R.E.O. ENGINEERING, P.C.
CIVIL ENGINEERING CONSULTANTS
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July 31, 2023

Attn: Tom Elder
Dreams & Designs Buildings
P.O. Box 7014
Lee's Summit, MO 64064

RE: R.E.O. Project #21-002-55
MD2 Designs Plan #: DD-7167
Additional comment response
1609 SW 27th St., Lee's Summit, MO
Permit #: PPRES20215798

Dear Mr. Elder,

We are providing herewith additional statement regarding items identified in an inspection of the residential construction at the above referenced address. Below the wall behind the double vanity in the Master Bedroom one of the double I-joists is cut approximately 75-percent through. This wall is non-bearing and does not support any ceiling or roof loading. The joist span from beam to beam at location of the cut joist is ten feet two inches (10'-2"). The directly adjacent 9-1/2" manufactured joist is adequate to support applied floor loads and wall dead loads above with no modification.

The cut joist is not required for the floor support system and may remain in place as-installed with no modification. If there are any questions, please contact our Offices.

Very Truly Yours,

R.E.O. ENGINEERING, P.C.

By: _____, President
Aaron D. Obermiller, P.E.

ADDENDUM: Calculations for oversized holes attached.

OVERSIZED HOLES IN LVL's:

A series of oversized holes (~3" with prescriptively allowed 2") for the Master Bath bathtub and zero-entry shower drains runs through the midline of several double LVL members in the floor framing around those features. An I-joist layout with as-built notations for LVL modifications and drain line location around the zero-entry shower is attached for reference.

Member A1: Header at interior face of zero-entry shower, ~6ft length, drain located at ~2ft from end. Hole is < 3inches diameter, maximum size hole permitted is 2d/3 (where d - depth of member, 9.5 inches) = 6-1/3 inches. Maximum size condition met.

Net Bending Capacity:

$M_{net} = C_{hole,M} M_{gross} = 0.95*(S_{net}/S_{gross})*M_{gross}$

M_{net}	= Net bending capacity with holes, ft-lbs
$C_{hole,M}$	= Hole effect factor = 0.95 * (Snet/Sgross)
	= 0.92
M_{gross}	= Bending Capacity without holes (mfg. table)
	= 13,057 ft-lbs
S_{gross}	= Gross section modulus without holes, $in^3 = (b*h^2)/6$
	= 52.65 in3
S_{net}	= Net section modulus with holes $in^3 = (1/6) * ((b(h_2^3-h_1^3))/h_2)$
$M_{@hole}$	= 1,700 ft-lbs (attached calculation output)

M_{net} = 12,015 ft-lbs > $M_{@hole}$ = 1,700 ft-lbs **OK**

Net Shear Capacity:

$V_{net} = C_{hold,V} V_{gross} = ((d-D)/d)^2*Vgross$

V_{net}	= Net shear capacity with holes, lbs
$C_{hole,V}$	= Hole effect factor = ((d-D)/d)^2
	= 0.47
Vgross	= Gross shear capacity without holes (mfg. table)
	= 4,322 lbs
d	= LVL depth (all members 9.5")
	= 9-1/2"
D	= Hole diameter <= 2d/3 or 16in whichever is smaller
	= <3 in
$V_{@hole}$	= 422 lbs (attached calculation output)

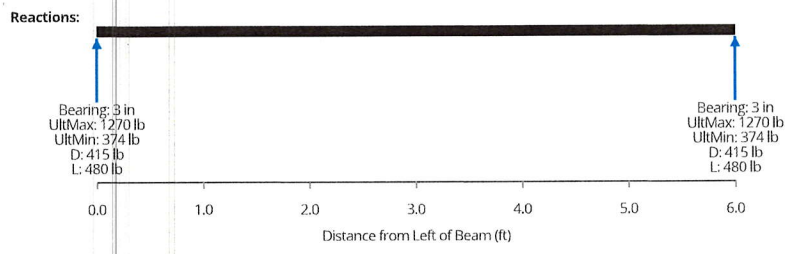
V_{net} = 2,957.7 lbs > $V_{@hole}$ = 422 lbs **OK**

Client:		**Date:**	Aug 1, 2023
Author:	Aaron Obermiller	**Job #:**	
Project:	23-002-18	**Subject:**	**BSMT A1 (ZERO ENTRY SHOWER HDR)** PASS
References:	NDS 2018 (LRFD)		

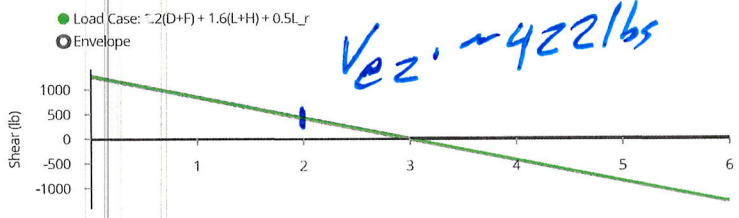
Summary

	Ultimate Bending Moment	$M_u =$	$1900\ \text{lb} \cdot \text{ft}$
9%	Moment Capacity	$\phi M_n =$	$21\,800\ \text{lb} \cdot \text{ft}$
	Ultimate Shear	$V_u =$	$1270\ \text{lb}$
12%	Shear Capacity	$\phi V_n =$	$10\,900\ \text{lb}$
	Governing Bearing Demand	$R_u =$	$1270\ \text{lb}$
11%	Governing Bearing Capacity	$\phi R_n =$	$11\,800\ \text{lb}$
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	$0.321\ \text{in}$
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	$0\ \text{in}$
5%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	$-0.00933\ \text{in}$
	Live / Short-Term Deflection Limit	$\Delta_{ST,max} =$	$0.2\ \text{in}$
	Governing Live / Short-Term Deflection Ratio	$(L/)_{ST} =$	7720
4%	Governing Long-Term Deflection	$\delta_{LT} =$	$-0.0134\ \text{in}$
	Governing Long-Term Deflection Ratio	$(L/)_{LT} =$	5390

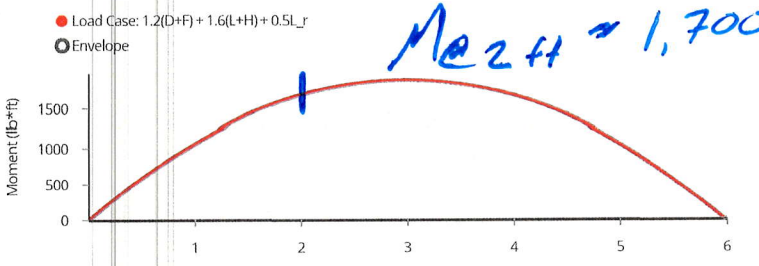
NDS 2018, Cl N.3.3



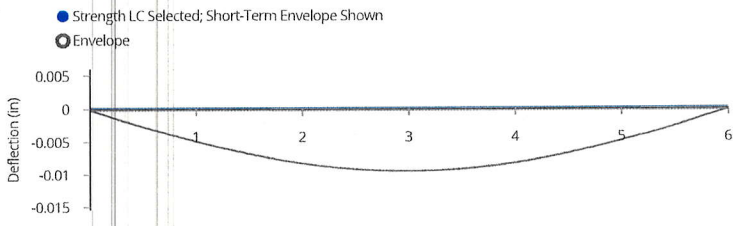
Graphed Load Combination 1.2D + 1.6L + 0.5Lr

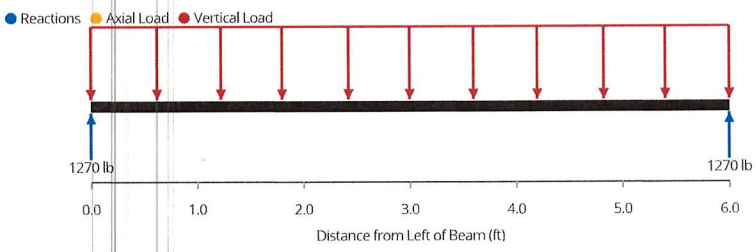


$V_{@2'} \approx 422\ \text{lbs}$

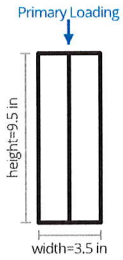


$M_{@2ft} = 1,700$ ft-lbs





Key Properties



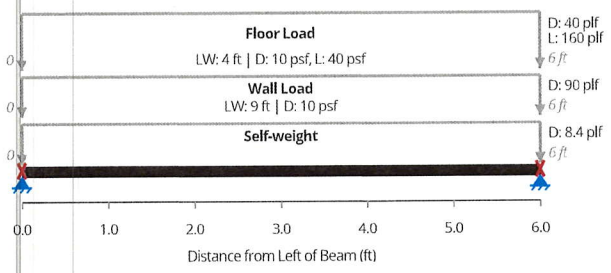
Section Type		Standard Sections Database
Size and Grade		1-3/4x9-1/2 Versa-Lam LVL 2.1E-2800Fb
Number of Plies	$n_{\text{plies}} =$	2
Beam Plan Length	$L_X =$	6 ft
Total Material Length	$L =$	6 ft, 0 in
Continuous Bracing for Lateral Torsional Buckling		Top Braced
Supports and Braces	$r =$	

Support/Brace Type	Position From Left x (ft)	Bearing Length ℓ_b (in)
Pinned	0	3
Pinned	6	3

Flitch Plate Properties

Add Flitch Plates?	No

Loads



Distributed Loads $w =$

Label	Start Location x_s (ft)	End Location x_e (ft)	Total Start Trib. Width TW_s (ft)	Total End Trib. Width TW_e (ft)	Load Magnitudes w
Roof Load	0	6	0	0	D, L, S, Lr, W, Dn, W up
Wall Load	0	6	9	9	D: 10 psf
Floor Load	0	6	4	4	D: 10 psf, L: 40 psf

Point & Moment Loads $P, M =$

Label	Location x (ft)	Load Magnitudes P, M
Alternative Minimum Live Load	3	

Bending Axis	Strong (X-X)	
Include Self-weight	Yes	
Use Reduced Companion Live Load?	No	ASCE 7-16, Cl 2.3.1.1
Live Load Type	Occupancy	
Brace at Point Loads?	No	

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018	
Beam Incline	Horizontal	
Repeating Member?	Non-Repeating	NDS 2018, Cl 4.3.9
Service Condition	Dry	NDS 2018, Cl 4.3.3
Temperature Range	T ≤ 100°F	NDS 2018, Table 2.3.3
Directly Consider Shear Deflection?	No	[APA TT-082, "True (Shear-Free) and Apparent Moduli of Elasticity"](https://www.apawood.org/publication-search?q=tt-082&id=1)
Deflection Limit Absolute Limit	$\Delta_{max} = 1$ in	
Live / Short-term Deflection Limit	$(L/)_{ST} = 360$	IBC, Table 1604.3
Long Term Deflection Limit	$(L/)_{LT} = 240$	
Double L/ Deflection Limits for Cantilevers?	Yes	[International Building Code 2018, Table 1604.3](https://codes.iccsafe.org/content/IBC2018/chapter-16-structural-design)

Member Properties

Base Allowable Shear Stress	$F_v = 285$ psi	NDS 2018 Supplement

Load Combination Analysis

Strength Load Combinations $LC_{str} =$

Load Combination	Time Factor λ	Total Load ΣR (lb)	Shear V_u (lb)	Pos. Moment M_u^+ (lb · ft)	Neg. Moment M_u^- (lb · ft)	Max Reaction R_u (lb)
1.4(D+F)	0.6	1160	581	872	0	581
1.2(D+F) + 1.6(L+H) + 0.5L_r	0.8	2530	1270	1900	0	1270
1.2(D+F) + 1.6(L+H) + 0.5S	0.8	2530	1270	1900	0	1270
1.2(D+F) + 1.6(L+H) + 0.5R	0.8	2530	1270	1900	0	1270
1.2(D+F) + 1.6L_r + 1.6H + f_1L	0.8	1960	978	1470	0	978
1.2(D+F) + 1.6L_r + 1.6H + 0.5W_dn	0.8	996	498	747	0	498
1.2(D+F) + 1.6S + 1.6H + f_1L	0.8	1960	978	1470	0	978
1.2(D+F) + 1.6S + 1.6H + 0.5W_dn	0.8	996	498	747	0	498
1.2(D+F) + 1.6R + 1.6H + f_1L	0.8	1960	978	1470	0	978
1.2(D+F) + 1.6R + 1.6H + 0.5W_dn	0.8	996	498	747	0	498
1.2(D+F) + 1.0W_dn + f_1L + 0.5L_r	1	1960	978	1470	0	978
1.2(D+F) + 1.0W_dn + f_1L + 0.5S	1	1960	978	1470	0	978
1.2(D+F) + 1.0W_dn + f_1L + 0.5R	1	1960	978	1470	0	978
1.2(D+F) + 1.0E_v + 1.0E_h + f_1L + 1.6H + f_2S	1	1960	978	1470	0	978
0.9D + 1.0W_up + 1.6H	1	747	374	561	0	374
0.9(D+F) - 1.0E_v + 1.0E_h + 1.6H	1	747	374	561	0	374

Short-term Serviceability Load Combinations $LC_{servST} =$

Load Combination	Total Load ΣR (lb)	Max Deflection δ_s (in)
L+Lr	960	-0.00933
S	0	0
0.42W_dn	0	0
0.42W_up	0	0
Simplified D+L Not Selected	0	0

Long-term Serviceability Load Combinations $LC_{servLT} =$

Load Combination	Total Load ΣR (lb)	Max Deflection δ_s (in)
D+L+Lr	1380	-0.0134

Unfactored Load Analysis

Unfactored Loads

Load Type	Total Load ΣR (lb)	Shear V_u (lb)	Moment M_u (lb · ft)	Max Reaction R_u (lb)	Deflection δ (in)
D	830	-415	623	415	-0.00807
L	960	480	720	480	-0.00933

Elastic Modulus (NDS 2018 2.3)

Wet Service Factor	$C_{M,E} = 1$	NDS 2018 Supplement
Temperature Factor	$C_{t,E} = 1$	NDS 2018, Table 2.3.3
Adjusted Modulus of Elasticity	$E' = 2\,000\,000$ psi	NDS 2018 Table 4.3.1 (Lumber), 5.3.1 (Glulam), 8.3.1 (SCL)
Adjusted Minimum Modulus of Elasticity	$E'_{min} = 1\,650\,000$ psi	NDS 2018 Table 4.3.1 (Lumber), 5.3.1 (Glulam), 8.3.1 (SCL)
Adjusted Flexural Stiffness	$E'I = 3\,470\,000$ lb · ft^2	

Section Bending (NDS 2018 2.3)

Load Applied on Compression Side?	Yes	AWC TR14, Cl 2.1.3.4
Wet Service Factor	$C_{M,b} = 1$	NDS 2018 Supplement, Tables 4A and 5A
Temperature Factor	$C_{t,b} = 1$	NDS 2018, Table 2.3.3
Repeating Member Factor	$C_r = 1$	NDS 2018 4.3.9

Volume Factor $C_V = 1.03$ NDS 2018, Cl 5.3.6

Positive Bending (NDS 2018 2.3)

Governing Time Effect Factor for Postive Bending $\lambda_b^+ = 0.8$ NDS 2018, Cl N.3.3

Governing Beam Stability Factor - Positive Bending $C_L^+ = 1$ AWC TR14, Cl 2.1.3.4

Adjusted Bending Strength - Positive Bending $F_b'^+ = 4960$ psi NDS 2018, Table 4.3.1

Negative Bending (NDS 2018 2.3)

Governing Time Effect Factor for Negative Bending $\lambda_b^- = 0.6$ NDS 2018, Cl N.3.3

Governing Buckling Moment Calculation - Negative Bending $M_{cr\text{Table}}^- =$ k-factor: AWC TR14 2.1.3.4 Load eccentricity factor: AWC TR14 2.1.3.4 Governing buckling moment: AWC TR14 2.1.3.2 Beam stability factor: AWC TR14 2.1.3.1

Span Length L (in)	Span Type	k-Factor k	Load Eccentricity Factor C_e	Governing Buckling Moment M_{cr} (lb · ft)	Beam Stability Factor C_L	M_u^-/C_L (lb · ft)
72	Int	1.72	0.748	71 500	0.986	0

Governing Beam Stability Factor - Negative Bending $C_L^- = 0.986$ AWC TR14, Cl 2.1.3.4

Adjusted Bending Strength - Negative Bending $F_b'^- = 3670$ psi NDS 2018, Table 4.3.1

Shear Design (NDS 2018 3.4)

Governing Time Effect Factor for Shear $\lambda_v = 0.8$ NDS 2018, Cl N.3.3

Wet Service Factor $C_{M,v} = 1$ NDS 2018 Supplement

Temperature Factor $C_{t,v} = 1$ NDS 2018, Table 2.3.3

Adjusted Shear Strength $F_v' = 492$ psi NDS 2018, Table 4.3.1

Bearing (NDS 2018 3.10)

Wet Service Factor $C_{M,\perp} = 1$ NDS 2018 Supplement

Temperature Factor $C_{t,\perp} = 1$ NDS 2018, Table 2.3.3

Base Bearing Strength $F_{c\perp}'/C_b = 1130$ psi NDS 2018, Table 4.3.1

Linear Base Bearing Resistance $\phi R_n/C_b\ell_b = 3950$ lbf/in

Bearing Strength per Support $BR =$ NDS 2018, Cl 3.10.4

Location (ft)	Bearing Length ℓ_b (in)	Bearing Area Factor C_b	Bearing Resistance ϕR_n (lb)	Ultimate Reaction R_u (lb)	Utilization $R_u/\phi R_n$	Min Bearing Length (in	Type
0	3	1	11 800	1270	0.107	0.321	Ext
6	3	1	11 800	1270	0.107	0.321	Ext

Deflections

Live / Short-term Deflections per Span $\delta_{\text{TableST}} =$

Span Length L (ft)	Span Type	Deflection δ (in)	Deflection Limit Δ_{lim} (in)	Deflection Utilisation δ/Δ_{lim}	Deflection Ratio $L/$
6	Int	-0.00933	0.2	0.0466	7720

Long-term Deflections per Span $\delta_{\text{TableLT}} =$

Span Length L (ft)	Span Type	Deflection δ (in)	Deflection Limit Δ_{lim} (in)	Deflection Utilisation δ/Δ_{lim}	Deflection Ratio $L/$
6	Int	-0.0134	0.3	0.0445	5390

Comments

Member B1: Double LVL parallel to cantilevered floor joists extending from interior LVL beam adjacent to zero-entry shower. A duplicate member is located on the opposite side of the zero-entry shower. The ~3in hole for the drain line extends from the bathtub location, parallel to the shower through both members and is located approximately one-foot from member A1 and ~2.5 ft from the end of the beam. Maximum size condition is met.

Net Bending Capacity (see previous calculations, same hole diameter, same member width and depth):

$M_{net} = C_{hole,M} M_{gross} = 0.95*(S_{net}/S_{gross})*M_{gross}$

M_{net} = Net bending capacity with holes, ft-lbs
= 12,015 ft-lbs

$M_{@Hole}$ = 1,820 ft-lbs (attached calculation output)

M_{Net} = 12,015 ft-lbs > $M_{@Hole}$ = 1,820 ft-lbs **OK**

Net Shear Capacity ((see previous calculations, same hole diameter, same member width and depth):

$V_{net} = C_{hold,V} V_{gross} = ((d-D)/d)^2*Vgross$

V_{net} = Net shear capacity with holes, lbs
= 2,957.7 lbs

$V_{@Hole}$ = 584 lbs (attached calculation output)

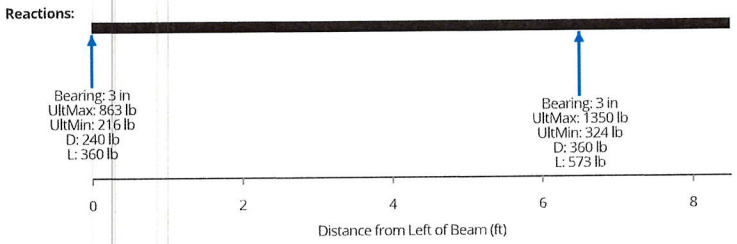
V_{net} = 2,957.7 lbs > $V_{@hole}$ = 584 lbs **OK**

Client:		**Date:**	Aug 1, 2023
Author:	Aaron Obermiller	**Job #:**	
Project:	23-002-18	**Subject:**	**BSMT B1 (SHOWER HEADER CARRIER BEAM)** PASS
References:	NDS 2018 (LRFD)		

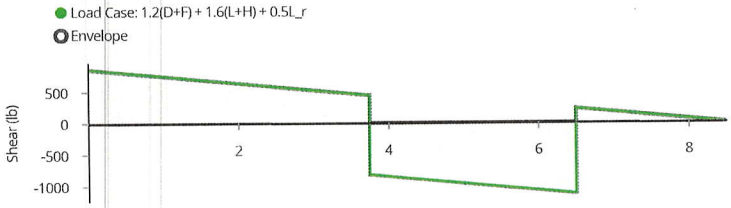
Summary

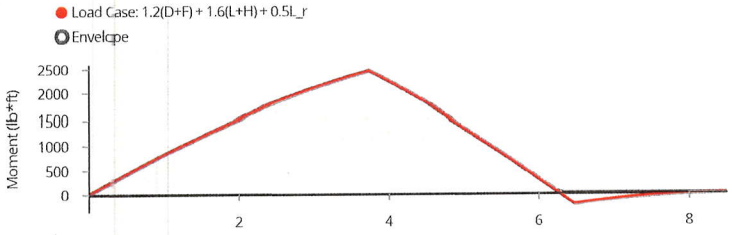
	Ultimate Bending Moment	$M_u =$	$2450\ \text{lb} \cdot \text{ft}$
11%	Moment Capacity	$\phi M_n =$	$21\,800\ \text{lb} \cdot \text{ft}$
	Ultimate Shear	$V_u =$	$1130\ \text{lb}$
10%	Shear Capacity	$\phi V_n =$	$10\,900\ \text{lb}$
	Governing Bearing Demand	$R_u =$	$1350\ \text{lb}$
10%	Governing Bearing Capacity	$\phi R_n =$	$13\,300\ \text{lb}$
	Minimum Bearing Length (End Supports)	$\ell_{b,min,end} =$	$0.219\ \text{in}$
	Minimum Bearing Length (Int Supports)	$\ell_{b,min,int} =$	$0.304\ \text{in}$
8%	Governing Live / Short-Term Deflection	$\delta_{ST} =$	$0.0112\ \text{in}$
	Live / Short-Term Deflection Limit	$\Delta_{ST,max} =$	$0.133\ \text{in}$
	Governing Live / Short-Term Deflection Ratio	$(L/)_{ST} =$	2140
8%	Governing Long-Term Deflection	$\delta_{LT} =$	$0.0156\ \text{in}$
	Governing Long-Term Deflection Ratio	$(L/)_{LT} =$	1540

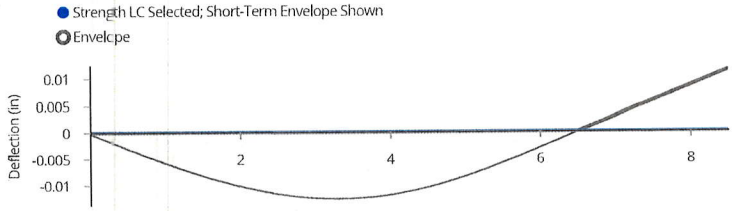
NDS 2018, Cl N.3.3

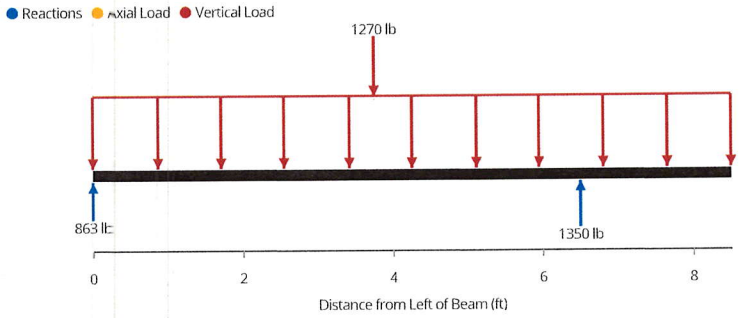


Graphed Load Combination 1.2D + 1.6L + 0.5Lr

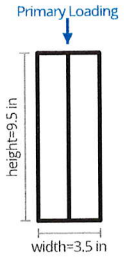








Key Properties



Section Type		Standard Sections Database
Size and Grade		1-3/4x9-1/2 Versa-Lam LVL 2.1E-2800Fb
Number of Plies	$n_{\text{plies}} =$	2
Beam Plan Length	$L_X =$	8.5 ft
Total Material Length	$L =$	8 ft, 6 in
Continuous Bracing for Lateral Torsional Buckling		Top Braced

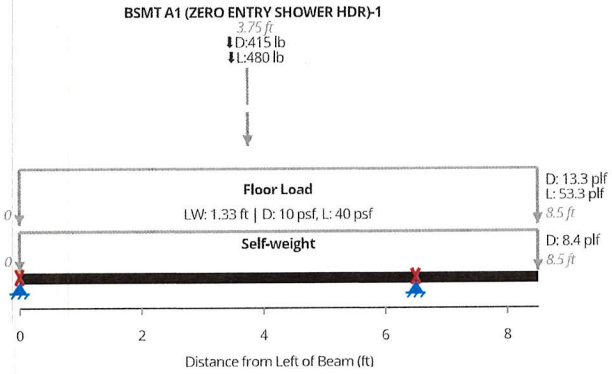
Supports and Braces $r =$

Support/Brace Type	Position From Left x (ft)	Bearing Length ℓ_b (in)
Pinned	0	3
Pinned	6.5	3

Flitch Plate Properties

Add Flitch Plates?	No

Loads



Distributed Loads $w =$

Label	Start Location x_s (ft)	End Location x_e (ft)	Total Start Trib. Width TW_s (ft)	Total End Trib. Width TW_e (ft)	Load Magnitudes w
Roof Load	0	8.5	0	0	D, L, S, Lr, W,dn, W,up
Wall Load	0	8.5	0	0	D: 30 psf
Floor Load	0	8.5	1.33	1.33	D: 10 psf, L: 40 psf

Point & Moment Loads $P, M =$

Label	Location x (ft)	Load Magnitudes P, M
Alternative Minimum Live Load	4.25	
BSMT A1 (ZERO ENTRY SHOWER HDR)-1	3.75	D: 415 lb, 0 lb ft, L: 480 lb, 0 lb ft

Bending Axis	Strong (X-X)	
Include Self-weight	Yes	
Use Reduced Companion Live Load?	No	ASCE 7-16, Cl 2.3.1.1
Live Load Type	Occupancy	
Brace at Point Loads?	No	

Design Conditions

Design Code for Load Combinations	International Building Code (IBC) 2018	
Beam Incline	Horizontal	
Repeating Member?	Non-Repeating	NDS 2018, Cl 4.3.9
Service Condition	Dry	NDS 2018, Cl 4.3.3
Temperature Range	T ≤ 100°F	NDS 2018, Table 2.3.3
Directly Consider Shear Deflection?	No	[APA TT-082, "True (Shear-Free) and Apparent Moduli of Elasticity"](https://www.apawood.org/publication-search?q=tt-082&tid=1)
Deflection Limit Absolute Limit	$\Delta_{max} = 1$ in	
Live / Short-term Deflection Limit	$(L/)_{ST} = 360$	IBC, Table 1604.3
Long Term Deflection Limit	$(L/)_{LT} = 240$	
Double L/ Deflection Limits for Cantilevers?	Yes	[International Building Code (IBC) 2018, Table 1604.3](https://codes.iccsafe.org/content/IBC2018/chapter-16-structural-design)

Member Properties

Base Allowable Shear Stress	$F_v = 285$ psi	NDS 2018 Supplement

Load Combination Analysis

Strength Load Combinations $LC_{str} =$

Load Combination	Time Factor λ	Total Load ΣR (lb)	Shear V_u (lb)	Pos. Moment M_u^+ (lb · ft)	Neg. Moment M_u^- (lb · ft)	Max Reaction R_u (lb)
1.4(D+F)	0.6	840	444	1040	-60.8	504
1.2(D+F) + 1.6(L+H) + 0.5L_r	0.8	2210	1130	2450	-223	1350
1.2(D+F) + 1.6(L+H) + 0.5S	0.8	2210	1130	2450	-223	1350
1.2(D+F) + 1.6(L+H) + 0.5R	0.8	2210	1130	2450	-223	1350
1.2(D+F) + 1.6L_r + 1.6H + f_1L	0.8	1650	847	1870	-159	1010
1.2(D+F) + 1.6L_r + 1.6H + 0.5W_dn	0.8	720	380	895	-52.2	432
1.2(D+F) + 1.6S + 1.6H + f_1L	0.8	1650	847	1870	-159	1010
1.2(D+F) + 1.6S + 1.6H + 0.5W_dn	0.8	720	380	895	-52.2	432
1.2(D+F) + 1.6R + 1.6H + f_1L	0.8	1650	847	1870	-159	1010
1.2(D+F) + 1.6R + 1.6H + 0.5W_dn	0.8	720	380	895	-52.2	432
1.2(D+F) + 1.0W_dn + f_1L + 0.5L_r	1	1650	847	1870	-159	1010
1.2(D+F) + 1.0W_dn + f_1L + 0.5S	1	1650	847	1870	-159	1010
1.2(D+F) + 1.0W_dn + f_1L + 0.5R	1	1650	847	1870	-159	1010
1.2(D+F) + 1.0E_v + 1.0E_h + f_1L + 1.6H + f_2S	1	1650	847	1870	-159	1010
0.9D + 1.0W_up + 1.6H	1	540	285	671	-39.1	324
0.9(D+F) - 1.0E_v + 1.0E_h + 1.6H	1	540	285	671	-39.1	324

Short-term Serviceability Load Combinations $LC_{servST} =$

Load Combination	Total Load ΣR (lb)	Max Deflection δ_s (in)
L+Lr	933	-0.0125
S	0	0
0.42W_dn	0	0
0.42W_up	0	0
Simplified D+L Not Selected	0	0

Long-term Serviceability Load Combinations $LC_{servLT} =$

Load Combination	Total Load ΣR (lb)	Max Deflection δ_s (in)
D+L+Lr	1230	-0.0171

Unfactored Load Analysis

Unfactored Loads

Load Type	Total Load ΣR (lb)	Shear V_u (lb)	Moment M_u (lb · ft)	Max Reaction R_u (lb)	Deflection δ (in)
D	600	-317	746	360	-0.00929
L	933	-467	975	573	-0.0125

Elastic Modulus (NDS 2018 2.3)

Wet Service Factor	$C_{M,E} = 1$	NDS 2018 Supplement
Temperature Factor	$C_{t,E} = 1$	NDS 2018, Table 2.3.3
Adjusted Modulus of Elasticity	$E' = 2\,000\,000$ psi	NDS 2018 Table 4.3.1 (lumber), 5.3.1 (glulam), 8.3.1 (SCL)
Adjusted Minimum Modulus of Elasticity	$E'_{min} = 1\,650\,000$ psi	NDS 2018 Table 4.3.1 (lumber), 5.3.1 (glulam), 8.3.1 (SCL)
Adjusted Flexural Stiffness	$E'I = 3\,470\,000$ lb · ft^2	

Section Bending (NDS 2018 2.3)

Load Applied on Compression Side?	Yes	AWC TR14, Cl 2.3
Wet Service Factor	$C_{M,b} = 1$	NDS 2018 Supplement (Table 4.3.3)
Temperature Factor	$C_{t,b} = 1$	NDS 2018, Table 2.3.3
Repeating Member Factor	$C_r = 1$	NDS 2018 4.3.9

Volume Factor $C_V = 1.03$ NDS 2018, Cl 5.3.6

Positive Bending (NDS 2018 2.3)

Governing Time Effect Factor for Postive Bending $\lambda_b^+ = 0.8$ NDS 2018, Cl N.3.3

Governing Beam Stability Factor - Positive Bending $C_L^+ = 1$ AWC TR14, Cl 2.1.3.4

Adjusted Bending Strength - Positive Bending $F_b'^+ = 4960$ psi NDS 2018, Table 4.3.1

Negative Bending (NDS 2018 2.3)

Governing Time Effect Factor for Negative Bending $\lambda_b^- = 0.8$ NDS 2018, Cl N.3.3

Governing Buckling Moment Calculation - Negative Bending $M_{cr\text{Table}}^- =$ k-factor: AWC TR14 2.1.3.4 Load eccentricity factor: AWC TR14 2.1.3.4 Governing buckling moment at: AWC TR14 2.1.3.2 Beam stability factor: AWC TR14 2.1.3.1

Span Length L (in)	Span Type	k-Factor k	Load Eccentricity Factor C_e	Governing Buckling Moment M_{cr} (lb · ft)	Beam Stability Factor C_L	M_{cr}^-/C_L (lb · ft)
78	Int	1.72	0.764	78 400	0.982	-227
24	Cant	1	0.61	154 000	0.992	-225

Governing Beam Stability Factor - Negative Bending $C_L^- = 0.982$ AWC TR14, Cl 2.1.3.4

Adjusted Bending Strength - Negative Bending $F_b'^- = 4870$ psi NDS 2018, Table 4.3.1

Shear Design (NDS 2018 3.4)

Governing Time Effect Factor for Shear $\lambda_v = 0.8$ NDS 2018, Cl N.3.3

Wet Service Factor $C_{M,v} = 1$ NDS 2018 Supplement

Temperature Factor $C_{t,v} = 1$ NDS 2018, Table 2.3.3

Adjusted Shear Strength $F_v' = 492$ psi NDS 2018, Table 4.3.1

Bearing (NDS 2018 3.10)

Wet Service Factor $C_{M,\perp} = 1$ NDS 2018 Supplement

Temperature Factor $C_{t,\perp} = 1$ NDS 2018, Table 2.3.3

Base Bearing Strength $F_{c\perp}'/C_b = 1130$ psi NDS 2018, Table 4.3.1

Linear Base Bearing Resistance $\phi R_n/C_b\ell_b = 3950$ lbf/in

Bearing Strength per Support $BR =$ NDS 2018, Cl 3.10.4

Location (ft)	Bearing Length ℓ_b (in)	Bearing Area Factor C_b	Bearing Resistance ϕR_n (lb)	Ultimate Reaction R_u (lb)	Utilization $R_u/\phi R_n$	Min Bearing Length (in)	Type
0	3	1	11 800	863	0.073	0.219	Ext
6.5	3	1.13	13 300	1350	0.101	0.304	Int

Deflections

Live / Short-term Deflections per Span $\delta_{\text{TableST}} =$

Span Length L (ft)	Span Type	Deflection δ (in)	Deflection Limit Δ_{lim} (in)	Deflection Utilisation δ/Δ_{lim}	Deflection Ratio $L/$
6.5	Int	-0.0125	0.217	0.0576	6250
2	Cant	0.0112	0.133	0.0843	2140

Long-term Deflections per Span $\delta_{\text{TableLT}} =$

Span Length L (ft)	Span Type	Deflection δ (in)	Deflection Limit Δ_{lim} (in)	Deflection Utilisation δ/Δ_{lim}	Deflection Ratio $L/$
6.5	Int	-0.0171	0.325	0.0527	4550
2	Cant	0.0156	0.2	0.0779	1540

Comments