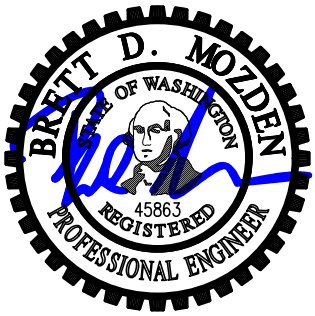
Structural Calculations For:

Ackley Residence

9603 SE 61st Place

Mercer Island, WA 98040



Prepared for:	Brandt Design Group
Job #:	01519-2025-01
Date:	May 30, 2025

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Criteria Sheet

Codes

Structural	IBC 2021
Loading	ASCE 7-16
Wood:	NDS 2018 / SDPWS 2021
Steel:	AISC 360-16
Concrete:	ACI 318-19
Masonry:	TMS 402/602-16

Project Location

Street & Number	9603 SE 61st Place		
City:	Mercer Island	State:	WA
ZIP:	98040		
Latitude:	47.5480	N	
Longitude:	-122.2116	W	
Ground Elevation	127	ft	

Occupancy Category

Risk Category: II — ASCE 7 Table 1.5-1

Seismic Load Summary:

Analysis Procedure:	Equivalent Lateral Force Procedure		
Lateral System:	Light-frame (wood) Walls Sheathed with Wood Structural Panels Rated for Shear Resistance		
R:	6.50	C_d=	4
Base Shear V =	20 kips	Ω_o=	2.5
S_S=	1.45	S_1=	0.502
S_{DS}=	1.16	S_{D1}=	0.57
C_s=	0.178	I_E=	1.0

Story Information

# Stories Above Grade (Including Mezzanine Levels)	3

Horizontal and Vertical Irregularities:

Is the building a "Regular Structure"? (No horizontal or vertical irregularities)	No

Wind Load Summary:

V=	98	K_{ZT}=	1.00
Exposure =	C		

Dead Loads:

Roof			Floor		
Roofing	1	psf	Finish Floor	2	psf
1/2" Sheathing	1.8	psf	3/4" Sheathing	2.7	psf
Trusses @ 24" oc	2.5	psf	Joists @ 16" oc	2.2	psf
Misc./Mech.	1.5	psf	Misc./Mech.	2	psf
Ceiling Finish	2.8	psf	Ceiling Finish	2.8	
Solar Panels	5	psf		11.7	psf
	15	psf	Use	12	psf
Use	12	psf	Add'l Seismic Weight	10	psf
Add'l Seismic Weight	5	psf	Seismic Weight	22	psf
Seismic Weight	17	psf			

Live Loads:

Roof	20	psf
Floor	40	psf

Snow Loading Criteria:

Ground Snow, p_g	25 psf	Flat Roof Snow Load, p_f	25.0 psf	Importance Factor, I_s	1.00
Exposure Factor, C_e	1.00	Sloped Roof Snow Load, p_s	25.0 psf		
Thermal Factor, C_t	1.00	Slope Factor, C_s	1.00		

Soils:

Allowable Bearing	2500 psf	Active	N/A	pcf (Restrained/Unrestrained)
Sliding, μ	0.4	Seismic Surcharge	N/A	
Passive	300 pcf			

Soils Report Provided?	Yes
Site Specific Ground Motion Hazard Analysis Provided?	Yes

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Seismic Design

ASCE 7-16 Seismic Analysis | Equivalent Lateral Force Procedure | Apply Section 12.8.1.3 (Where Applicable)? Yes

Seismic Force Resisting System Per Table 12.2-1	System	Bearing Wall Systems
	Type:	Light-frame (wood) Walls Sheathed with Wood Structural Panels Rated for Shear Resistance

Seismic Design Cat.	D	
Risk Category	II	I, II, or III, or IV per Table 1.5-1
Site Class	D (Default)	Assumed default soil properties, per 11.4.3.
Diaphragm Flexibility	Flexible	

Section 12.8.1.3

1. Regular Structure	No
2. ≤ 5 Stories above grade	Yes
3. T ≤ 0.5s	Yes
4. ρ = 1.0	No
5. Not Site Class E or F	Yes
6. Risk Category I or II	Yes

If all items above are met, S_{DS} may be taken as 1.0, but not less than 0.7*(Calculated S_{DS})

S_S	1.45 g	2% in 50 yr, Latitude & Longitude lookup
S_1	0.502 g	2% in 50 yr, Latitude & Longitude lookup
R	6.50	
C_d	4.0	
Ω_o	2.5	
I_e	1.00	Table 1.5-2
h_n	28.5 ft	
Ct	0.02	Table 12.8-2
x	0.75	Table 12.8-2
T_a	0.25 sec	
T	0.25 sec	Eq. 12.8-7
T_0	0.10 sec	
T_S	0.49 sec	
T_L	6.00 sec	
F_a	1.20	Table 11.4-1
F_v	1.70	Table 11.4-2
S_{MS}	1.74 g	Eq. 11.4-1
S_{M1}	0.85 g	Eq. 11.4-2
S_{DS}	1.160 g	Eq. 11.4-3
S_{D1}	0.569 g	Eq. 11.4-4
C_s	***0.178 Controls***	Eq. 12.8-2
	0.355	Eq. 12.8-3 need not exceed, T < T_L
	0.010	Eq. 12.8-5 or 12.8-6 minimum
C_s, design	0.178	
Bldg. Weight	110.7 k	
V = C_SW	19.8 k	Eq. 12.8-1, Strength Level Base Shear
V = C_{Sasd}W	13.8 k	Eq. 12.8-1 ASD Base Shear

Building Period Per Alternate Analysis

T (sec)	

Per Geotech Report

F_a	
F_v	

$$T_a = C_t h_n^x \quad \text{Eq. 12.8.7}$$

$$S_{MS} = F_a S_S \quad \text{Eq. 11.4-1}$$
$$S_{M1} = F_v S_1 \quad \text{Eq. 11.4-2}$$
$$S_{DS} = {}^2/_3\, S_{MS} \quad \text{Eq. 11.4-3}$$
$$S_{D1} = {}^2/_3\, S_{M1} \quad \text{Eq. 11.4-4}$$

$$C_S = \frac{S_{DS}}{(R/I_e)} \quad \text{Eq. 12.8-2}$$
$$C_S = \frac{S_{D1}}{T(R/I_e)} \quad \text{Eq. 12.8-3}$$
$$C_S = \frac{S_{D1} T_L}{T^2(R/I_e)} \quad \text{Eq. 12.8-4}$$
$$C_S \geq 0.044 S_{DS} I_e \quad \text{Eq. 12.8-5}$$
$$C_S \geq 0.01 \quad \text{Eq. 12.8-5}$$
$$C_S \geq 0.5 \frac{S_1}{(R/I_e)} \quad \text{Eq. 12.8-6}$$

$$C_{VX} = w_x h_x^k / \sum_{i=1}^{n} w_x h_i^k \quad \text{Eq. 12.8-12}$$

$$F_{px} = {}^{\sum_{i=x}^{n} F_i}/_{\sum_{i=x}^{n} w_i}\, w_{px} \quad \text{Eq. 12.10-1}$$
$$F_{px} \geq 0.2 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-2}$$
$$F_{px} \leq 0.4 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-3}$$

Vertical Distribution ASD ρ= 1.3 k= 1.000

Level	h_x (ft)	W_x (k)	h_x^k (ft)	$W_x h_x^k$	Story Shear ASD			Diaphragm Force (ρ not included)				
					C_{vx} (%)	F_x (k)	SV (k)	$F_{px,calc}$	$F_{px,min}$	$F_{px,max}$	$F_{px,design}$	γ=F_{px}/F_x
Roof	28.5	36.9	28.5	1052	0.479	8.6	**8.6**	6.6	6.0	12.0	**6.6**	0.77
Upper	20.5	36.9	20.5	756	0.345	6.2	**14.8**	5.7	6.0	12.0	**6.0**	0.97
Main	10.5	37	10.5	387	0.176	3.2	**18.0**	4.6	6.0	12.0	**6.0**	1.89
Σ		110.7		2196		**18.0**						

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Wind Design - MWFRS

ASCE 7 Chapter 27 - Directional Procedure

Design Method	ASD

Wind Coefficients

Exposure	C	
V=	98	mph
K_d=	0.85	Table 26.6-1
K_h=	0.99	Table 27.3-1
K_e=	1.00	Table 26.9-1
G=	0.85	26.9.4

Transverse Wind Pressures

L/B = 0.37 h/L = 1.12

Pressure Coefficients from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.50
Windward Roof	-1.3 / -0.18
Leeward Roof	-0.70

Location and Building Dimensions

Calculate Kzt?	No	
Kzt	1.00	
Roof Type	Monoslope	
Roof Slope - Transverse Dir	0	degrees
Roof Slope - Long Dir	0	degrees
Ground to top of roof	30.5	ft
Bot of roof to top of roof	0	ft
Mean Roof Height, h	30.5	ft
Short Plan Dimension	27.25	ft
Long Plan Dimension	73	ft
Parapet ?	No	
Ground to top of parapet		ft
Average Parapet Height		ft

Velocity Pressure at Mean Roof Height, q_h =	20.5	psf

Wall Pressures (Unfactored): ASD

Ht	K_z	q_z	$P_{ww\ walls}$	$P_{lwwalls}$	**P_{walls} (psf)**
0-15	0.85	17.68	12.02	8.71	**12.4**
15-20	0.9	18.72	12.73	8.71	**12.9**
20-25	0.94	19.55	13.30	8.71	**13.2**
25-30	0.98	20.39	13.86	8.71	**13.5**
30-40	1.04	21.63	14.71	8.71	**14.1**
41-50	1.09	22.67	15.42	8.71	**14.5**
51-60	1.13	23.51	15.98	8.71	**14.8**
61-70	1.17	24.34	16.55	8.71	**15.2**
71-80	1.21	25.17	17.12	8.71	**15.5**
81-90	1.24	25.80	17.54	8.71	**15.8**
91-100	1.26	26.21	17.82	8.71	**15.9**

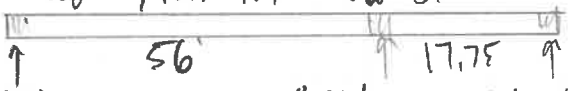
Roof Pressures (Unfactored) ASD

Windward		Leeward	**Horiz Proj (psf)**
Max	Min		
-3.1	-22.7	-12.2	**5.44**

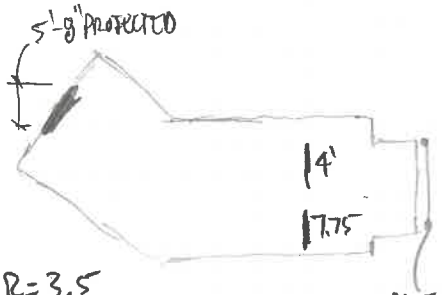
LATERAL DESIGN

N/S

ROOF: West $v_{eq} = 8.6/73.75 = 117^{\#}$ $v_w = 81^{\#}$ East



V(w) EG/w	3.28/2.27	4.31/2.99	1.04/.72
L(ft)	5.67'	11.75	O.M.F.
v(#/')	578	367	SEE
SW	1x12	1x13	N. PAGE
OT	4.63	2.93	
HD	(3)CS16	(2)CS16	

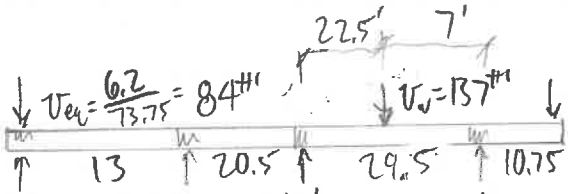


$R = 3.5$

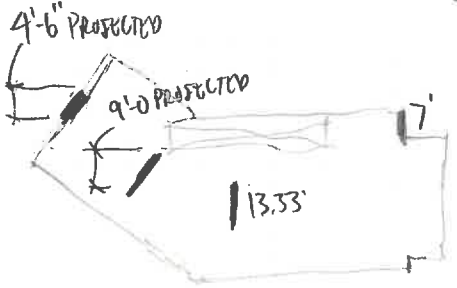
↳ $V_{eq} = 2.75^{k}$ STRENGTH (w/ P)

$\Delta_a = .025(102") = 2.55"$ / 3 Cd = .85" IN MODEL

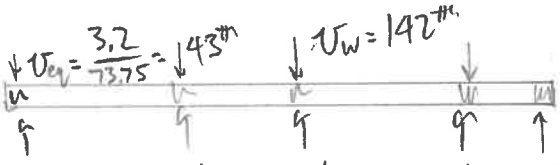
UPPER: $v_{eq} = 6.2/73.75 = 84^{\#}$ $v_w = 137^{\#}$



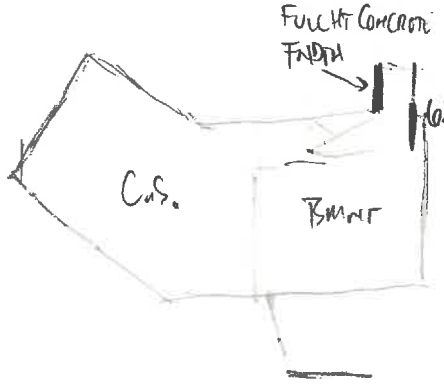
V(w) EG/w	3.83/3.16	1.41/2.29	3.12/4.13	5.43/5.77
L(ft)	4.5	9	13.33	7
v(#/')	851	254	310	824
SW	2W3	W6	W4	2W3
OT	7.66+4.63	2.29	2.79	8.51
HD	HDU14	HDU2	HDU4	HDU11



MAIN: $v_{eq} = 3.2/73.75 = 43^{\#}$ $v_w = 142^{\#}$



V(k) EG/w	4.11/4.00	2.13/4.67	4.2/7.60	6.3/8.6	.23/1.76
L(ft)	From	From	From	From	6.25'
v(#/')					122
SW					W6
OT					—
HD					—



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STRUCTURAL ENGINEERING

PROJECT: Acker Residence

DATE: 5/20/25

PROJ. #: 0519-2025-01

DESIGN: BDM

SHEET: L1

Analysis Information

FEA Model Node Count:4
FEA Model Member Count:3 (3 unique)
FEA Model Degrees of Freedom: 24
FEA Stiffness Matrix Terms: 193
FEA Stiffness Diagonal Maximum: 82792.1568627451, Minimum: 1108.46356517942
Lowest Frequencies Calculated (Hz) : 6.712, 225.54, 241.5, 241.57

Model Check Information

No errors were found in your model.

Model Summary

Model Dimensions:
X: 19.5 ft
Y: 8.5 ft
Z: 0 ft
Object Counts:
Nodes: 4
Spring Supports: 0
Members: 3
Cables: 0
Areas: 0
Plates: 0
Auto-Meshed Areas: 0
Auto-Meshed Plates: 0
Foundations: 0
Nonlinear Features:
One-Way Spring Supports: 0
One-Way Members: 0

Factored Load Combinations

Name	Code	Effective Equation	Design	Deflection
1. 1.4D	ASCE 7-16 LRFD	1.4D	Strength	Other
2. 1.2D+1.6L+0.5Lr	ASCE 7-16 LRFD	1.2D	Strength	Other
5. 0.9D+W	ASCE 7-16 LRFD	0.9D	Strength	Other
6. 1.2D+E+L+0.2S »+X	ASCE 7-16 LRFD	1.2D + E+X	Strength	Other
7. 0.9D+E »+X	ASCE 7-16 LRFD	0.9D + E+X	Strength	Other

Nodes

Name	X ft	Y ft	Support	Mass K	Scissor
N001	0.0000	0.0000	Pinned	0.0000	No
N002	19.5000	0.0000	Pinned	0.0000	No
N003	0.0000	8.5000	Free	0.0000	No
N004	19.5000	8.5000	Free	0.0000	No

Nodal Supports

Name	Fix DX	Fix DY	Fix RZ
N001	Yes	Yes	No
N002	Yes	Yes	No

Nodal Loads

Node	Service Case	Type & Direction	Magnitude	Predefined Load
N003	E+X	Force X	2.7500 K	N.A.

Members

Name	Node 1	Node 2	Shape	Material	End Connection	Crossing Connection?	Beta, B deg	Length ft	Weight K	Offset y in	Offset z in	Framing	Action
BmX001	N003	N004	HSS7X4X.500	ASTM A500 Grade C (Fy = 50ksi)	Rigid Connect	Yes	0.0000	19.5000	0.5855	0.0000	0.0000	Beam	Normal
COL001	N001	N003	HSS7X4X.500	ASTM A500 Grade C (Fy = 50ksi)	Rigid Connect	Yes	0.0000	8.5000	0.2552	0.0000	0.0000	Column	Normal
COL002	N004	N002	HSS7X4X.500	ASTM A500 Grade C (Fy = 50ksi)	Rigid Connect	Yes	0.0000	8.5000	0.2552	0.0000	0.0000	Column	Normal

Member Connection Forces

Member	Result Case	Location	Fx K	Ry K	Rz K	Torsion K-ft	My K-ft	Mz K-ft
BmX001	1. 1.4D	Start	-0.1214	0.4098	0.0000	0.0000	0.0000	-1.0316
BmX001	6. 1.2D+E+L+0.2S »+X	End	-1.4784	1.5500	0.0000	0.0000	0.0000	-12.5667
BmX001	6. 1.2D+E+L+0.2S »+X	Start	-1.4784	-0.8474	0.0000	0.0000	0.0000	10.8083
BmX001	E+X	Start	-1.3744	-1.1987	0.0000	0.0000	0.0000	11.6925
COL001	1. 1.4D	End	-0.4098	0.1214	0.0000	0.0000	0.0000	-1.0316
COL001	1. 1.4D	Start	-0.7671	-0.1214	0.0000	0.0000	0.0000	0.0000
COL001	E+X	End	1.1987	-1.3756	0.0000	0.0000	0.0000	11.6925
COL001	E+X	Start	1.1987	1.3756	0.0000	0.0000	0.0000	0.0000
COL002	6. 1.2D+E+L+0.2S »+X	End	-1.8563	-1.4784	0.0000	0.0000	0.0000	0.0000
COL002	6. 1.2D+E+L+0.2S »+X	Start	-1.5500	1.4784	0.0000	0.0000	0.0000	-12.5667

Ry and Rz reactions are positive when in the direction of member local y and z (i.e. in typical situations uplift is negative).

Member Displacements (extreme rows: max and min)

Member	Dy Min in	Dy Max in	Dz Min in	Dz Max in
COL001	**-0.7114 (6)**	**0.0056 (3)**	0.0000 (7)	0.0000 (7)
COL002	**-0.0001 (3)**	**0.7101 (2)**	0.0000 (7)	0.0000 (7)

Member Stresses (extreme rows: max and min)

Member	fa Min Ksi	fa Max Ksi	fby Min Ksi	fby Max Ksi	fbz Min Ksi	fbz Max Ksi	fc comb Min Ksi	fc comb Max Ksi
BmX001	-0.1678 (6)	-0.0089 (5)	0.0000 (7)	0.0000 (7)	**-10.4103 (6)**	**10.4103 (6)**	-10.5781 (6)	**10.2425 (6)**
COL001	**-0.0871 (3)**	**0.1361 (2)**	0.0000 (7)	0.0000 (7)	**-9.6861 (2)**	**9.6861 (2)**	**-9.5500 (2)**	**9.8222 (2)**
COL002	**-0.2107 (6)**	**-0.0299 (5)**	0.0000 (7)	0.0000 (7)	**-10.4103 (6)**	**10.4103 (6)**	**-10.5862 (6)**	10.2344 (6)

Node Reactions (extreme rows: max and min)

Node	Result Case	FX K	FY K	MZ K-ft
N001	1. 1.4D	**0.1214**	0.7671	0.0000

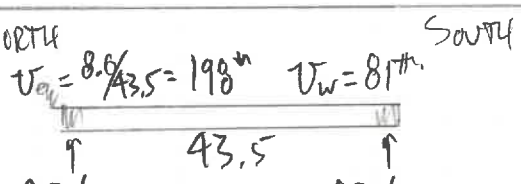
Node Reactions (continued)

(extreme rows: max and min)

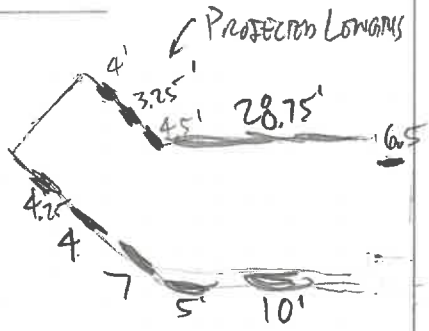
Node	Result Case	FX K	FY K	MZ K-ft
N001	E+X	-1.3756	**-1.1987**	0.0000
N002	6. 1.2D+E+L+0.2S »+X	**-1.4784**	**1.8563**	0.0000

E/W

ROOF:

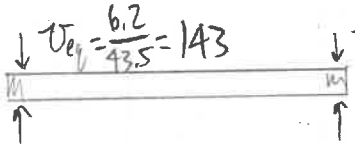


V(k) EQ/W	4.3/1.76	4.3/1.76
L(ft)	47'	30.25
v(#/')	91#/'	142
SW	1w6 @ EXSTG	1w6 @ EXSTG
OT	—	—
HD	—	—

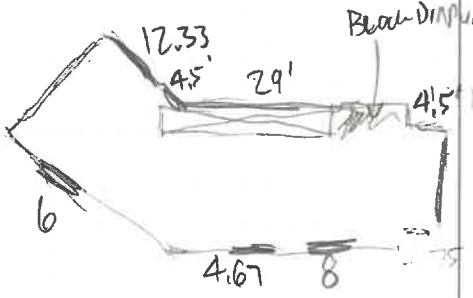


FROM (E) 1984 DWGS
EXTERIOR WALLS ARE 1/2" SHTG W/8d @ 6"o/c
CONSERVATIVELY ASSUME 150#/' IN Δx

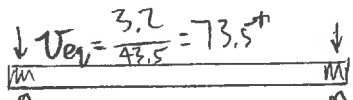
UPPER:



V(k) EQ/W	7.41/4.74	7.41/4.74
L(ft)	50.33	18.67
v(#/')	147	396
SW	1w6 @ EXSTG	1w13
OT	—	3.57k
HD	—	HDU4/(2)CSI6

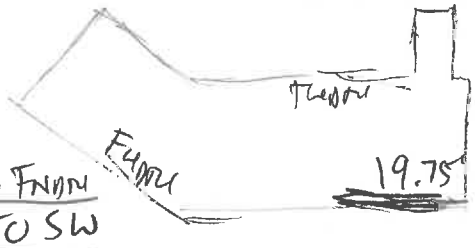


MAIN:



V(k) EQ/W	9.01/7.83	9.01/7.83
L(ft)	FNDTN	19.75
v(#/')		305
SW		1w14
OT		2.75k
HD		HDU4

ASSUME 1/2 TO FNDN AND 1/2 TO SW
V = 4.5k TO SW



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STRUCTURAL ENGINEERING

PROJECT: ACKLEY RESIDENCE

DATE: 5/20/25

PROJ. #: 0579-2025-01

DESIGN: BDM

SHEET: L5

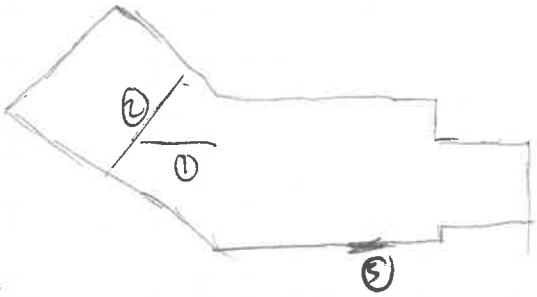
GRAVITY DESIGN

ROOF

① - Bm

$w = 480^{plf}$
$L = 9.75'$
$R = 2.3^{k}$
$m = 5.7^{k\text{-}ft}$

$f_b = .49^{ksi}$
$f_v = 48^{psi}$
$\Delta_{TL} = .06'' = \ell/2018$
LSL $3\frac{1}{2} \times 15\frac{1}{2}$



② - Bm

$w_1 = 80^{plf}$ $w_2 = 140^{plf}$
$P = 2.3^{k}$
$L_1 = 14.5'$ $L_2 = 8.75'$
$R_1 = 1.9^{k}$ $R_2 = 2.79^{k}$
$m = 19.06^{k\text{-}ft}$

$f_b = .82^{ksi}$
$f_v = 36^{psi}$
$\Delta_{TL} = .31'' = \ell/757$
(4) LVL $1\frac{3}{4} \times 15\frac{1}{2}$

③ - TYP HDR

$w = 400^{plf}$
$L = 5'$
$R = 1.0^{k}$
$m = 1.25^{k\text{-}ft}$

$f_b = .57^{ksi}$
$f_v = 52^{psi}$
$\Delta_{TL} = .05'' = \ell/1321$
(2) 2x8

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STRUCTURAL ENGINEERING

PROJECT ACKLEY

DATE 5/27/25
PROJ # 2019-2025-C1
DESIGN BDM
SHEET G1

e UPPER FLOOR

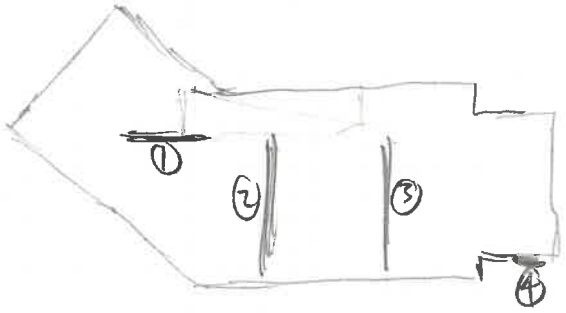
① - Bm

$w_1 = 670^{\#}$ $w_2 = 295^{\#}$ $f_b = 1.04^{ksi}$

$L = 10.25'$ $f_v = 83^{psi}$

$R_1 = 2.79^{k}$ $R_2 = 2.15^{k}$ $\Delta_{TL} = .17" = \ell/727$

$M = 6.39^{k\text{-}ft}$ 4X12



② - Bm

$w_1 = w_2 = 67^{\#}$

$P = 2.27^{k}$

$L_1 = 11.75$ $L_2 = 8.75$

$R_1 = 1.66^{k}$ $R_2 = 1.99^{k}$

$M = 14.8^{k\text{-}ft}$

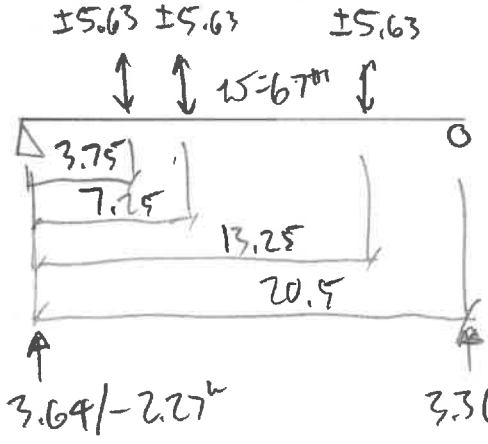
$f_b = 1.61^{ksi}$

$f_v = 49^{psi}$

$\Delta_{TL} = .76" = \ell/323$ $\Delta_{LL} = .59" = \ell/417$

(3) LVL 1¾ x 11¼

③ - XFER Bm w/ OT $S_D = 2.5$



$M_{max} = 22.6^{k\text{-}ft}$

$f_b = 2.95^{ksi}$

$f_v = 92^{psi}$

$\Delta_{TL} = .21" = \ell/1151$ (NO OT)

(3) LVL 1¾ x 11¼

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(A) - HDR

$w = 546^{\#}$
$L = 5'$
$R = 1.37^{k}$
$M = 1.71^{k\text{-}ft}$

$f_b = .78^{ksi}$
$f_v = 71^{psi}$
$\Delta_{TL} = .06" = L/968$
(2) 2x8

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STRUCTURAL ENGINEERING

PROJECT Ackley

DATE 5/27/25
PROJ. # 01519-2025-01
DESIGN BDM
SHEET G3

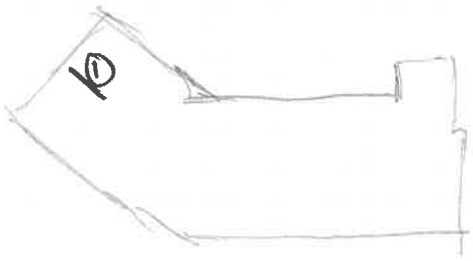
• LOWER FLOOR FRAMING

① BM

W = 1250#
L = 6.75
R = 4.2k
M = 7.1k-ft

f_b = .9ksi
f_v = 90psi
Δ_{TL} = .08" = L/965

(3) 2x12



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STRUCTURAL ENGINEERING

PROJECT Ackley

DATE 5/29/15
PROJ. # 01519-2015-01
DESIGN BDM
SHEET G4