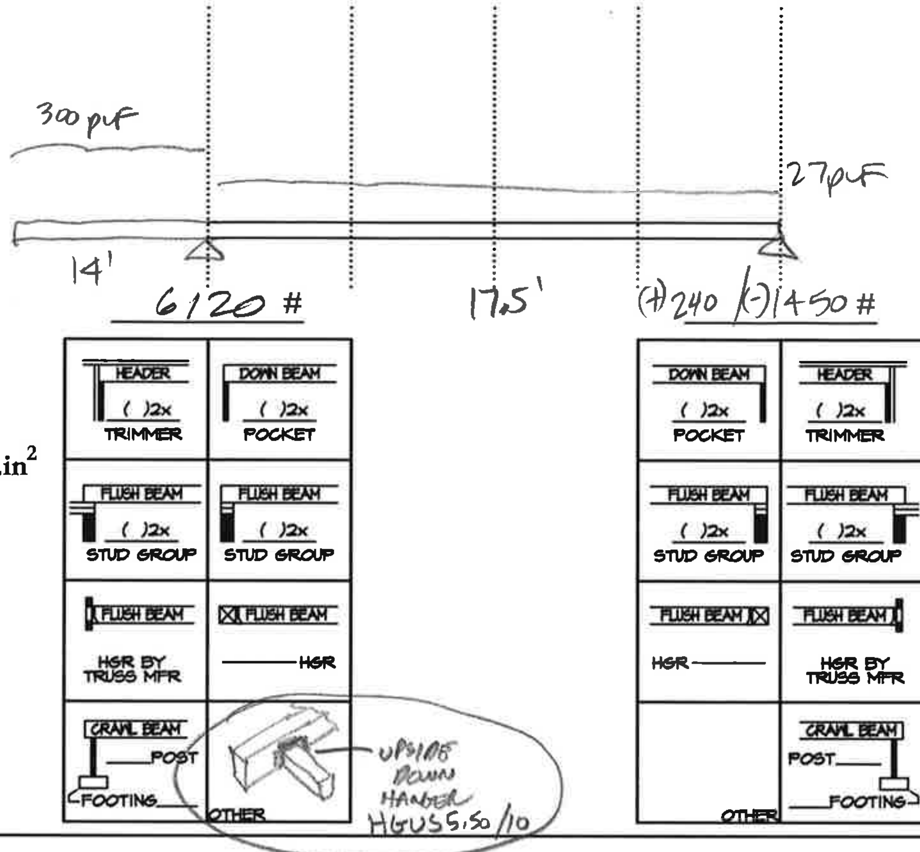
V = ______

L/360 = 0.93"/0.58" (LL)

L/240 = 1.40"/0.88" (TL)

$EI_{req'd}$ = 5700 $\times 10^6$ lb.in$^2$

5½x19½GLB




## RB-06

M = 35.48 k.ft

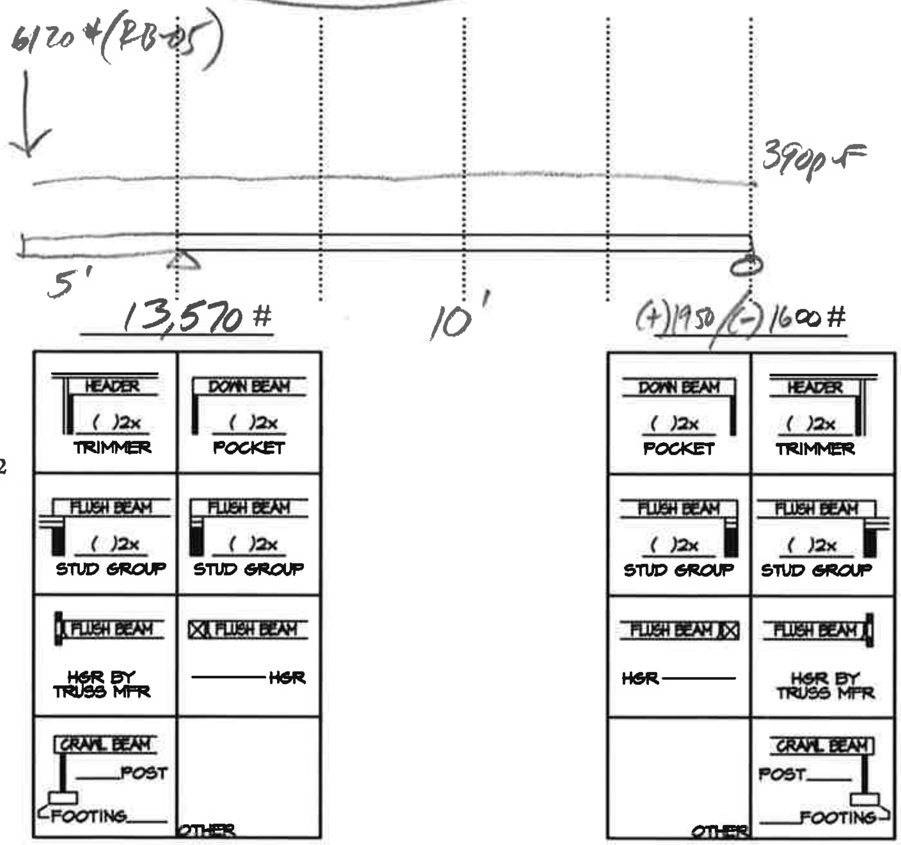
V = ______

L/360 = 0.33"/0.33" (LL)

L/240 = 0.50"/0.50" (TL)

$EI_{req'd}$ = 2840 $\times 10^6$ lb.in$^2$

7x14 PSL

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## RB-07

M = 4.34 k.ft

V = 

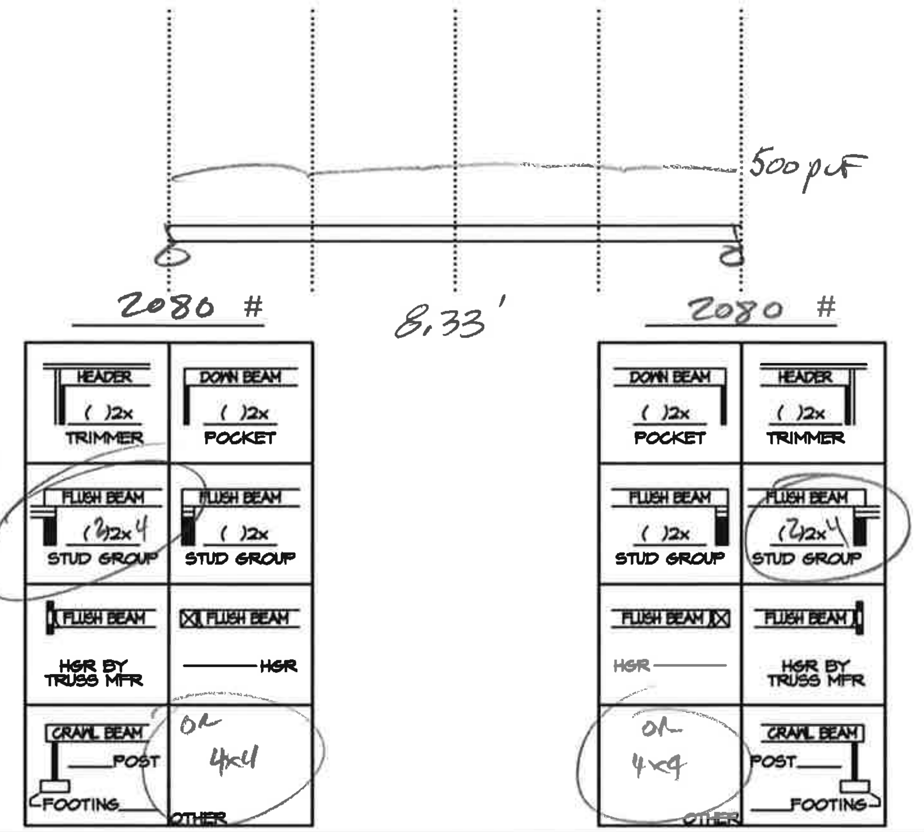
L/360 = 0.28" (LL)

L/240 = 0.42" (TL)

$EI_{req'd}$ = 130 $\times 10^6$ lb.in$^2$

4x10 OR

3½x9½LSL




## RB-08

M = 2.21 k.ft

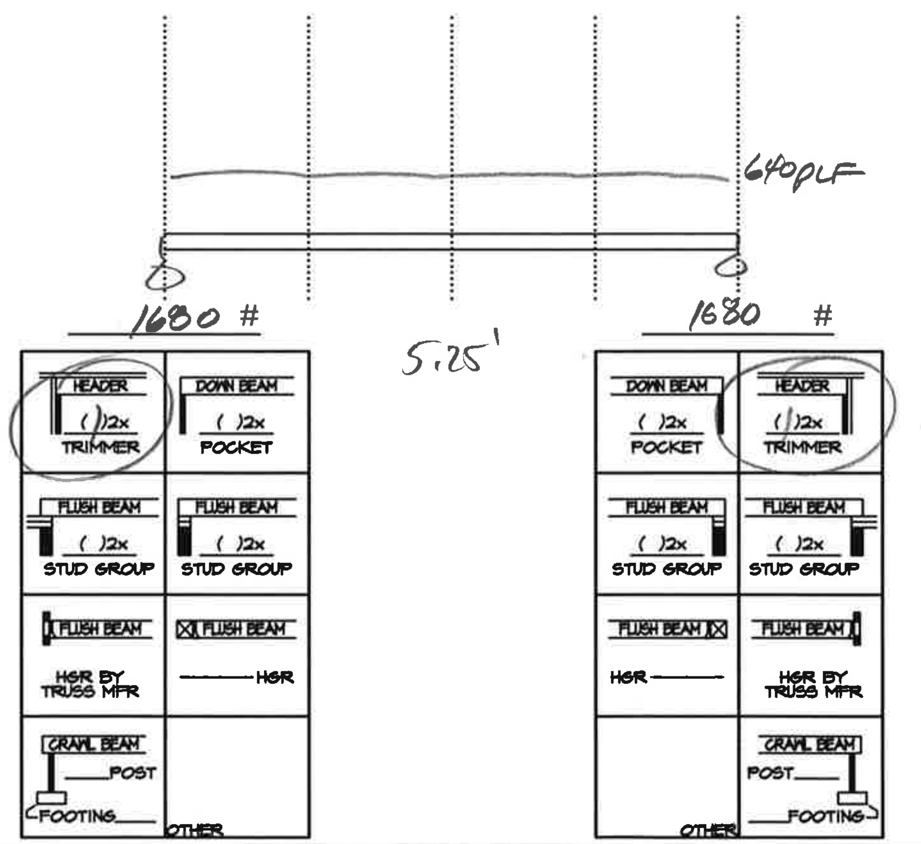
V = 

L/360 = 0.18 (LL)

L/240 = 0.26 (TL)

$EI_{req'd}$ = 42 $\times 10^6$ lb.in$^2$

4x8

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## RB- 09

M = 9.21 k.ft

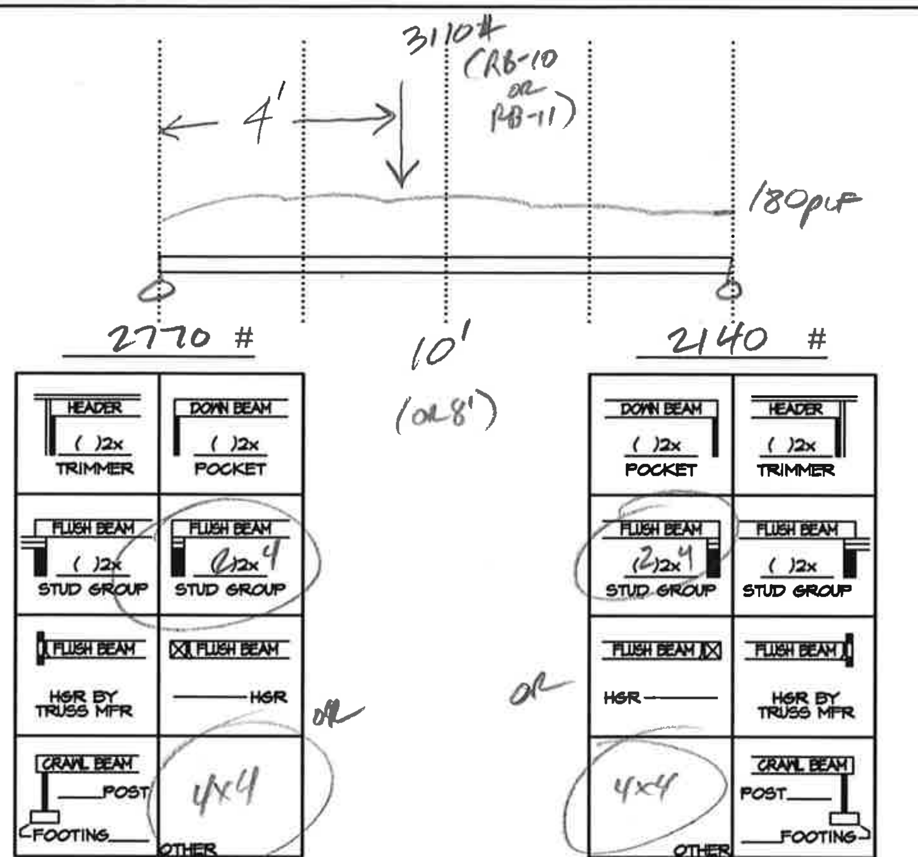
V =

L/360 = 0.33 (LL)

L/240 = 0.50 (TL)

$EI_{req'd}$ = 292 $\times 10^6$ lb.in$^2$

3½x9 GLB




## RB- 10

M = 17.40 k.ft

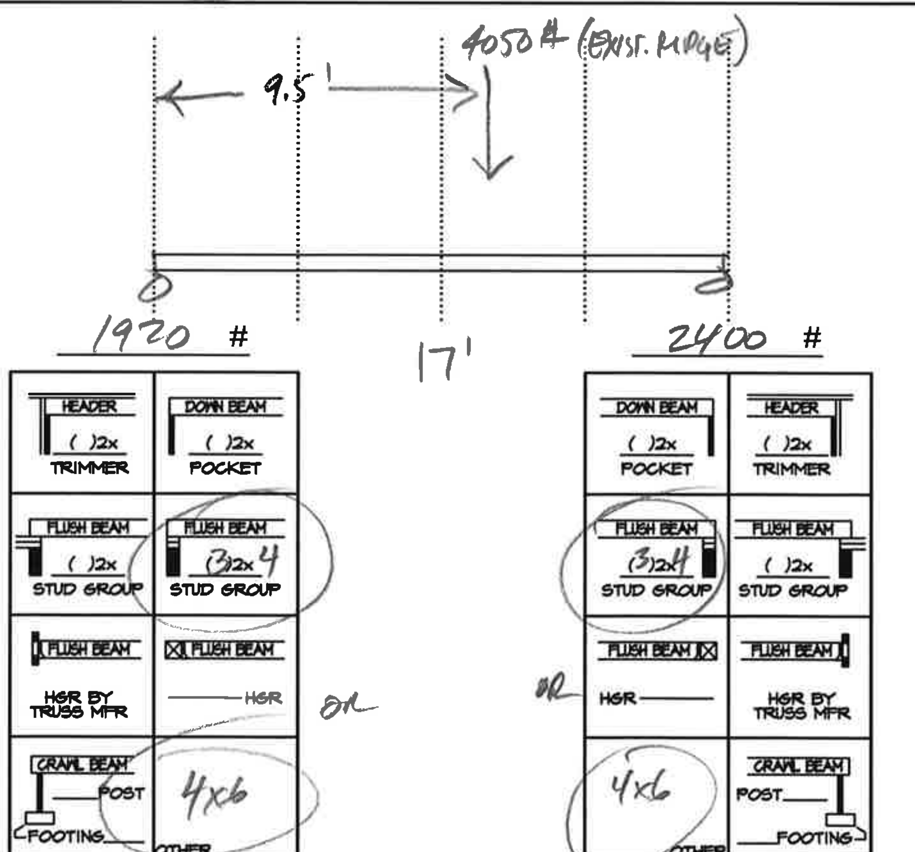
V =

L/360 = 0.57" (LL)

L/240 = 0.85" (TL)

$EI_{req'd}$ = 861 $\times 10^6$ lb.in$^2$

5⅛x10½GLB
or 5½x10½ GLB

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Project Number: Client: Scale: Page: R2.7

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RB- 11

M = 16.81 k.ft

V =

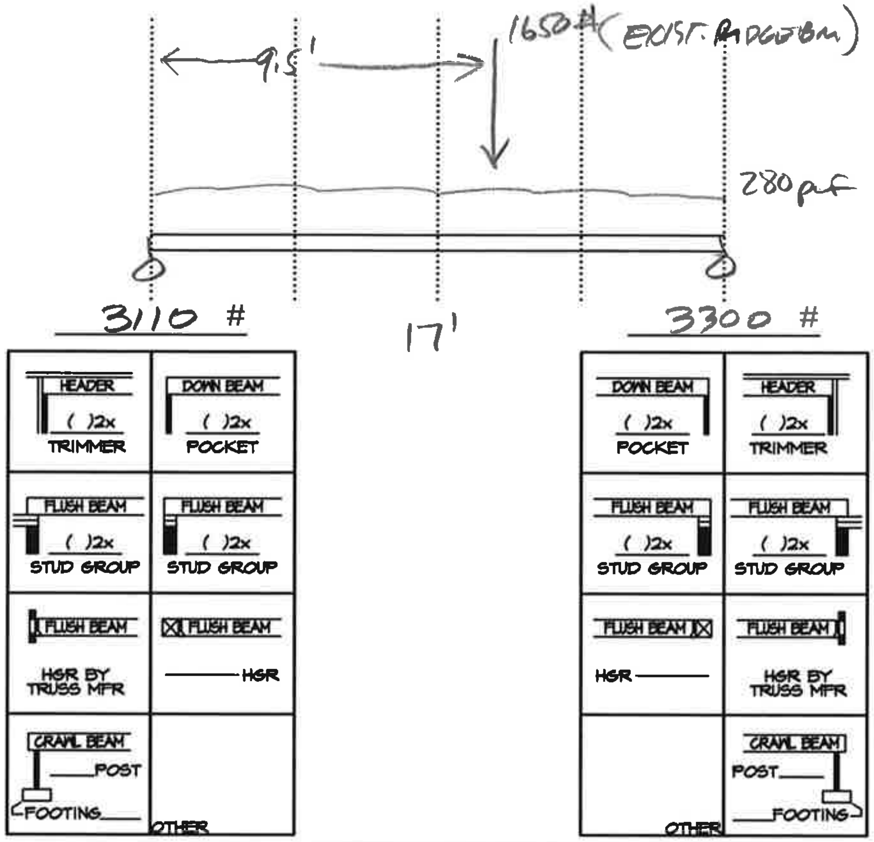
L/360 = 0.57" (LL)

L/240 = 0.85" (TL)

$EI_{req'd}$ = 956 $x10^6 lb.in^2$

5 1/8 x 10 1/2 GLB

OR 5 1/2 x 10 1/2 GLB




RB-

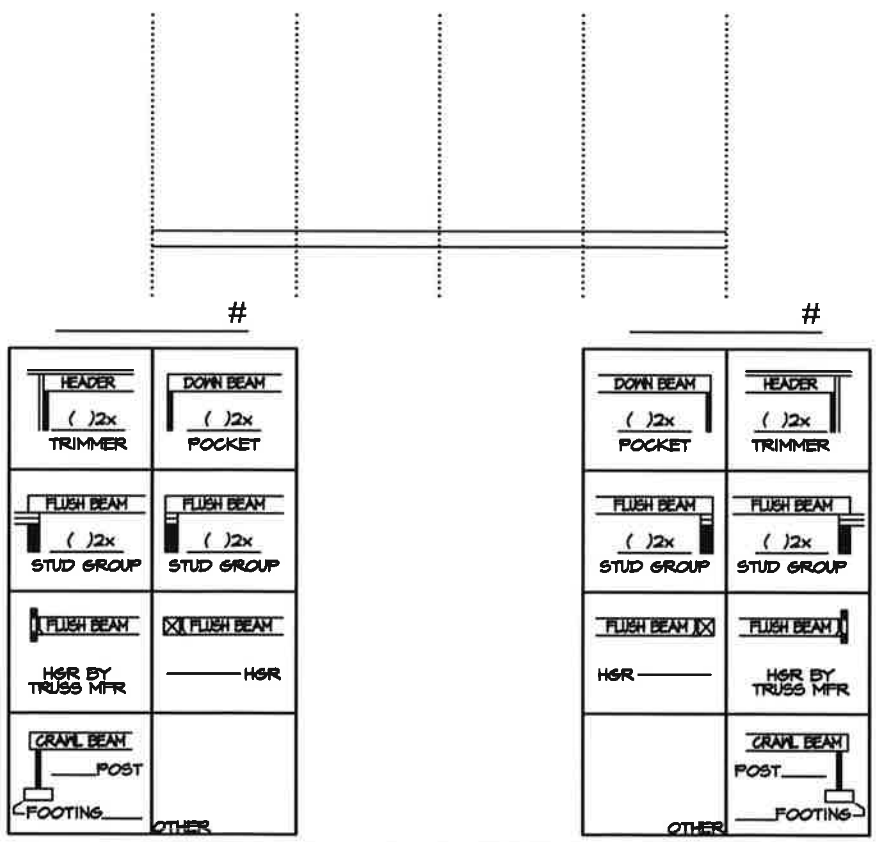
M = k.ft

V =

L/360 = (LL)

L/240 = (TL)

$EI_{req'd}$ = $x10^6 lb.in^2$

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Project Number: Client: Scale: Page: R2.8

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# Gravity

Main Floor Framing


MAIN FLOOR FRAMING

KEY PLAN

MF1.1

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## MJ-01 (TYP)

M = 1.92 k.ft

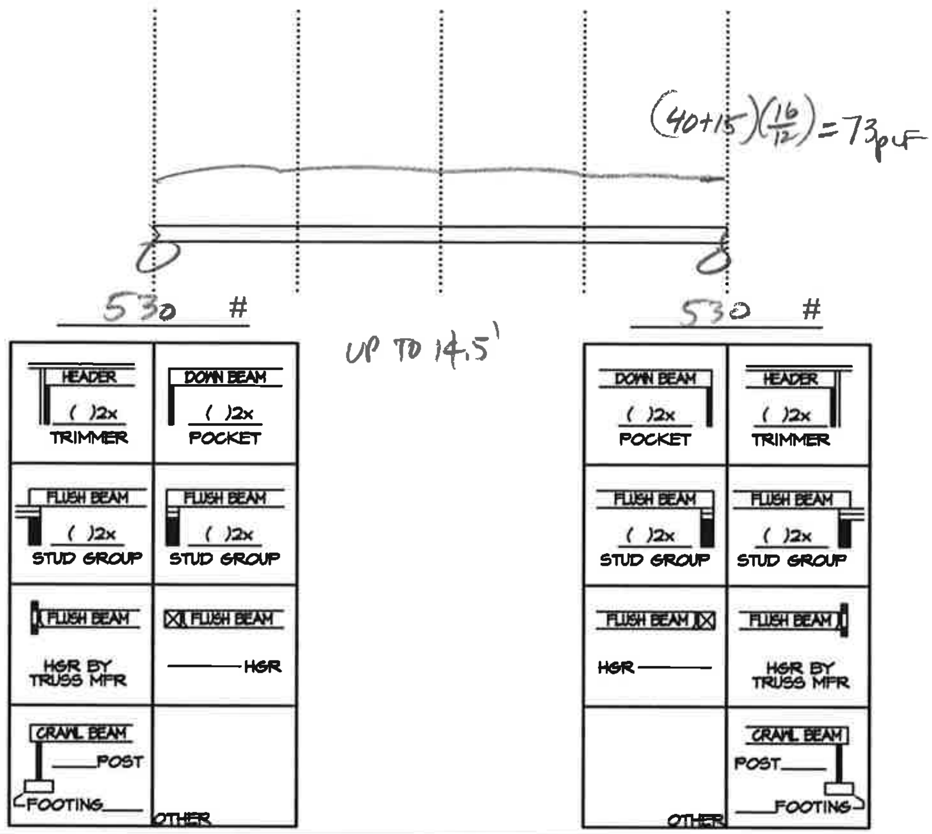
V = ______

$L/480$ = 0.36" (LL)

$L/240$ = 0.73" (TL)

$EI_{req'd}$ = 146 $\times 10^6$ lb.in$^2$

2x10 @ 16" oc




## MJ-02

M = 0.56 k.ft

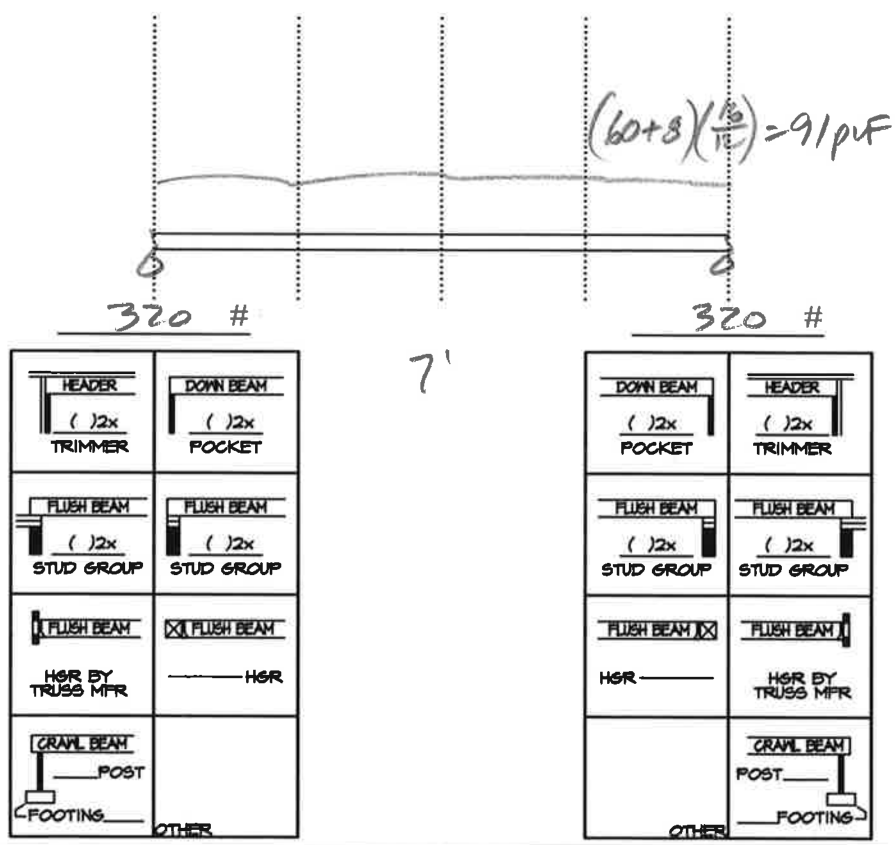
V = ______

$L/480$ = 0.18" (LL)

$L/240$ = 0.35" (TL)

$EI_{req'd}$ = 25 $\times 10^6$ lb.in$^2$

P.T. 2x6 @ 16" oc

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Project Number: ______ Client: ______ Scale: ______ Page: MF2.1

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## MJ-03

M = 3.37 k.ft

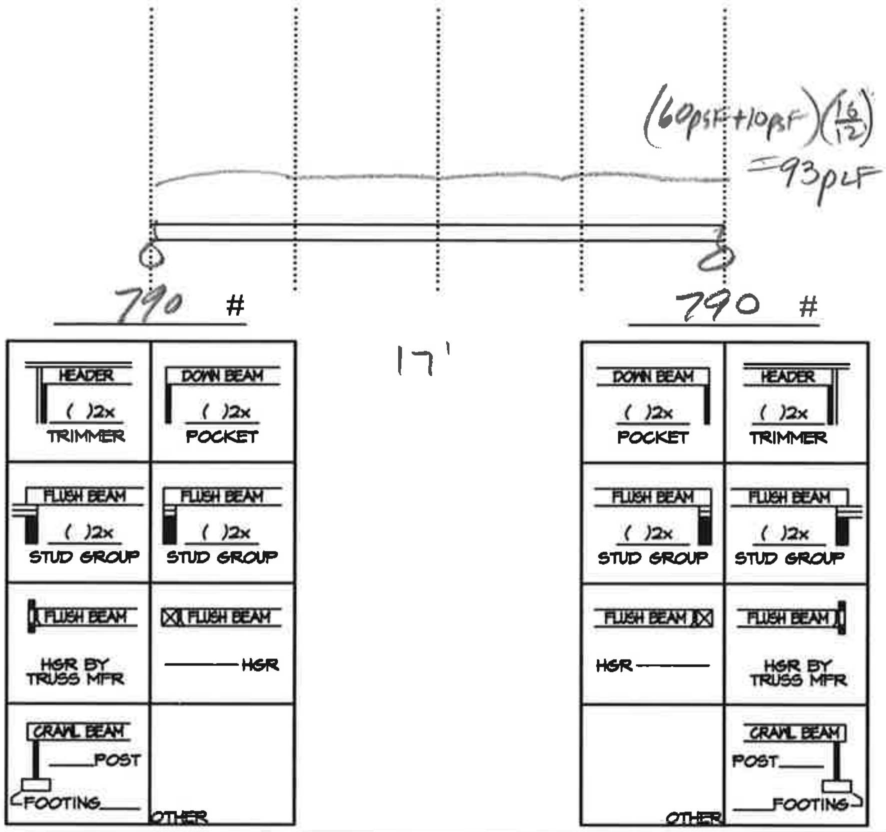
V =

L/480 = 0.43 (LL)

L/240 = 0.85 (TL)

$EI_{req'd}$ = 354 $\times 10^6$ lb.in$^2$

(2)2x12 P.T. @16" oc




## MJ-

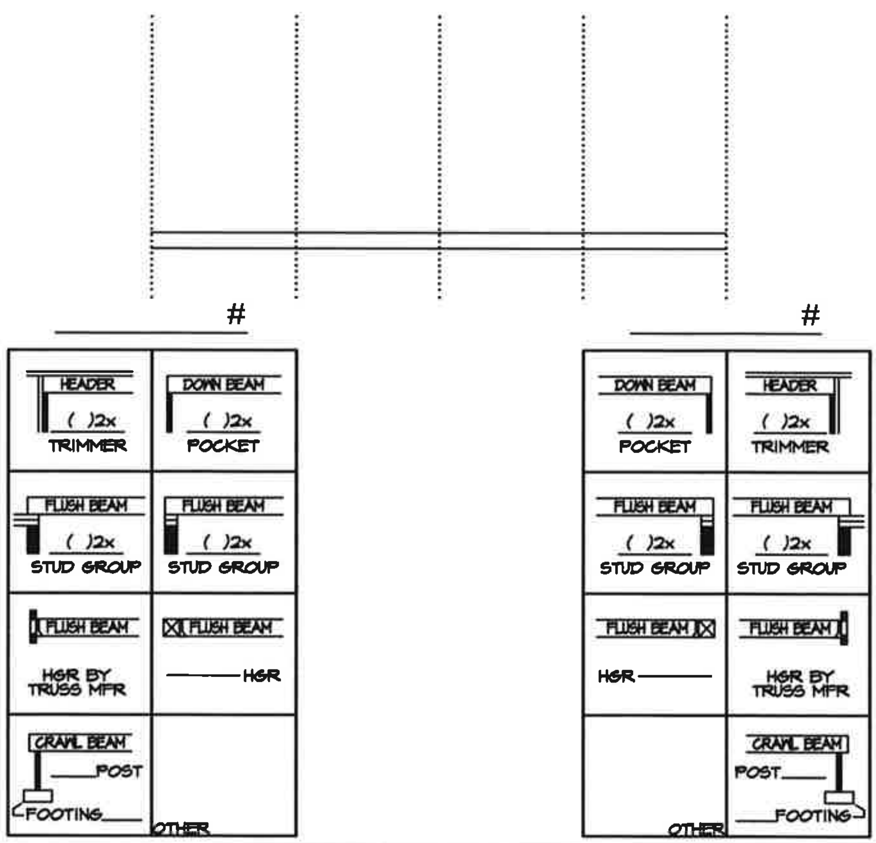
M = k.ft

V =

L/ = (LL)

L/240 = (TL)

$EI_{req'd}$ = $\times 10^6$ lb.in$^2$

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## MB-01

M = 6.67 k.ft

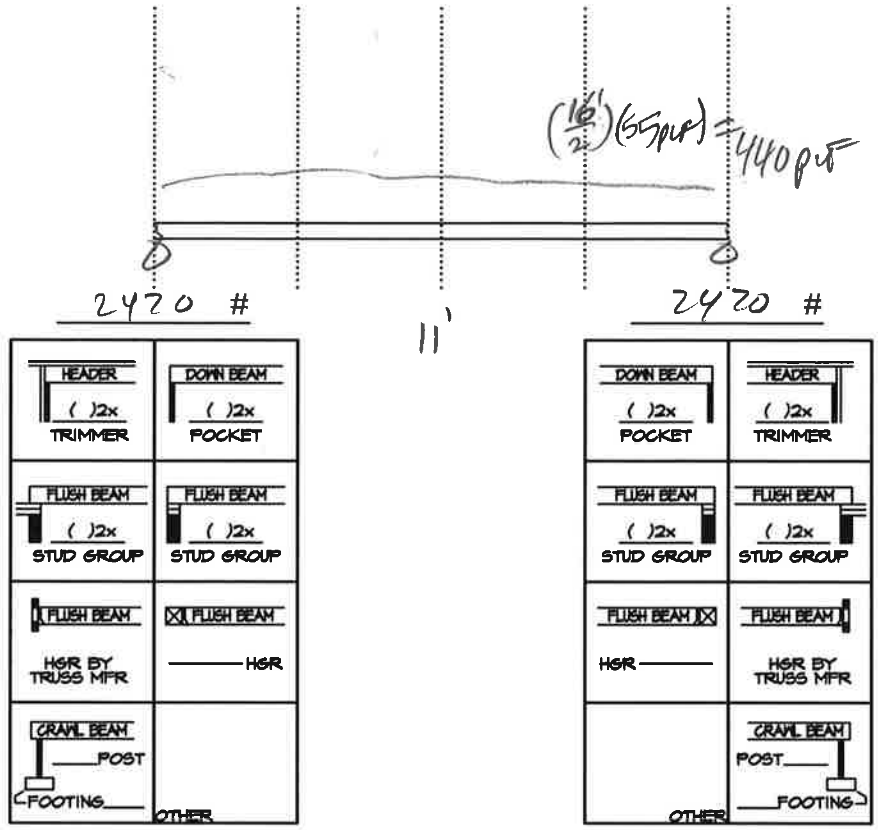
V = ______

L/480 = 0.28 (LL)

L/240 = 0.55 (TL)

$EI_{req'd}$ = 383 $\times 10^6$ lb.in$^2$

(2) 1 3/4 x 9 1/4 LVL




## MB-02

M = 2.86 k.ft

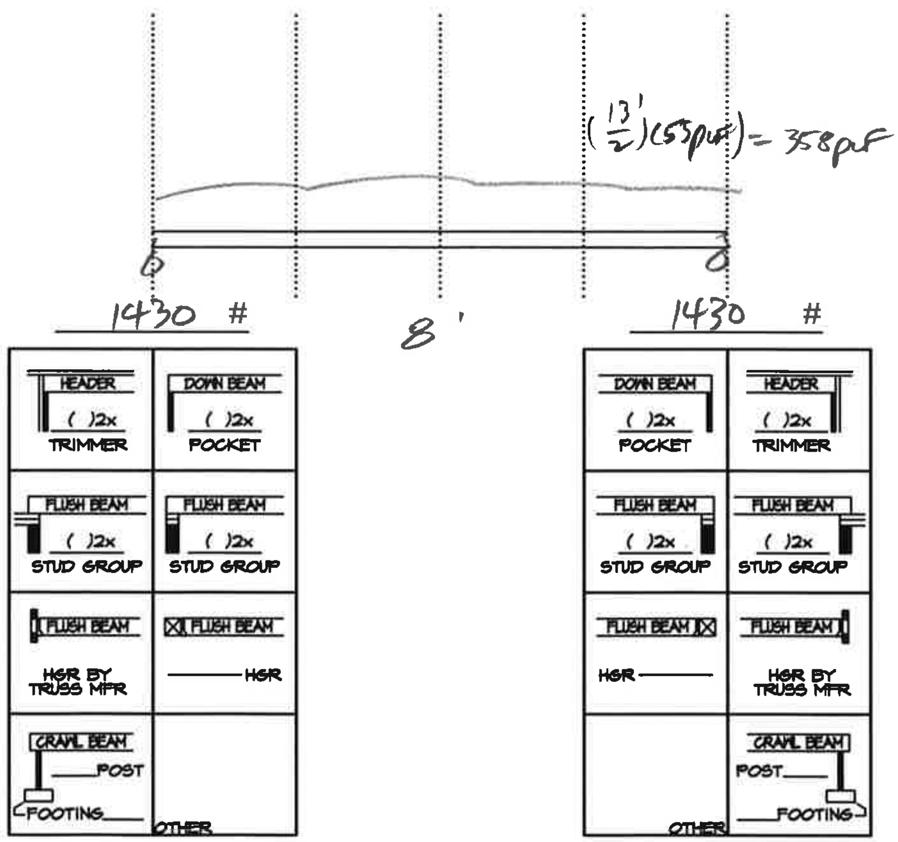
V = ______

L/480 = 0.20 (LL)

L/240 = 0.40 (TL)

$EI_{req'd}$ = 120 $\times 10^6$ lb.in$^2$

(2) 2x10

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Project Number: ______ Client: ______ Scale: ______ Page: MF23

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## MB-03

M = 5.85 k.ft

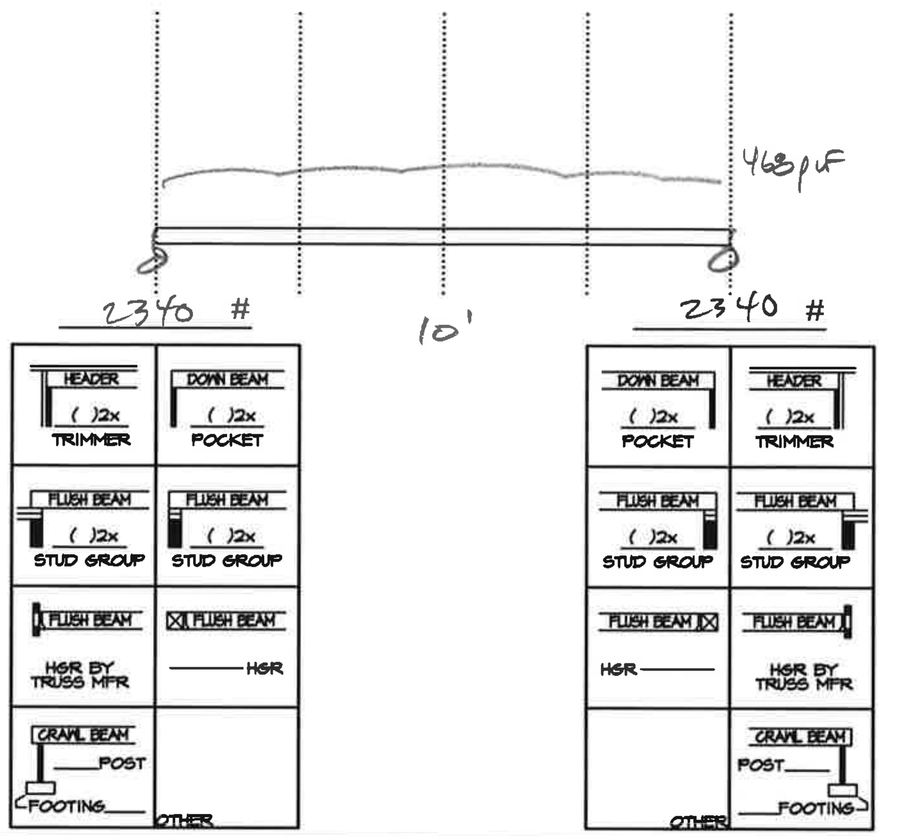
V = ____

L/480 = 0.25 (LL)

L/240 = 0.50 (TL)

$EI_{req'd}$ = 306 $\times 10^6$ lb.in$^2$

6x12 P.T.




## MB-04

M = 1.68 k.ft

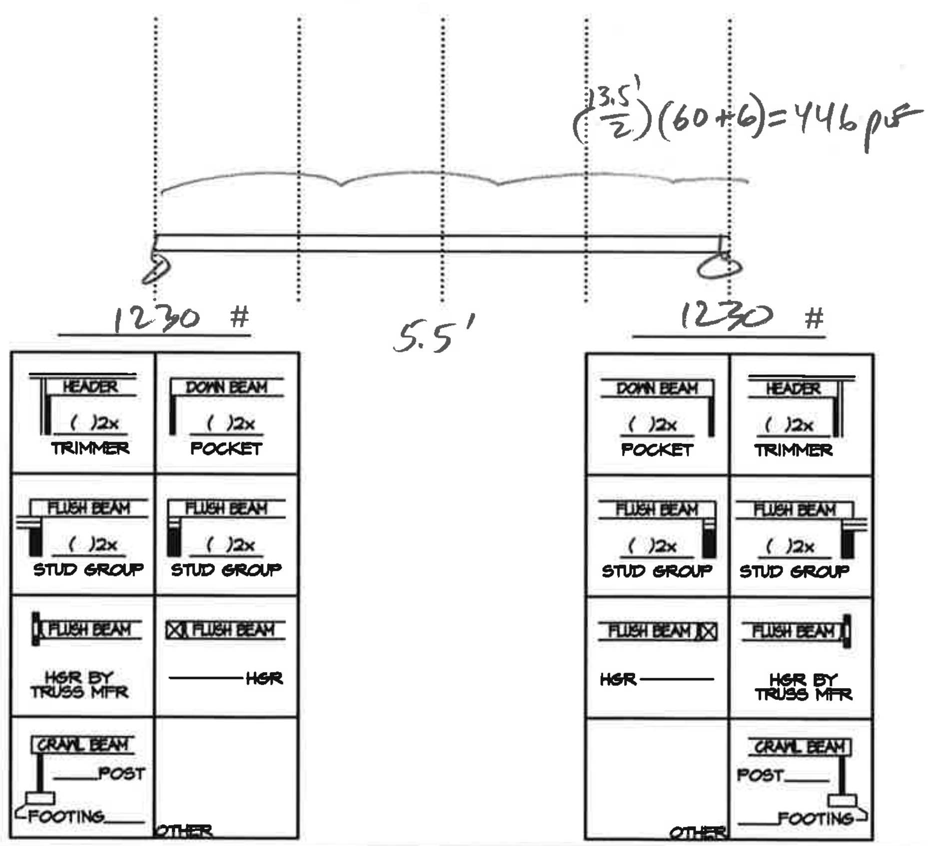
V = ____

L/480 = 0.14 (LL)

L/240 = 0.28 (TL)

$EI_{req'd}$ = 61 $\times 10^6$ lb.in$^2$

4x6 P.T.

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## MB-05

M = 1.00 k.ft

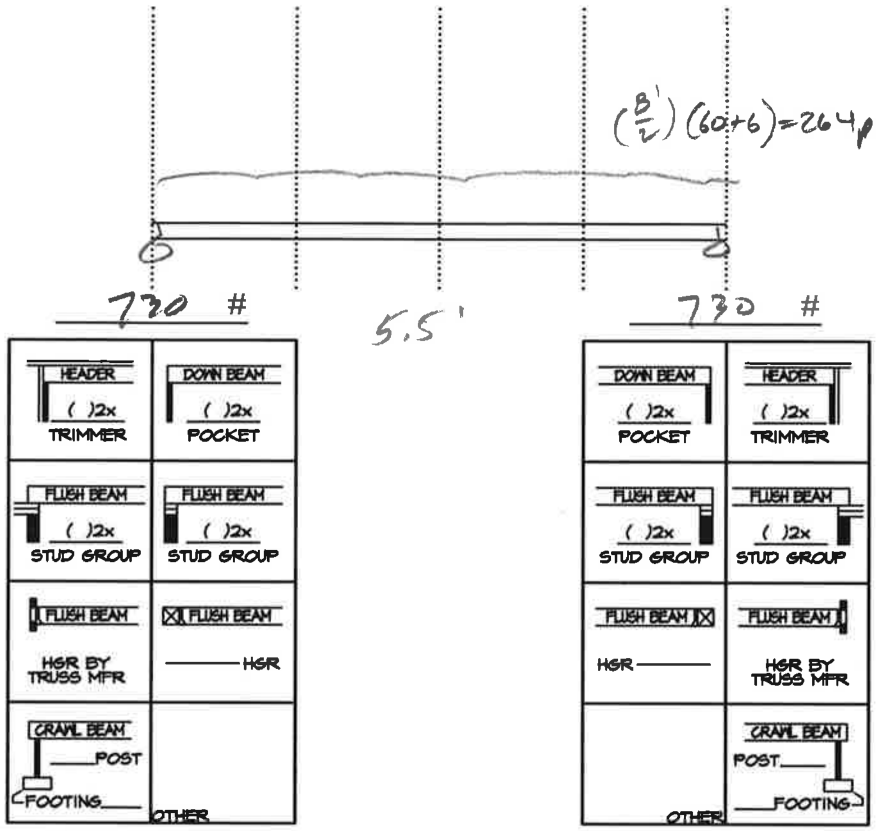
V = ______

L/480 = 0.14 (LL)

L/240 = 0.28 (TL)

$EI_{req'd}$ = 36 $\times 10^6$ lb.in$^2$

4x6 P.T.




## MB-06 [OPTIONAL]

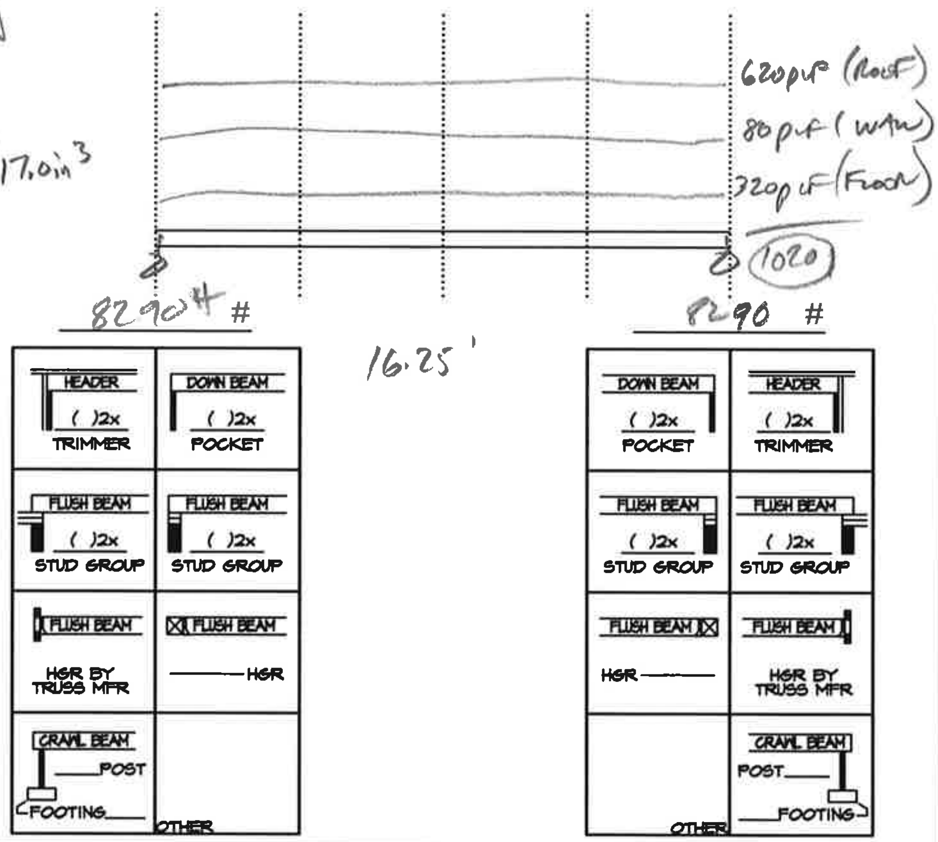
M = 33.67 k.ft [STEEL]
→ $S_{REQ'D} = 17.0 in^3$

V = ______

L/480 = 0.41 (LL)
L/360 = 0.54
L/240 = 0.81 (TL)

$EI_{req'd}$ = 2150 $\times 10^6$ lb.in$^2$
→ $I_{REQ'D} = 74 in^4$
[STEEL]

W8x21
or 5 1/2 x 15 GLB

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# Lateral

Forces

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Munson Residence
4628 Forest Avenue SE

Revision Date: 1/25/2019

**Criteria**

| | | | |
|---|---|---|---|
| **Code:** | 2015 IBC | | |
| | Allowable Stress Design (ASD) | | |
| **Seismic Design:** | **ASCE 7-10: 12.8 Equivalent Lateral Force Procedure** | | |
| **Wind Design:** | **ASCE 7-10: Ch. 28.5 Envelope Low-Rise** | | |
| **Risk Category:** | II - Other Structures | | *Table 1.5-1* |
| Snow Importance Factor | $I_S$ = | 1.00 | *Table 1.5-2* |
| Ice Importance Factor - Thickness | $I_i$ = | 1.00 | *Table 1.5-2* |
| Ice Importance Factor - Wind | $I_w$ = | 1.00 | *Table 1.5-2* |
| Seismic Importance Factor | $I_e$ = | 1.00 | *Table 1.5-2* |
| Spectral Response, Short Period | $S_S$ = | 1.430 | (Mapped) |
| Spectral Response, 1-s Period | $S_1$ = | 0.549 | (Mapped) |
| **Site Class:** | D | | *Table 20.3-1* |
| Site Coefficient | $F_a$ = | 1.00 | *Table 11.4-1* |
| Site Coefficient | $F_v$ = | 1.50 | *Table 11.4-2* |

**Structural Systems:**

*Light framed walls with shear panels*

| | | | |
|---|---|---|---|
| All other structural systems | $T_L$ = | 6 | *(Figs. 22-12 thru 22-16)* |
| Response Modification Coefficient | $R$ = | 6.5 | *Table 12.2-1* |
| Overstrength Factor | $\Omega_0$ = | 3 | *Table 12.2-1* |
| Deflection Amplification Factor | $C_d$ = | 4 | *Table 12.2-1* |

| | | | |
|---|---|---|---|
| **Ultimate Design Wind Speed:** | 110 mph | | |
| **Exposure to Wind:** | Exposure C | | *Section 26.7.3* |
| Topographical Factor | $K_{ZT}$ = | 1.00 | |

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WIND: EXP C; $K_{ZT} = 1.0$; $\lambda = 1.29$ (MEAN ROOF HT = 20')

NEW AREA (3)

ZONE A → (26.1 PSF)(1.29) = 33.7 PSF

AREA N/S: $V_{(4)}$ (130 SF)(33.7 PSF) = 4380 #

$V_{(4)(ASD)} = 0.6 V_{(4)} = 2630$ #

AREA E/W → NO NEW AREA

Project: MUNSON Designed By: BTL Date:

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Munson Residence
4628 Forest Avenue SE

Revision Date: 1/25/2019

Redundancy, $\rho$ 1.0 *(Section 12.3.4)*

Design Base Shear

$S_{MS} = F_a S_S$ *(Eq. 11.4-1)*
$= 1.43$

$S_{M1} = F_v S_1$ *(Eq. 11.4-2)*
$= 0.82$

$S_{DS} = ⅔\, S_{MS}$ *(Eq. 11.4-3)*
$= 0.95$

$S_{D1} = ⅔\, S_{M1}$ *(Eq. 11.4-4)*
$= 0.55$

**Seismic Design Category:**

Short Period -- D

1-Second Period -- D

**Structure Period and Weight:**

$C_t = 0.020$ *Table 12.8-2*

$x = 0.75$

Building Height (Mean Roof), $h_n$ = 32 ft

Approximate Fundamental Period, $T_a = C_t\,(h_n)^x$ *(Eq. 12.8-7)*

$T = T_a = 0.27$

$T_L = 6$ *(Figs. 22-12 thru 22-16)*

*Calculated design base shear:*

$V = C_s W$ (Eq. 12.8-1)

$$C_s = \frac{S_{DS}}{\left(\frac{R}{I_e}\right)}$$ (Eq. 12.8-2)

$C_s = 0.15$

*The total design base shear need not exceed:*

(Eq. 12.8-3)

for $T \leqq T_L$ $$C_s = \frac{S_{D1}}{T\left(\frac{R}{I_e}\right)}$$

$C_s = 0.32$

$C_s = 0.32$

(Eq. 12.8-4)

for $T > T_L$ $$C_s = \frac{S_{D1} T_L}{T^2\left(\frac{R}{I_e}\right)}$$

$C_s = 7.17$

*The total design base shear shall not be less than:*

$C_s = 0.044 S_{DS} I_e \geq 0.01$ (Eq. 12.8-5)

$C_s = 0.04$

*nor where $S_1 \geq 0.6g$:*

$C_s = 0.5 S_1/(R/I_e)$ (Eq. 12.8-6)

$C_s = 0.00$

$C_s = 0.15$

$V = 0.15\, W$

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① $W_1 = (15\,psf)(256\,sf) = 3840\#$

$V_1 = 0.15\,W_1 = 576\#$

$V_{1(ASD)} = 0.7\,V_1 = 403\#$

② $W_2 = 3840\#$

$V_{2(ASD)} = 403\#$

③ $W_3 = \underbrace{(15\,psf)(576\,sf)}_{Roof} + \underbrace{(10\,psf)(400\,sf)}_{WALL} = 12{,}640\#$

$V_3 = (0.15)(W_3) = 1896\#$

$V_{3(ASD)} = 0.7\,V_3 = 1330\#$

④ $W_4 = (15\,psf)(450\,sf) = 6750\#$

$V_4 = (0.15)(W_4) = 1013\#$

$V_{4(ASD)} = 0.7\,V_4 = 710\#$

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# Lateral

Shear Walls/Diaphragms

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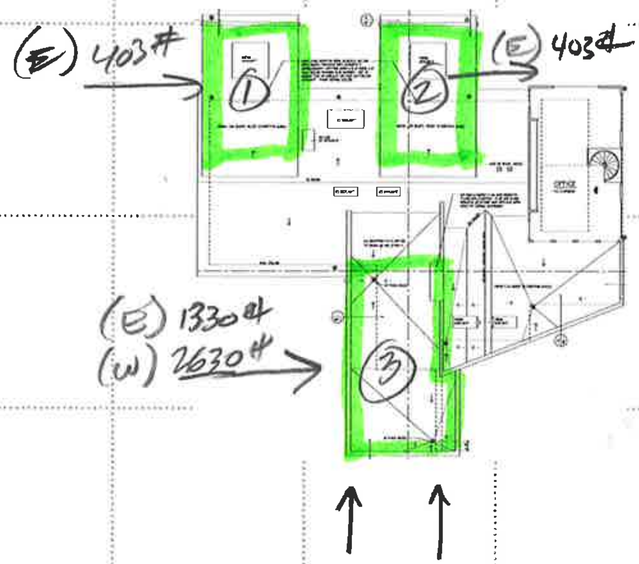
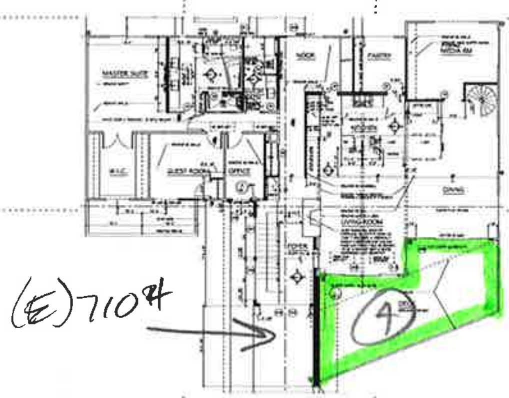
N




Project: MUNSON Designed By: Date:

Project Number: Client: Scale: Page: L2.1

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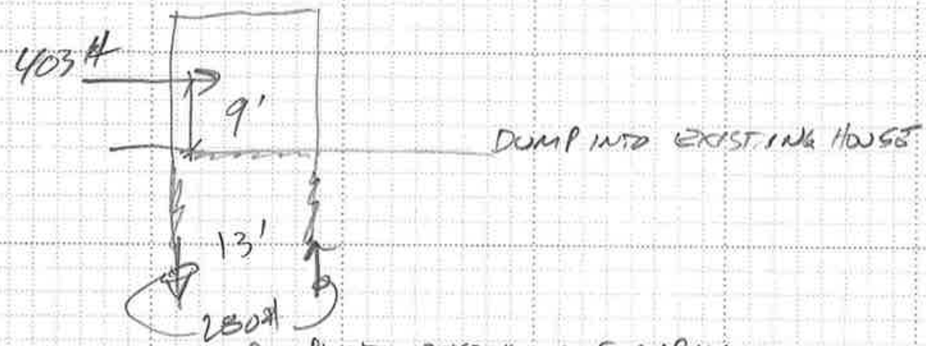
1




DUMP INTO EXISTING ROOF DIAPHRAGM
w/ $\boxed{\text{PT-6}}$ PONY WALLS

$$\frac{280\#}{12'} = 23\text{plf} \quad \checkmark \text{ OK}$$

(SEE 20/S3.2)

2 (SAME AS 1)

Project: MUNSON Designed By: BTL Date:

Project Number: Client: Scale: Page: L2.2

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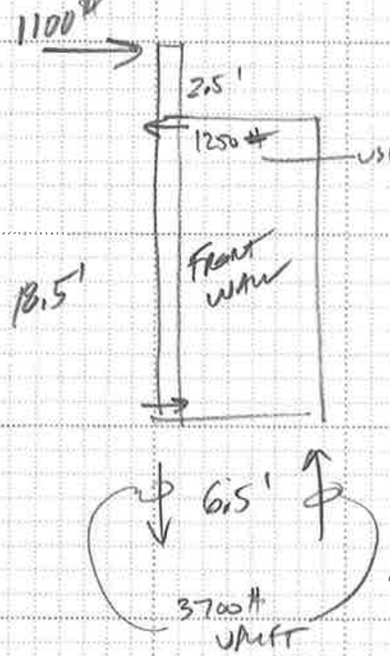
3 (ENTRY)




USE CS16

RATIO: $\frac{18.5'}{6.5'} = 2.84$ >2.0 <3.5

USE REDUCED VALUES

(W) $\frac{2630\#}{6.5'} = 404\ plf$

$490(1.25 - (0.125(\frac{18.5}{6.5}))$

$= 438 plf > 404$

$\therefore$ OK

(E) $\frac{1330\#}{6.5'} = 204\ plf$

USE $\boxed{P1\text{-}4}$

A.B. SPACING =

$\frac{1376\#/BOLT}{404\ plf} = 40''oc$

M = 2.75 ft-#

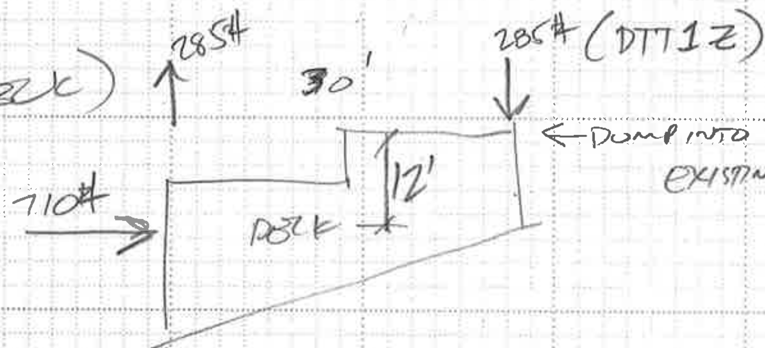
USE 6x6 @ CORNER

HDU5-SDS2.5

(SEE 3/S3.1)

4 (DECK)

(E)




(SEE 7/S3.2)

Project: MUNSON Designed By: Date:

Project Number: Client: Scale: Page: L2.3

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# Lateral

Shear Wall/Diaphragm Capacities

# 2015 IBC – Diaphragms (8d Nailing)

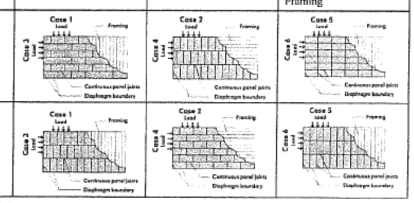
**Table 4.2C Nominal Unit Shear Capacities for Wood-Frame Diaphragms**

**Unblocked Wood Structural Panel Diaphragms[1,2,3,4,5]**

| Sheathing Grade | Common Nail Size | Minimum Fastener Penetration in Framing (in.) | Minimum Nominal Panel Thickness (in.) | Minimum Nominal Width of Nailed Face at Supported Edges and Boundaries (in.) | A SEISMIC — 6 in. Nail Spacing at diaphragm boundaries and supported panel edges | | | | | | B WIND — 6 in. Nail Spacing at diaphragm boundaries and supported panel edges | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Case 1 | | | Cases 2,3,4,5,6 | | | Case 1 | Cases 2,3,4,5,6 |
| | | | | | $v_s$ (plf) | $G_a$ (kips/in.) OSB | $G_a$ (kips/in.) PLY | $v_s$ (plf) | $G_a$ (kips/in.) OSB | $G_a$ (kips/in.) PLY | $v_w$ (plf) | $v_w$ (plf) |
| Structural I | 6d | 1-1/4 | 5/16 | 2 | 330 | 9.0 | 7.0 | 250 | 6.0 | 4.5 | 460 | 350 |
| | | | | 3 | 370 | 7.0 | 6.0 | 280 | 4.5 | 4.0 | 520 | 390 |
| | 8d | 1-3/8 | 3/8 | 2 | 480 | 8.5 | 7.0 | 360 | 6.0 | 4.5 | 670 | 505 |
| | | | | 3 | 530 | 7.5 | 6.0 | 400 | 5.0 | 4.0 | 740 | 560 |
| | 10d | 1-1/2 | 15/32 | 2 | 570 | 14 | 10 | 430 | 9.5 | 7.0 | 800 | 600 |
| | | | | 3 | 640 | 12 | 9.0 | 480 | 8.0 | 6.0 | 895 | 670 |
| Sheathing and Single-Floor | 6d | 1-1/4 | 5/16 | 2 | 300 | 9.0 | 6.5 | 220 | 6.0 | 4.0 | 420 | 310 |
| | | | | 3 | 340 | 7.0 | 5.5 | 250 | 5.0 | 3.5 | 475 | 350 |
| | | | 3/8 | 2 | 330 | 7.5 | 5.5 | 250 | 5.0 | 4.0 | 460 | 350 |
| | | | | 3 | 370 | 6.0 | 4.5 | 280 | 4.0 | 3.0 | 520 | 390 |
| | 8d | 1-3/8 | 3/8 | 2 | 430 | 9.0 | 6.5 | 320 | 6.0 | 4.5 | 600 | 450 |
| | | | | 3 | 480 | 7.5 | 5.5 | 360 | 5.0 | 3.5 | 670 | 505 |
| | | | 7/16 | 2 | 460 | 8.5 | 6.0 | 340 | 5.5 | 4.0 | 645 | 475 |
| | | | | 3 | 510 | 7.0 | 5.5 | 380 | 4.5 | 3.5 | 715 | 530 |
| | | | 15/32 | 2 | 480 | 7.5 | 5.5 | 360 | 5.0 | 4.0 | 670 | 505 |
| | | | | 3 | 530 | 6.5 | 5.0 | 400 | 4.0 | 3.5 | 740 | 560 |
| | 10d | 1-1/2 | 15/32 | 2 | 510 | 15 | 9.0 | 380 | 10 | 6.0 | 715 | 530 |
| | | | | 3 | 580 | 12 | 8.0 | 430 | 8.0 | 5.5 | 810 | 600 |
| | | | 19/32 | 2 | 570 | 13 | 8.5 | 430 | 8.5 | 5.5 | 800 | 600 |
| | | | | 3 | 640 | 10 | 7.5 | 480 | 7.0 | 5.0 | 895 | 670 |

1. Nominal unit shear capacities shall be adjusted in accordance with 4.2.3 to determine ASD allowable unit shear capacity and LRFD factored unit resistance. For general construction requirements see 4.2.6. For specific requirements, see 4.2.7.1 for wood structural panel diaphragms. See Appendix A for common nail dimensions.
2. For species and grades of framing other than Douglas-Fir-Larch or Southern Pine, reduced nominal unit shear capacities shall be determined by multiplying the tabulated nominal unit shear capacity by the Specific Gravity Adjustment Factor = [1-(0.5-G)], where G = Specific Gravity of the framing lumber from the *NDS* (Table 12.3.3A). The Specific Gravity Adjustment Factor shall not be greater than 1.
3. Apparent shear stiffness values, $G_a$, are based on nail slip in framing with moisture content less than or equal to 19% at time of fabrication and panel stiffness values for diaphragms constructed with either OSB or 3-ply plywood panels. When 4-ply or 5-ply plywood panels or composite panels are used, $G_a$ values shall be permitted to be multiplied by 1.2.
4. Where moisture content of the framing is greater than 19% at time of fabrication, $G_a$ values shall be multiplied by 0.5.
5. Diaphragm resistance depends on the direction of continuous panel joints with respect to the loading direction and direction of framing members, and is independent of the panel orientation.

| | Cases 1&3: Continuous Panel Joints Perpendicular to Framing | Cases 2&4: Continuous Panel Joints Parallel to Framing | Cases 5&6: Continuous Panel Joints Perpendicular and Parallel to Framing |
|---|---|---|---|
| Long Panel Direction Perpendicular to Supports | | | |
| Long Panel Direction Parallel to Supports[a] | | | |




(a) Panel span rating for out-of-plane loads may be lower than the span rating with the long panel direction perpendicular to supports (See Section 3.2.2 and Section 3.2.3)

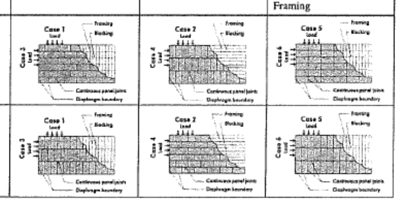
**Table 4.2A Nominal Unit Shear Capacities for Wood-Frame Diaphragms**

**Blocked Wood Structural Panel Diaphragms[1,2,3,4,5]**

| Sheathing Grade | Common Nail Size | Minimum Fastener Penetration in Framing Member or Blocking (in.) | Minimum Nominal Panel Thickness (in.) | Minimum Nominal Width of Nailed Face at Adjoining Panel Edges and Boundaries (in.) | A SEISMIC — Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6): 6 | | | 4 | | | 2-1/2 | | | 2 | | | B WIND — Nail Spacing (in.) at diaphragm boundaries (all cases), at continuous panel edges parallel to load (Cases 3 & 4), and at all panel edges (Cases 5 & 6): 6 | 4 | 2-1/2 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Nail Spacing (in.) at other panel edges (Cases 1, 2, 3, & 4): 6 | | | 6 | | | 4 | | | 3 | | | Nail Spacing (in.) at other panel edges (Cases 1, 2, 3, & 4): 6 | 6 | 4 | 3 |
| | | | | | $v_s$ (plf) | $G_a$ (kips/in.) OSB | $G_a$ (kips/in.) PLY | $v_s$ (plf) | $G_a$ (kips/in.) OSB | $G_a$ (kips/in.) PLY | $v_s$ (plf) | $G_a$ (kips/in.) OSB | $G_a$ (kips/in.) PLY | $v_s$ (plf) | $G_a$ (kips/in.) OSB | $G_a$ (kips/in.) PLY | $v_w$ (plf) | $v_w$ (plf) | $v_w$ (plf) | $v_w$ (plf) |
| Structural I | 6d | 1-1/4 | 5/16 | 2 | 370 | 15 | 12 | 500 | 8.5 | 7.5 | 750 | 12 | 10 | 840 | 20 | 15 | 520 | 700 | 1050 | 1175 |
| | | | | 3 | 420 | 12 | 9.5 | 560 | 7.0 | 6.0 | 840 | 9.5 | 8.5 | 950 | 17 | 13 | 590 | 785 | 1175 | 1330 |
| | 8d | 1-3/8 | 3/8 | 2 | 540 | 14 | 11 | 720 | 9.0 | 7.5 | 1060 | 13 | 10 | 1200 | 21 | 15 | 755 | 1010 | 1485 | 1680 |
| | | | | 3 | 600 | 12 | 10 | 800 | 7.5 | 6.5 | 1200 | 10 | 9.0 | 1350 | 18 | 13 | 840 | 1120 | 1680 | 1890 |
| | 10d | 1-1/2 | 15/32 | 2 | 640 | 24 | 17 | 850 | 15 | 12 | 1280 | 20 | 15 | 1460 | 31 | 21 | 895 | 1190 | 1790 | 2045 |
| | | | | 3 | 720 | 20 | 15 | 960 | 12 | 9.5 | 1440 | 16 | 13 | 1640 | 26 | 18 | 1010 | 1345 | 2015 | 2295 |
| Sheathing and Single-Floor | 6d | 1-1/4 | 5/16 | 2 | 340 | 15 | 10 | 450 | 9.0 | 7.0 | 670 | 13 | 9.5 | 760 | 21 | 13 | 475 | 630 | 940 | 1065 |
| | | | | 3 | 380 | 12 | 9.0 | 500 | 7.0 | 6.0 | 760 | 10 | 8.0 | 860 | 17 | 12 | 530 | 700 | 1065 | 1205 |
| | | | 3/8 | 2 | 370 | 13 | 9.5 | 500 | 7.0 | 6.0 | 750 | 10 | 8.0 | 840 | 18 | 12 | 520 | 700 | 1050 | 1175 |
| | | | | 3 | 420 | 10 | 8.0 | 560 | 5.5 | 5.0 | 840 | 8.5 | 7.0 | 950 | 14 | 10 | 590 | 785 | 1175 | 1330 |
| | 8d | 1-3/8 | 3/8 | 2 | 480 | 15 | 11 | 640 | 9.5 | 7.5 | 960 | 13 | 9.5 | 1090 | 21 | 13 | 670 | 895 | 1345 | 1525 |
| | | | | 3 | 540 | 12 | 9.5 | 720 | 7.5 | 6.0 | 1080 | 11 | 8.5 | 1220 | 18 | 12 | 755 | 1010 | 1510 | 1710 |
| | | | 7/16 | 2 | 510 | 14 | 10 | 680 | 8.5 | 7.0 | 1010 | 12 | 9.5 | 1150 | 20 | 13 | 715 | 950 | 1415 | 1610 |
| | | | | 3 | 570 | 11 | 9.0 | 760 | 7.0 | 6.0 | 1140 | 10 | 8.0 | 1290 | 17 | 12 | 800 | 1065 | 1595 | 1805 |
| | | | 15/32 | 2 | 540 | 13 | 9.5 | 720 | 7.5 | 6.5 | 1060 | 11 | 8.5 | 1200 | 19 | 13 | 755 | 1010 | 1485 | 1680 |
| | | | | 3 | 600 | 10 | 8.5 | 800 | 6.0 | 5.5 | 1200 | 9.0 | 7.5 | 1350 | 15 | 11 | 840 | 1120 | 1680 | 1890 |
| | 10d | 1-1/2 | 15/32 | 2 | 580 | 25 | 15 | 770 | 15 | 11 | 1150 | 21 | 14 | 1310 | 33 | 18 | 810 | 1080 | 1610 | 1835 |
| | | | | 3 | 650 | 21 | 14 | 860 | 12 | 9.5 | 1300 | 17 | 12 | 1470 | 28 | 16 | 910 | 1205 | 1820 | 2060 |
| | | | 19/32 | 2 | 640 | 21 | 14 | 850 | 13 | 9.5 | 1280 | 18 | 12 | 1460 | 28 | 17 | 895 | 1190 | 1790 | 2045 |
| | | | | 3 | 720 | 17 | 12 | 960 | 10 | 8.0 | 1440 | 14 | 11 | 1640 | 24 | 15 | 1010 | 1345 | 2015 | 2295 |

1. Nominal unit shear capacities shall be adjusted in accordance with 4.2.3 to determine ASD allowable unit shear capacity and LRFD factored unit resistance. For general construction requirements see 4.2.6. For specific requirements, see 4.2.7.1 for wood structural panel diaphragms. See Appendix A for common nail dimensions.
2. For species and grades of framing other than Douglas-Fir-Larch or Southern Pine, reduced nominal unit shear capacities shall be determined by multiplying the tabulated nominal unit shear capacity by the Specific Gravity Adjustment Factor = [1-(0.5-G)], where G = Specific Gravity of the framing lumber from the *NDS* (Table 12.3.3A). The Specific Gravity Adjustment Factor shall not be greater than 1.
3. Apparent shear stiffness values, $G_a$, are based on nail slip in framing with moisture content less than or equal to 19% at time of fabrication and panel stiffness values for diaphragms constructed with either OSB or 3-ply plywood panels. When 4-ply or 5-ply plywood panels or composite panels are used, $G_a$ values shall be permitted to be multiplied by 1.2.
4. Where moisture content of the framing is greater than 19% at time of fabrication, $G_a$ values shall be multiplied by 0.5.
5. Diaphragm resistance depends on the direction of continuous panel joints with respect to the loading direction and direction of framing members, and is independent of the panel orientation.

| | Cases 1&3: Continuous Panel Joints Perpendicular to Framing | Cases 2&4: Continuous Panel Joints Parallel to Framing | Cases 5&6: Continuous Panel Joints Perpendicular and Parallel to Framing |
|---|---|---|---|
| Long Panel Direction Perpendicular to Supports | | | |
| Long Panel Direction Parallel to Supports[a] | | | |




(a) Panel span rating for out-of-plane loads may be lower than the span rating with the long panel direction perpendicular to supports (See Section 3.2.2 and Section 3.2.3)

1. Reduction Factor = 2
2. G = 0.42 (SPF or Hem Fir)… Adjustment Factor = [1-(0.5-0.42)] = 0.92 or 0.5 (I-Joists or Douglas Fir)… Adjustment Factor = 1.0

| Diaphragm | Sheathing Thickness | Nail Spacing Edge/Intermediate | Blocked | Framing | Seismic Capacity (Case 1/Other) | Wind Capacity (Case 1/Other) |
|---|---|---|---|---|---|---|
| Roof – Unblocked | 7/16" | 6"/12" oc | N | 2x (SPF/HF) | 212-plf/156-plf | 297-plf/219-plf |
| Roof – Blocked | 7/16" | 4"/12" oc | Y | 2x (SPF/HF) | 313-plf | 437-plf |
| Floor – Unblocked | 3/4" | 6"/12" oc | N | 2x (DF) or 3x (HF) | 240-plf/180-plf | 335-plf/252-plf |
| Floor – Blocked | 3/4" | 4"/12" oc, | Y | 2x (DF) or 3x (HF) | 360-plf | 505-plf |

# 2015 IBC – Shear Wall Schedule

## 7/16"OSB; 0.131"ϕ Nails; SPF or HF Studs @ 16"oc

### Table 4.3A Nominal Unit Shear Capacities for Wood-Frame Shear Walls[1,3,6,7]

**Wood-based Panels[4]**

| Sheathing Material | Minimum Nominal Panel Thickness (in.) | Minimun Fastener Penetration in Framing Member or Blocking (in.) | Fastener Type & Size | A SEISMIC | | | | | | | | | | | | B WIND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Panel Edge Fastener Spacing (in.) | | | | | | | | | | | | Panel Edge Fastener Spacing (in.) | | | |
| | | | | 6 | | | 4 | | | 3 | | | 2 | | | 6 | 4 | 3 | 2 |
| | | | | $v_s$ (plf) | $G_a$ (kips/in.) | | $v_s$ (plf) | $G_a$ (kips/in.) | | $v_s$ (plf) | $G_a$ (kips/in.) | | $v_s$ (plf) | $G_a$ (kips/in.) | | $v_w$ (plf) | $v_w$ (plf) | $v_w$ (plf) | $v_w$ (plf) |
| | | | Nail (common or galvanized box) | | OSB | PLY | | OSB | PLY | | OSB | PLY | | OSB | PLY | | | | |
| Wood Structural Panels - Structural I[4,5] | 5/16 | 1-1/4 | 6d | 400 | 13 | 10 | 600 | 18 | 13 | 780 | 23 | 16 | 1020 | 35 | 22 | 560 | 840 | 1090 | 1430 |
| | 3/8[2] | 1-3/8 | 8d | 460 | 19 | 14 | 720 | 24 | 17 | 920 | 30 | 20 | 1220 | 43 | 24 | 645 | 1010 | 1290 | 1710 |
| | 7/16[2] | | | 510 | 16 | 13 | 790 | 21 | 16 | 1010 | 27 | 19 | 1340 | 40 | 24 | 715 | 1105 | 1415 | 1875 |
| | 15/32 | | | 560 | 14 | 11 | 860 | 18 | 14 | 1100 | 24 | 17 | 1460 | 37 | 23 | 785 | 1205 | 1540 | 2045 |
| | 15/32 | 1-1/2 | 10d | 680 | 22 | 16 | 1020 | 29 | 20 | 1330 | 36 | 22 | 1740 | 51 | 28 | 950 | 1430 | 1860 | 2435 |
| Wood Structural Panels – Sheathing[4,5] | 5/16 | 1-1/4 | 6d | 360 | 13 | 9.5 | 540 | 18 | 12 | 700 | 24 | 14 | 900 | 37 | 18 | 505 | 755 | 980 | 1260 |
| | 3/8 | | | 400 | 11 | 8.5 | 600 | 15 | 11 | 780 | 20 | 13 | 1020 | 32 | 17 | 560 | 840 | 1090 | 1430 |
| | 3/8[2] | 1-3/8 | 8d | 440 | 17 | 12 | 640 | 25 | 15 | 820 | 31 | 17 | 1060 | 45 | 20 | 615 | 895 | 1150 | 1485 |
| | 7/16[2] | | | 480 | 15 | 11 | 700 | 22 | 14 | 900 | 28 | 17 | 1170 | 42 | 21 | 670 | 980 | 1260 | 1640 |
| | 15/32 | | | 520 | 13 | 10 | 760 | 19 | 13 | 980 | 25 | 15 | 1280 | 39 | 20 | 730 | 1065 | 1370 | 1790 |
| | 15/32 | 1-1/2 | 10d | 620 | 22 | 14 | 920 | 30 | 17 | 1200 | 37 | 19 | 1540 | 52 | 23 | 870 | 1290 | 1680 | 2155 |
| | 19/32 | | | 680 | 19 | 13 | 1020 | 26 | 16 | 1330 | 33 | 18 | 1740 | 48 | 22 | 950 | 1430 | 1860 | 2435 |
| Plywood Siding | | | Nail (galvanized casing) | | | | | | | | | | | | | | | | |
| | 5/16 | 1-1/4 | 6d | 280 | 13 | | 420 | 16 | | 550 | 17 | | 720 | 21 | | 390 | 590 | 770 | 1010 |
| | 3/8 | 1-3/8 | 8d | 320 | 16 | | 480 | 18 | | 620 | 20 | | 820 | 22 | | 450 | 670 | 870 | 1150 |
| Particleboard Sheathing - (M-S "Exterior Glue" and M-2 "Exterior Glue") | | | Nail (common or galvanized box) | | | | | | | | | | | | | | | | |
| | 3/8 | | 6d | 240 | 15 | | 360 | 17 | | 460 | 19 | | 600 | 22 | | 335 | 505 | 645 | 840 |
| | 3/8 | | 8d | 260 | 18 | | 380 | 20 | | 480 | 21 | | 630 | 23 | | 365 | 530 | 670 | 880 |
| | 1/2 | | | 280 | 18 | | 420 | 20 | | 540 | 22 | | 700 | 24 | | 390 | 590 | 755 | 980 |
| | 1/2 | | 10d | 370 | 21 | | 550 | 23 | | 720 | 24 | | 920 | 25 | | 520 | 770 | 1010 | 1290 |
| | 5/8 | | | 400 | 21 | | 610 | 23 | | 790 | 24 | | 1040 | 26 | | 560 | 855 | 1105 | 1455 |
| Structural Fiberboard Sheathing | 1/2 | | Nail (galvanized roofing) 11 ga. galv. roofing nail (0.120" x 1-1/2" long x 7/16" head) | | | | 340 | 4.0 | | 460 | 5.0 | | 520 | 5.5 | | | 475 | 645 | 730 |
| | 25/32 | | 11 ga. galv. roofing nail (0.120" x 1-3/4" long x 3/8" head) | | | | 340 | 4.0 | | 460 | 5.0 | | 520 | 5.5 | | | 475 | 645 | 730 |

1. Nominal unit shear capacities shall be adjusted in accordance with 4.3.3 to determine ASD allowable unit shear capacity and LRFD factored unit resistance. For general construction requirements see 4.3.6. For specific requirements, see 4.3.7.1 for wood structural panel shear walls, 4.3.7.2 for particleboard shear walls, and 4.3.7.3 for fiberboard shear walls. See Appendix A for common and box nail dimensions.
2. Shears are permitted to be increased to values shown for 15/32 inch (nominal) sheathing with same nailing provided (a) studs are spaced a maximum of 16 inches on center, or (b) panels are applied with long dimension across studs.
3. For species and grades of framing other than Douglas-Fir-Larch or Southern Pine, reduced nominal unit shear capacities shall be determined by multiplying the tabulated nominal unit shear capacity by the Specific Gravity Adjustment Factor = [1-(0.5-G)], where G = Specific Gravity of the framing lumber from the NDS (Table 12.3.3A). The Specific Gravity Adjustment Factor shall not be greater than 1.
4. Apparent shear stiffness values $G_a$, are based on nail slip in framing with moisture content less than or equal to 19% at time of fabrication and panel stiffness values for shear walls constructed with either OSB or 3-ply plywood panels. When 4-ply or 5-ply plywood panels or composite panels are used, $G_a$ values shall be permitted to be multiplied by 1.2.
5. Where moisture content of the framing is greater than 19% at time of fabrication, $G_a$ values shall be multiplied by 0.5.
6. Where panels are applied on both faces of a shear wall and nail spacing is less than 6" on center on either side, panel joints shall be offset to fall on different framing members as shown below. Alternatively, the width of the nailed face of framing members shall be 3" nominal or greater at adjoining panel edges and nails at all panel edges shall be staggered.
7. Galvanized nails shall be hot-dipped or tumbled.

1. Reduction Factor = 2
2. 16"oc studs – use values for 15/32
3. G = 0.42 (SPF or Hem Fir)… Adjustment Factor = [1-(0.5-0.42)] = 0.92

| Wall Type | Blocked | Sheathing (1) or (2) Sides | Nail Spacing Edge/Intermediate | Framing | Sill Plate | Seismic Capacity $h/b_s = 2$ | Seismic Capacity $h/b_s = 3.5$ | Wind Capacity $h/b_s = 2$ | Wind Capacity $h/b_s = 3.5$ |
|---|---|---|---|---|---|---|---|---|---|
| P1-6U | N | 1 | 6"/12" oc | 2x | 2x | 144-plf | 117-plf | 201-plf | 164-plf |
| P1-6 | Y | 1 | 6"/12" oc | 2x | 2x | 240-plf | 194-plf | 335-plf | 272-plf |
| P1-4 | Y | 1 | 4"/12" oc | 2x | 2x | 350-plf | 284-plf | 490-plf | 398-plf |
| P1-3 | Y | 1 | 3"/12" oc | 2-2x | 2x | 450-plf | 366-plf | 630-plf | 512-plf |
| P1-2 | Y | 1 | 2"12" oc | 2-2x | 2x | 590-plf | 478-plf | 820-plf | 669-plf |
| P2-4 | Y | 2 | 4"/12" oc, ea.side | 2-2x | 3x | 700-plf | 568-plf | 980-plf | 796-plf |
| P2-3 | Y | 2 | 3"/12" oc, ea. side | 2-2x | 3x | 900-plf | 733-plf | 1260-plf | 1024-plf |
| P2-2 | Y | 2 | 2"/12" oc, ea. side | 2-2x | 3x | 1180-plf | 957-plf | 1640-plf | 1338-plf |

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# Miscellaneous

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Phone: 425-814-8448
Fax: 425-821-2120

# Stud Wall Design

Based on 2015 NDS Combined axial and bending formula:

$[f_c/F_c']^2 + f_b/F_b'[1-(f_c/F_{cE})] < 1$ in which: $F_{cE} = 0.822(Emin')/(\ell_e/d)^2$

Wall: Exterior Walls

No Fire Rating
2x6
SPF Stud

| | | |
|---|---|---|
| Wall Height: | 9 | ft |
| Desired Stud Spacing: | 16 | in oc |
| Design Axial Dead Load: | 700 | plf |
| Design Axial Live Load: | 800 | plf |
| Design Axial Snow Load: | 700 | plf |
| Design Lateral Pressure (0.6W): | 15 | psf |
| Deflection Criteria: L/ | 240 | |

| STUD CHECK | | | | |
|---|---|---|---|---|
| | $\ell_e/d$ | < | 50 | OK |
| D+0.6W ($C_D$ = 1.60) | | | | |
| $[f_c/F_c']^2 + f_b/F_b'[1-(f_c/F_{cE})] =$ | 0.32 | < | 1 | OK |
| $f_c/F_{cE2} + (f_b/F_{bE})^2 =$ | 0.00 | < | 1 | OK |
| D+0.75L+0.75(0.6W)+0.75S ($C_D$ = 1.60) | | | | |
| $[f_c/F_c']^2 + f_b/F_b'[1-(f_c/F_{cE})] =$ | 0.45 | < | 1 | OK |
| $f_c/F_{cE2} + (f_b/F_{bE})^2 =$ | 0.00 | < | 1 | OK |
| D+0.75L+0.75S ($C_D$ = 1.15) | | | | |
| $f_c/F_c' =$ | 0.48 | < | 1 | OK |
| D+L ($C_D$ = 1.0) | | | | |
| $f_c/F_c' =$ | 0.43 | < | 1 | OK |
| Deflection (No Increase for Load Duration): | | | | |
| Defl: L/ 240 = 0.45 | 0.12 | < | 0.45 | OK |
| SPF Stud 2x6 @ 16 oc | | | | OK |

| PLATE CRUSHING CHECK[1] | | | | | |
|---|---|---|---|---|---|
| Checks Crushing for Stud Spacing[2] | | | | | |
| No Stress Increase for Load Duration | | | | | |
| Hem Fir Plates: | $f_c/F_{c\perp}' =$ | 0.58 | < | 1 | OK |
| Douglas Fir Plates: | $f_c/F_{c\perp}' =$ | 0.38 | < | 1 | OK |

[1] Plate must also be checked for bending.

[2] Check on crushing only applies to stud spacing. Joists above must also be checked for crushing effect on plate. Also, no stress increase is allowed due to load duration.

Date: 12/14/2016

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$[f_c/F_c']^2 + f_b/F_b'[1-(f_c/F_{cE})] < 1$ in which: $F_{cE} = 0.822(Emin')/(\ell_e/d)^2$

Wall: Interior Walls

No Fire Rating

2x4

SPF Stud

| | | |
|---|---|---|
| Wall Height: | 9 | ft |
| Desired Stud Spacing: | 16 | in oc |
| Design Axial Dead Load: | 400 | plf |
| Design Axial Live Load: | 800 | plf |
| Design Axial Snow Load: | 0 | plf |
| Design Lateral Pressure (0.6W): | 5 | psf |
| Deflection Criteria: | L/ 240 | |

| STUD CHECK | $\ell_e/d$ | < | 50 | OK |
|---|---|---|---|---|
| D+0.6W ($C_D$ = 1.60) | | | | |
| $[f_c/F_c']^2 + f_b/F_b'[1-(f_c/F_{cE})] =$ | 0.35 | < | 1 | OK |
| $f_c/F_{cE2} + (f_b/F_{bE})^2 =$ | 0.00 | < | 1 | OK |
| D+0.75L+0.75(0.6W)+0.75S ($C_D$ = 1.60) | | | | |
| $[f_c/F_c']^2 + f_b/F_b'[1-(f_c/F_{cE})] =$ | 0.96 | < | 1 | OK |
| $f_c/F_{cE2} + (f_b/F_{bE})^2 =$ | 0.00 | < | 1 | OK |
| D+0.75L+0.75S ($C_D$ = 1.15) | | | | |
| $f_c/F_c' =$ | 0.75 | < | 1 | OK |
| D+L ($C_D$ = 1.0) | | | | |
| $f_c/F_c' =$ | 0.92 | < | 1 | OK |
| Deflection (No Increase for Load Duration): | | | | |
| Defl: L/ 240 = 0.45 | 0.15 | < | 0.45 | OK |
| SPF Stud 2x4 @ 16 oc | | | | OK |

| PLATE CRUSHING CHECK[1] Checks Crushing for Stud Spacing[2] No Stress Increase for Load Duration | | | | |
|---|---|---|---|---|
| Hem Fir Plates: $f_c/F_{c\perp}' =$ | 0.50 | < | 1 | OK |
| Douglas Fir Plates: $f_c/F_{c\perp}' =$ | 0.33 | < | 1 | OK |

[1] Plate must also be checked for bending.

[2] Check on crushing only applies to stud spacing. Joists above must also be checked for crushing effect on plate. Also, no stress increase is allowed due to load duration.

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## 2015 NDS

### 3.7-SOLID COLUMNS and 15.3-BUILT-UP COLUMNS

Solid Column

Visually graded lumber (Dimensional)

No Fire Rating

Hem-Fir Stud

| | | | |
|---|---|---|---|
| $F_c =$ | 800 psi | $E_{min} =$ | 440 ksi |
| $C_D =$ | 1.00 | $E_{min}' =$ | 440 ksi |
| $C_M =$ | 1.00 | $l =$ | 9.0 ft |
| $C_t =$ | 1.00 | $d =$ | 5 1/2 in |
| $C_F =$ | 1.00 | $K_e =$ | 1.0 |
| | | $l_e =$ | 108.0 in |
| | | $l_e/d =$ | 19.6 |

$$F_c' = F_c^* C_P$$

$$F_c^* = F_c C_D C_M C_t C_F$$

$F_c^* =$ 800 psi

$C_p =$ 0.743

$\boxed{F_c' = 594 \text{ psi}}$

$$C_p = K_f \left[ \frac{1+\left(F_{cE}/F_c^*\right)}{2c} - \sqrt{\left[\frac{1+\left(F_{cE}/F_c^*\right)}{2c}\right]^2 - \frac{F_{cE}/F_c^*}{c}} \right]$$

$F_{cE} =$ 938

$$F_{cE} = \frac{0.822\, E_{min}'}{\left(l_e/d\right)^2}$$

$c =$ 0.8

$K_f =$ 1.0

| | STUD | HF Plate Crushing | DF Plate Crushing |
|---|---|---|---|
| (1) 2x6 | 4904 | 3341 | 5156 |
| (2) 2x6 | 9807 | 6683 | 10313 |
| (3) 2x6 | 14711 | 10024 | 15469 |
| (4) 2x6 | 19614 | 13365 | 20625 |
| (5) 2x6 | 24518 | 16706 | 25781 |

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## 2015 NDS

### 3.7-SOLID COLUMNS and 15.3-BUILT-UP COLUMNS

Solid Column

Visually graded lumber (Dimensional)

No Fire Rating

Hem-Fir Stud

| | | | |
|---|---|---|---|
| $F_c$ = | 800 psi | $E_{min}$ = | 440 ksi |
| $C_D$ = | 1.00 | $E_{min}'$ = | 440 ksi |
| $C_M$ = | 1.00 | l = | 9.0 ft |
| $C_t$ = | 1.00 | d = | 3 1/2 in |
| $C_F$ = | 1.00 | $K_e$ = | 1.0 |
| | | $l_e$ = | 108.0 in |
| | | $l_e/d$ = | 30.9 |

$$F_c' = F_c^* \, C_P$$

$$F_c^* = F_c \, C_D \, C_M \, C_t \, C_F$$

$F_c^*$ = 800 psi

$C_p$ = 0.416

$\boxed{F_c' = 333 \text{ psi}}$

$$C_p = K_f \left[ \frac{1 + \left( F_{cE} / F_c^* \right)}{2c} - \sqrt{\left[ \frac{1 + \left( F_{cE} / F_c^* \right)}{2c} \right]^2 - \frac{F_{cE} / F_c^*}{c}} \right]$$

$F_{cE}$ = 380

$$F_{cE} = \frac{0.822 \, E_{min}'}{\left( l_e / d \right)^2}$$

$c$ = 0.8

$K_f$ = 1.0

| | STUD | HF Plate Crushing | DF Plate Crushing |
|---|---|---|---|
| (1) 2x4 | 1746 | 2126 | 3281 |
| (2) 2x4 | 3492 | 4253 | 6563 |
| (3) 2x4 | 5237 | 6379 | 9844 |
| (4) 2x4 | 6983 | 8505 | 13125 |
| (5) 2x4 | 8729 | 10631 | 16406 |

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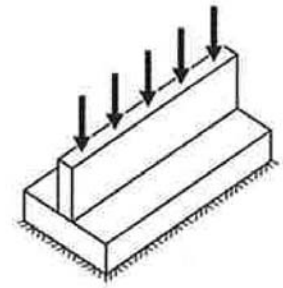
Project: Continuous Strip Footing
18" wide x 8" thick

IBC Section 13.3.2: One-way shallow foundations

Footing width, $B$ = 18 in
Footing Thickness, $t$ = 8 in
Stem Wall width, $C$ = 8 in
Stem Wall Height = 24 in



Strip footing

Normalweight — $f'_c$ = 2500 psi
Uncoated — $f_y$ = 40000 psi
Longintudinal Reinforcement: (2) #4
Bar Diameter = 0.500 in
Bar Area = 0.20 in$^2$
$A_s$ = 0.40 in$^2$
Cover: 3 in

Stem Wall Reinforcement: #4 @ 24 "oc — Straight Dowels
Bar Diameter = 0.500 in
Bar Area = 0.20 in$^2$
$A_s$ = 0.00 in$^2$
Cover: 3 in
$b_w =$ 12 in (per ft)
$d =$ 4.75 in

Footing + Stem Wall Weight - Weight of Displaced Soil = 240 plf

*One-way shear, no shear reinforcement:*

[22.5.5.1] $V_c = 2\lambda\sqrt{f'_c}\,b_w d =$ 5700 # per foot length — $\phi =$ 0.75

[22.5.10.1] $V_u \le \phi V_c$

$$V_u = q_u b_w\left(\frac{B-C}{2}-d\right) \rightarrow q_u = \frac{\phi V_c}{b_w\left(\frac{B-C}{2}-d\right)}$$

$q_u =$ 51300 psf
Max Uniform Load on Stem = 76950 plf [Ultimate]
48094 plf [Service]

*Moment:*

[22.2.1.1] $M_n = A_s f_y(d - a/2) =$ 0.000 k-ft per foot length — $\phi =$ 0.90

$M_u \le \phi M_n$

$$M_u = \frac{q_u b_w\left(\frac{B-C}{2}\right)^2}{2} \rightarrow q_u = \frac{2\phi M_n}{b_w\left(\frac{B-C}{2}\right)^2}$$

$$a = \frac{A_s f_y}{0.85 f'_c b} =$$ 0.00 in

$q_u =$ NO MOMENT
Max Uniform Load on Stem = 12000 plf [Ultimate]
7500 plf [Service]

*Development of Reinforcement:*

[25.4.2.3] $l_d = \left(\frac{3}{40}\frac{f_y}{\lambda\sqrt{f'_c}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b+K_{tr}}{d_b}\right)}\right)d_b =$ N/A

**OK**

| **Allowable Soil Bearing Pressure** | **1500 psf** | **2000 psf** | **2500 psf** | **3000 psf** | **3500 psf** | **4000 psf** |
|---|---|---|---|---|---|---|
| Max Uniform Load, Soil | 2010 plf | 2760 plf | 3510 plf | 4260 plf | 5010 plf | 5760 plf |
| Max Uniform Load, Shear | 48094 plf | 48094 plf | 48094 plf | 48094 plf | 48094 plf | 48094 plf |
| Max Uniform Load, Moment | 7500 plf | 7500 plf | 7500 plf | 7500 plf | 7500 plf | 7500 plf |
| **Max Uniform Load (Service)** | **2010 plf** | **2760 plf** | **3510 plf** | **4260 plf** | **5010 plf** | **5760 plf** |
| **Max Uniform Load (Ultimate)** | **3216 plf** | **4416 plf** | **5616 plf** | **6816 plf** | **8016 plf** | **9216 plf** |
| | | | | | | |
| **Max Point Load (Service)** | **16080 #** | **22080 #** | **28080 #** | **34080 #** | **40080 #** | **46080 #** |
| **Max Point Load (Ultimate)** | **25728 #** | **35328 #** | **44928 #** | **54528 #** | **64128 #** | **73728 #** |

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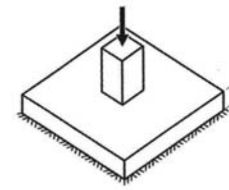
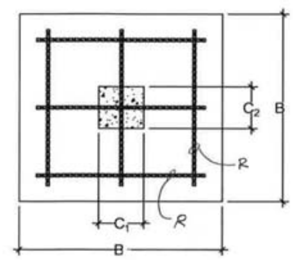
Project: Typical Footing
Footing: 18" x 18" x 8" thick




Isolated footing




Footing $B$ = 1.50 ft
$t$ = 8 in
Reinforcement $R$ = (2) #4
$A_{s1}$ = 0.40 in²
$d$ = 4.25 in Cover: 3 in
Column $C_1$ = 3.50 in $C_2$ = 3.50 in
Materials $f'_c$ = 2500 psi Normalweight $\lambda$ = 1.00
$f_y$ = 40000 psi Uncoated $\psi_e$ = 1.00

Net Footing Weight
$P_{FTG}$ = 0.06 k

*Soil Pressure:*
$$P_{ASD} = q_a B^2 - P_{FTG} =$$

*One-way shear:* $\emptyset$ = 0.75

$V_c = 2\lambda\sqrt{f_c'}Bd =$ 7.65 k
$V_u \le \emptyset V_c$ $\emptyset V_c =$ 5.74 k

$$V_u = q_u B\left(\frac{B-C_2}{2}-d\right) \to q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_2}{2}-d\right)} \qquad V_u = q_u B\left(\frac{B-C_1}{2}-d\right) \to q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_1}{2}-d\right)}$$

$q_u =$ 10392 psf or 10392 psf $P_u = q_u B^2 =$ 23383 #

*Two-way shear:* $\emptyset$ = 0.75

[22.6.5.2(a)] $v_c = 4\lambda\sqrt{f_c'} =$ 200 psi ⇦
[22.6.5.2(b)] $v_c = \left(2+\frac{4}{\beta}\right)\lambda\sqrt{f_c'} =$ 300 psi
[22.6.5.2(c)] $v_c = \left(2+\frac{\alpha_x d}{b_0}\right)\lambda\sqrt{f_c'} =$ 374 psi

$\beta$ = 1.00
$\alpha_x$ = 40
$b_0$ = 2($C_1$+d)+2($C_2$+d)
31

$V_u \le \phi V_c$ $\phi V_c = \phi v_c b_0 d =$ 19.76 k

$$V_u = q_u[B^2-(C_1+d)(C_2+d)] \to q_u = \frac{\emptyset V_c}{[B^2-(C_1+d)(C_2+d)]}$$

$q_u =$ 10782 psf $P_u = q_u B^2 =$ 24260 #

*Moment:* $\emptyset$ = 0.90

$M_n = A_s f_y(d - a/2) =$ 5.4 k-ft
$a = A_s f_y/(0.85 f'_c B) =$ 0.42 in
$M_u \le \emptyset M_n$ $\emptyset M_n =$ 4.8 k-ft

$$M_u = \frac{q_u B\left(\frac{B-C_2}{2}\right)^2}{2} \to q_u = \frac{2\emptyset M_n}{B\left((B-C_2)/2\right)^2} \qquad M_u = \frac{q_u B\left(\frac{B-C_1}{2}\right)^2}{2} \to q_u = \frac{2\emptyset M_n}{B\left((B-C_1)/2\right)^2}$$

$q_u =$ 17712 psf or 17712 psf $P_u = q_u B^2 =$ 39853 #

*Development of Reinforcement:*

$$l_d = \left(\frac{3}{40}\frac{f_y}{\lambda\sqrt{f_c'}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b+K_{tr}}{d_b}\right)}\right)d_b =$$ 4 in ...4 in available **OK**

Adjusted

| **Soil Bearing Pressure** | **1500 psf** | **2000 psf** | **2500 psf** | **3000 psf** | **3500 psf** | **4000 psf** |
|---|---|---|---|---|---|---|
| Max Load (lbs), Soil | 3315 | 4440 | 5565 | 6690 | 7815 | 8940 |
| Max Load (lbs), One-Way Shear | 14614 | 14614 | 14614 | 14614 | 14614 | 14614 |
| Max Load (lbs), Two-Way Shear | 15162 | 15162 | 15162 | 15162 | 15162 | 15162 |
| Max Load (lbs), Moment | 24908 | 24908 | 24908 | 24908 | 24908 | 24908 |
| **Max Load (ASD)** | **3315** | **4440** | **5565** | **6690** | **7815** | **8940** |
| **Max Load (Factored)** | **5304** | **7104** | **8904** | **10704** | **12504** | **14304** |

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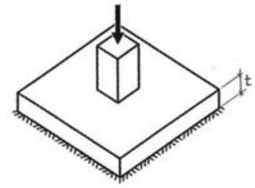
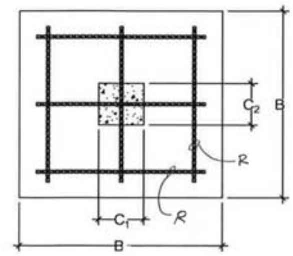
Project: Typical Footing
Footing: 24" x 24" x 8" thick




Isolated footing




Footing $B$ = 2.00 ft
$t$ = 8 in
Reinforcement $R$ = (2) #4
$A_{s1}$ = 0.40 in²
$d$ = 4.25 in Cover: 3 in
Column $C_1$ = 3.50 in $C_2$ = 3.50 in
Materials $f'_c$ = 2500 psi Normalweight $\lambda$ = 1.00
$f_y$ = 40000 psi Uncoated $\psi_e$ = 1.00

Net Footing Weight
$P_{FTG}$ = 0.11 k

*Soil Pressure:*

$P_{ASD} = q_a B^2 - P_{FTG} =$

*One-way shear:* $\emptyset$ = 0.75

$V_c = 2\lambda\sqrt{f'_c}Bd =$ 10.20 k

$V_u \le \emptyset V_c$ $\emptyset V_c =$ 7.65 k

$$V_u = q_u B\left(\frac{B-C_2}{2}-d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_2}{2}-d\right)}$$

$$V_u = q_u B\left(\frac{B-C_1}{2}-d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_1}{2}-d\right)}$$

$q_u =$ 5649 psf or 5649 psf $P_u = q_u B^2 =$ 22597 #

*Two-way shear:* $\emptyset$ = 0.75

[22.6.5.2(a)] $v_c = 4\lambda\sqrt{f'_c} =$ 200 psi ⇦

[22.6.5.2(b)] $v_c = \left(2+\frac{4}{\beta}\right)\lambda\sqrt{f'_c} =$ 300 psi

[22.6.5.2(c)] $v_c = \left(2+\frac{\alpha_x d}{b_0}\right)\lambda\sqrt{f'_c} =$ 374 psi

$\beta$ = 1.00
$\alpha_x$ = 40
$b_0$ = 2($C_1$+d)+2($C_2$+d)
31

$V_u \le \phi V_c$ $\phi V_c = \phi v_c b_0 d =$ 19.76 k

$$V_u = q_u[B^2-(C_1+d)(C_2+d)] \rightarrow q_u = \frac{\emptyset V_c}{[B^2-(C_1+d)(C_2+d)]}$$

$q_u =$ 5516 psf $P_u = q_u B^2 =$ 22063 #

*Moment:* $\emptyset$ = 0.90

$M_n = A_s f_y(d - {}^{a}/_{2}) =$ 5.5 k-ft

$a = A_s f_y/(0.85 f'_c B) =$ 0.31 in

$M_u \le \emptyset M_n$ $\emptyset M_n =$ 4.9 k-ft

$$M_u = \frac{q_u B\left(\frac{B-C_2}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B-C_2)/2\right)^2}$$

$$M_u = \frac{q_u B\left(\frac{B-C_1}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B-C_1)/2\right)^2}$$

$q_u =$ 6732 psf or 6732 psf $P_u = q_u B^2 =$ 26929 #

*Development of Reinforcement:*

$$l_d = \left(\frac{3}{40}\frac{f_y}{\lambda\sqrt{f'_c}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b+K_{tr}}{d_b}\right)}\right)d_b =$$

7 in ...7 in available **OK**

Adjusted

| **Soil Bearing Pressure** | **1500 psf** | **2000 psf** | **2500 psf** | **3000 psf** | **3500 psf** | **4000 psf** |
|---|---|---|---|---|---|---|
| Max Load (lbs), Soil | 5893 | 7893 | 9893 | 11893 | 13893 | 15893 |
| Max Load (lbs), One-Way Shear | 14123 | 14123 | 14123 | 14123 | 14123 | 14123 |
| Max Load (lbs), Two-Way Shear | 13789 | 13789 | 13789 | 13789 | 13789 | 13789 |
| Max Load (lbs), Moment | 16830 | 16830 | 16830 | 16830 | 16830 | 16830 |
| **Max Load (ASD)** | **5893** | **7893** | **9893** | **11893** | **12710** | **12710** |
| **Max Load (Factored)** | **9429** | **12629** | **15829** | **19029** | **20337** | **20337** |

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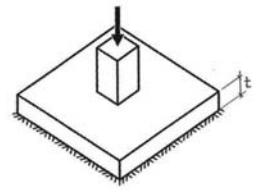
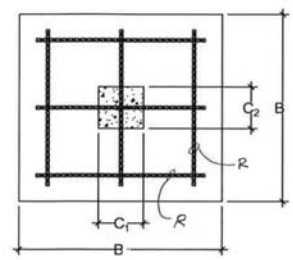
Project: Typical Footing
Footing: 30" x 30" x 8" thick




*Isolated footing*




Footing $B$ = 2.50 ft
$t$ = 8 in
Reinforcement $R$ = (3) #4
$A_{s1}$ = 0.60 in²
$d$ = 4.25 in Cover: 3 in
Column $C_1$ = 3.50 in $C_2$ = 3.50 in
Materials $f'_c$ = 2500 psi Normalweight $\lambda$ = 1.00
$f_y$ = 40000 psi Uncoated $\psi_e$ = 1.00

Net Footing Weight
$P_{FTG}$ = 0.17 k

*Soil Pressure:*

$P_{ASD} = q_a B^2 - P_{FTG} =$

*One-way shear:* $\emptyset$ = 0.75

$V_c = 2\lambda\sqrt{f_c'}Bd =$ 12.75 k

$V_u \le \emptyset V_c$ $\emptyset V_c =$ 9.56 k

$$V_u = q_u B\left(\frac{B-C_2}{2}-d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_2}{2}-d\right)} \qquad V_u = q_u B\left(\frac{B-C_1}{2}-d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_1}{2}-d\right)}$$

$q_u =$ 3974 psf or 3974 psf $P_u = q_u B^2 =$ 24838 #

*Two-way shear:* $\emptyset$ = 0.75

[22.6.5.2(a)] $v_c = 4\lambda\sqrt{f_c'} =$ 200 psi ⇦

[22.6.5.2(b)] $v_c = \left(2+\frac{4}{\beta}\right)\lambda\sqrt{f_c'} =$ 300 psi

$\beta$ = 1.00
$\alpha_x$ = 40
$b_o$ = 2(C₁+d)+2(C₂+d)
31

[22.6.5.2(c)] $v_c = \left(2+\frac{\alpha_x d}{b_0}\right)\lambda\sqrt{f_c'} =$ 374 psi

$V_u \le \phi V_c$ $\phi V_c = \phi v_c b_0 d =$ 19.76 k

$$V_u = q_u[B^2-(C_1+d)(C_2+d)] \rightarrow q_u = \frac{\emptyset V_c}{[B^2-(C_1+d)(C_2+d)]}$$

$q_u =$ 3388 psf $P_u = q_u B^2 =$ 21176 #

*Moment:* $\emptyset$ = 0.90

$M_n = A_s f_y\left(d - {}^a/_2\right) =$ 8.1 k-ft

$a = A_s f_y/(0.85f'_c B) =$ 0.38 in

$M_u \le \emptyset M_n$ $\emptyset M_n =$ 7.3 k-ft

$$M_u = \frac{q_u B\left(\frac{B-C_2}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B-C_2)/2\right)^2} \qquad M_u = \frac{q_u B\left(\frac{B-C_1}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B-C_1)/2\right)^2}$$

$q_u =$ 4797 psf or 4797 psf $P_u = q_u B^2 =$ 29984 #

*Development of Reinforcement:*

$$l_d = \left(\frac{3}{40}\frac{f_y}{\lambda\sqrt{f_c'}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b+K_{tr}}{d_b}\right)}\right)d_b =$$ 10 in ...10 in available **OK**

| **Soil Bearing Pressure** | **1500 psf** | **2000 psf** | **2500 psf** | **3000 psf** | **3500 psf** | **4000 psf** |
|---|---|---|---|---|---|---|
| Max Load (lbs), Soil | 9208 | 12333 | 15458 | 18583 | 21708 | 24833 |
| Max Load (lbs), One-Way Shear | 15524 | 15524 | 15524 | 15524 | 15524 | 15524 |
| Max Load (lbs), Two-Way Shear | 13235 | 13235 | 13235 | 13235 | 13235 | 13235 |
| Max Load (lbs), Moment | 18740 | 18740 | 18740 | 18740 | 18740 | 18740 |
| **Max Load (ASD)** | **9208** | **12333** | **13235** | **13235** | **13235** | **13235** |
| **Max Load (Factored)** | **14733** | **19733** | **21176** | **21176** | **21176** | **21176** |

Date: 3/19/2018

BTL ENGINEERING

19011 Wood-Sno Road NE, Suite 100
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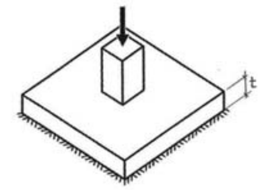
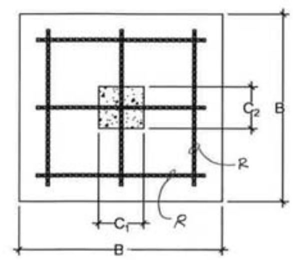
Phone: 425-814-8448
Fax: 425-821-2120

Project: Typical Footing
Footing: 36" x 36" x 12" thick



Isolated footing




Footing $B$ = 3.00 ft

$t$ = 12 in

Reinforcement $R$ = (3) #4

$A_{s1}$ = 0.60 in²

$d$ = 8.25 in Cover: 3 in

Column $C_1$ = 5.50 in $C_2$ = 5.50 in

Materials $f'_c$ = 2500 psi Normalweight $\lambda$ = 1.00

$f_y$ = 40000 psi Uncoated $\psi_e$ = 1.00

Net Footing Weight

$P_{FTG}$ = 0.36 k

*Soil Pressure:*

$P_{ASD} = q_a B^2 - P_{FTG} =$

*One-way shear:* $\emptyset$ = 0.75

$V_c = 2\lambda\sqrt{f_c'}Bd =$ 29.70 k

$V_u \le \emptyset V_c$ $\emptyset V_c =$ 22.28 k

$$V_u = q_u B\left(\frac{B-C_2}{2} - d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_2}{2} - d\right)} \qquad V_u = q_u B\left(\frac{B-C_1}{2} - d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B-C_1}{2} - d\right)}$$

$q_u =$ 7128 psf or 7128 psf $P_u = q_u B^2 =$ 64152 #

*Two-way shear:* $\emptyset$ = 0.75

[22.6.5.2(a)] $v_c = 4\lambda\sqrt{f_c'} =$ 200 psi ⇦

[22.6.5.2(b)] $v_c = \left(2 + \frac{4}{\beta}\right)\lambda\sqrt{f_c'} =$ 300 psi

$\beta$ = 1.00

$\alpha_x$ = 40

[22.6.5.2(c)] $v_c = \left(2 + \frac{\alpha_x d}{b_0}\right)\lambda\sqrt{f_c'} =$ 400 psi

$b_0$ = 2(C1+d)+2(C2+d)

55

$V_u \le \phi V_c$ $\phi V_c = \phi v_c b_0 d =$ 68.06 k

$$V_u = q_u[B^2 - (C_1 + d)(C_2 + d)] \rightarrow q_u = \frac{\emptyset V_c}{[B^2 - (C_1 + d)(C_2 + d)]}$$

$q_u =$ 8854 psf $P_u = q_u B^2 =$ 79687 #

*Moment:* $\emptyset$ = 0.90

$M_n = A_s f_y\left(d - {}^{a}/_{2}\right) =$ 16.2 k-ft

$a = A_s f_y/(0.85 f'_c B) =$ 0.31 in

$M_u \le \emptyset M_n$ $\emptyset M_n =$ 14.6 k-ft

$$M_u = \frac{q_u B\left(\frac{B-C_2}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B-C_2)/2\right)^2} \qquad M_u = \frac{q_u B\left(\frac{B-C_1}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B-C_1)/2\right)^2}$$

$q_u =$ 6013 psf or 6013 psf $P_u = q_u B^2 =$ 54121 #

*Development of Reinforcement:*

$$l_d = \left(\frac{3}{40}\frac{f_y}{\lambda\sqrt{f_c'}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b + K_{tr}}{d_b}\right)}\right)d_b =$$

12 in ...12 in available **OK**

| **Soil Bearing Pressure** | **1500 psf** | **2000 psf** | **2500 psf** | **3000 psf** | **3500 psf** | **4000 psf** |
|---|---|---|---|---|---|---|
| Max Load (lbs), Soil | 13140 | 17640 | 22140 | 26640 | 31140 | 35640 |
| Max Load (lbs), One-Way Shear | 40095 | 40095 | 40095 | 40095 | 40095 | 40095 |
| Max Load (lbs), Two-Way Shear | 49805 | 49805 | 49805 | 49805 | 49805 | 49805 |
| Max Load (lbs), Moment | 33825 | 33825 | 33825 | 33825 | 33825 | 33825 |
| **Max Load (ASD)** | **13140** | **17640** | **22140** | **26640** | **31140** | **33825** |
| **Max Load (Factored)** | **21024** | **28224** | **35424** | **42624** | **49824** | **54121** |

Date: 3/19/2018

BTL ENGINEERING
19011 Wood-Sno Road NE, Suite 100
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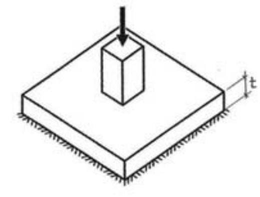
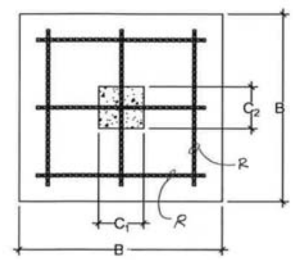
Project: Typical Footing
Footing: 42" x 42" x 12" thick




Isolated footing




Footing $B$ = 3.50 ft
$t$ = 12 in
Reinforcement $R$ = (4) #4
$A_{s1}$ = 0.80 in²
$d$ = 8.25 in Cover: 3 in
Column $C_1$ = 5.50 in $C_2$ = 5.50 in
Materials $f'_c$ = 2500 psi Normalweight $\lambda =$ 1.00
$f_y$ = 40000 psi Uncoated $\psi_e =$ 1.00
Net Footing Weight
$P_{FTG}$ = 0.49 k
*Soil Pressure:*
$P_{ASD} = q_a B^2 - P_{FTG} =$

*One-way shear:* $\emptyset$ = 0.75
$V_c = 2\lambda\sqrt{f'_c}Bd =$ 34.65 k
$V_u \le \emptyset V_c$ $\emptyset V_c =$ 25.99 k

$$V_u = q_u B\left(\frac{B - C_2}{2} - d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B - C_2}{2} - d\right)}$$ $$V_u = q_u B\left(\frac{B - C_1}{2} - d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B - C_1}{2} - d\right)}$$

$q_u =$ 5606 psf or 5606 psf $P_u = q_u B^2 =$ 68677 #

*Two-way shear:* $\emptyset$ = 0.75
[22.6.5.2(a)] $v_c = 4\lambda\sqrt{f'_c} =$ 200 psi ⇦
[22.6.5.2(b)] $v_c = \left(2 + \frac{4}{\beta}\right)\lambda\sqrt{f'_c} =$ 300 psi
$\beta$ = 1.00
$\alpha_x$ = 40
$b_0$ = 2(C₁+d)+2(C₂+d)
55
[22.6.5.2(c)] $v_c = \left(2 + \frac{\alpha_x d}{b_0}\right)\lambda\sqrt{f'_c} =$ 400 psi
$V_u \le \phi V_c$ $\phi V_c = \phi v_c b_0 d =$ 68.06 k

$$V_u = q_u[B^2 - (C_1 + d)(C_2 + d)] \rightarrow q_u = \frac{\emptyset V_c}{[B^2 - (C_1 + d)(C_2 + d)]}$$

$q_u =$ 6223 psf $P_u = q_u B^2 =$ 76233 #

*Moment:* $\emptyset$ = 0.90
$M_n = A_s f_y\left(d - {}^a/_2\right) =$ 21.5 k-ft
$a = A_s f_y/(0.85 f'_c B) =$ 0.36 in
$M_u \le \emptyset M_n$ $\emptyset M_n =$ 19.4 k-ft

$$M_u = \frac{q_u B\left(\frac{B - C_2}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B - C_2)/2\right)^2}$$ $$M_u = \frac{q_u B\left(\frac{B - C_1}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B - C_1)/2\right)^2}$$

$q_u =$ 4785 psf or 4785 psf $P_u = q_u B^2 =$ 58622 #

*Development of Reinforcement:*
$$l_d = \left(\frac{3}{40}\frac{f_y}{\lambda\sqrt{f'_c}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b + K_{tr}}{d_b}\right)}\right)d_b =$$ 12 in ...15 in available **OK**

| **Soil Bearing Pressure** | **1500 psf** | **2000 psf** | **2500 psf** | **3000 psf** | **3500 psf** | **4000 psf** |
|---|---|---|---|---|---|---|
| Max Load (lbs), Soil | 17885 | 24010 | 30135 | 36260 | 42385 | 48510 |
| Max Load (lbs), One-Way Shear | 42923 | 42923 | 42923 | 42923 | 42923 | 42923 |
| Max Load (lbs), Two-Way Shear | 47646 | 47646 | 47646 | 47646 | 47646 | 47646 |
| Max Load (lbs), Moment | 36639 | 36639 | 36639 | 36639 | 36639 | 36639 |
| **Max Load (ASD)** | **17885** | **24010** | **30135** | **36260** | **36639** | **36639** |
| **Max Load (Factored)** | **28616** | **38416** | **48216** | **58016** | **58622** | **58622** |

Date: 3/19/2018

BTL ENGINEERING

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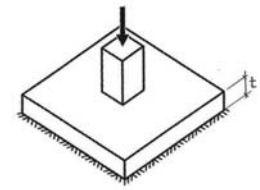
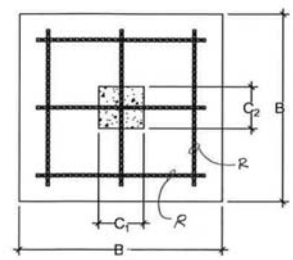
Project: Typical Footing
Footing: 48" x 48" x 12" thick



Isolated footing




Footing $B$ = 4.00 ft
$t$ = 12 in
Reinforcement $R$ = (5) #4
$A_{s1}$ = 1.00 in²
$d$ = 8.25 in   Cover: 3 in
Column $C_1$ = 5.50 in   $C_2$ = 5.50 in
Materials $f'_c$ = 2500 psi   Normalweight   $\lambda$ = 1.00
$f_y$ = 40000 psi   Uncoated   $\psi_e$ = 1.00
Net Footing Weight
$P_{FTG}$ = 0.64 k
*Soil Pressure:*
$P_{ASD} = q_a B^2 - P_{FTG} =$

*One-way shear:* $\emptyset$ = 0.75
$V_c = 2\lambda\sqrt{f'_c}Bd =$ 39.60 k
$V_u \leq \emptyset V_c$   $\emptyset V_c =$ 29.70 k

$$V_u = q_u B\left(\frac{B - C_2}{2} - d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B - C_2}{2} - d\right)}$$

$$V_u = q_u B\left(\frac{B - C_1}{2} - d\right) \rightarrow q_u = \frac{\emptyset V_c}{B\left(\frac{B - C_1}{2} - d\right)}$$

$q_u =$ 4644 psf or 4644 psf   $P_u = q_u B^2 =$ 74298 #

*Two-way shear:* $\emptyset$ = 0.75
[22.6.5.2(a)] $v_c = 4\lambda\sqrt{f'_c} =$ 200 psi ⇦
[22.6.5.2(b)] $v_c = \left(2 + \frac{4}{\beta}\right)\lambda\sqrt{f'_c} =$ 300 psi   $\beta$ = 1.00
$\alpha_x$ = 40
[22.6.5.2(c)] $v_c = \left(2 + \frac{\alpha_x d}{b_0}\right)\lambda\sqrt{f'_c} =$ 400 psi   $b_0$ = 2($C_1$+d)+2($C_2$+d)
55
$V_u \leq \phi V_c$   $\phi V_c = \phi v_c b_0 d =$ 68.06 k

$$V_u = q_u[B^2 - (C_1 + d)(C_2 + d)] \rightarrow q_u = \frac{\emptyset V_c}{[B^2 - (C_1 + d)(C_2 + d)]}$$

$q_u =$ 4634 psf   $P_u = q_u B^2 =$ 74147 #

*Moment:* $\emptyset$ = 0.90
$M_n = A_s f_y\left(d - {}^{a}\!/_{2}\right) =$ 26.8 k-ft
$a = A_s f_y/(0.85f'_c B) =$ 0.39 in
$M_u \leq \emptyset M_n$   $\emptyset M_n =$ 24.2 k-ft

$$M_u = \frac{q_u B\left(\frac{B - C_2}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B - C_2)/2\right)^2}$$

$$M_u = \frac{q_u B\left(\frac{B - C_1}{2}\right)^2}{2} \rightarrow q_u = \frac{2\emptyset M_n}{B\left((B - C_1)/2\right)^2}$$

$q_u =$ 3853 psf or 3853 psf   $P_u = q_u B^2 =$ 61640 #

*Development of Reinforcement:*

$$l_d = \left(\frac{3}{40}\frac{f_y}{\lambda\sqrt{f'_c}}\frac{\psi_t\psi_e\psi_s}{\left(\frac{c_b + K_{tr}}{d_b}\right)}\right)d_b =$$

12 in   ...18 in available   **OK**

| **Soil Bearing Pressure** | **1500 psf** | **2000 psf** | **2500 psf** | **3000 psf** | **3500 psf** | **4000 psf** |
|---|---|---|---|---|---|---|
| Max Load (lbs), Soil | 23360 | 31360 | 39360 | 47360 | 55360 | 63360 |
| Max Load (lbs), One-Way Shear | 46436 | 46436 | 46436 | 46436 | 46436 | 46436 |
| Max Load (lbs), Two-Way Shear | 46342 | 46342 | 46342 | 46342 | 46342 | 46342 |
| Max Load (lbs), Moment | 38525 | 38525 | 38525 | 38525 | 38525 | 38525 |
| **Max Load (ASD)** | **23360** | **31360** | **38525** | **38525** | **38525** | **38525** |
| **Max Load (Factored)** | **37376** | **50176** | **61640** | **61640** | **61640** | **61640** |

Date: 3/19/2018