Prepared by TimberLogic LLC for:

Honest Abe Log Homes, Inc.

9995 Clay County Hwy., Moss, TN 17837

931-258-3648, www.honestabe.com

See Disclaimer, page 2

Contents (pgs):

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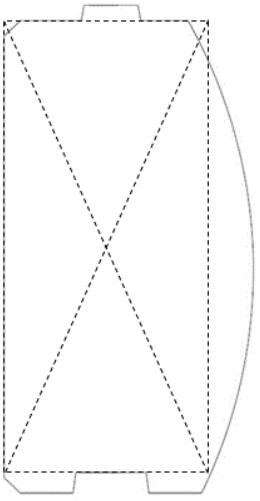
2-Log Properties (14-18)

3-Design Criteria (19-27)

5-Fastening (28-32)

6x12 D-Log: 6x12 (Nominal) Tongue & Groove (T&G) D-Shape Wall-Log

The purpose of this report is to define the log wall system according to ICC400-2012 *Standard on the Design and Construction of Log Structures* .



1.1 Wall-Log Summary

Ref. 2.3

Variable		ICC400	U/M	Vertical	Horizontal
	Wood species	302.2.1.2		Eastern White Pine	
	Log Profile	302.2.1.4			
Wn	Least width dimension		in.		3- 7/8
B_{LP}	Profile bearing width		in.		2- 1/2
IR	Inscribed Rectangle		in.	11	4-5/8
H_L	Stack height	302.2.3.5	in.	11- 1/2	
	Section Properties	302.2.3.4			
A	Area of cross-section		$in.^2$	59.212	
S	Section modulus		$in.^3$	109.107	48.743
I	Moment of inertia		$in.^4$	627.365	125.665
W_L	Average width (A/H_L)	302.2.3.6	in.		5- 5/32
Calculated fire-resistance rating:		303.2.2	Ref. 1.8		0.7-hr.

MC	**Moisture Content**	302.2.2	**Climate Zone:**	**Initial**	**Dry**	**Moist**	**Warm-Humid**	**Marine**
MC_D	Design MC	302.2.2.1	%	18				
MCs	Service MC = EMC	302.2.2.2	Ref. 2.41		10	13	14	15
G	Specific Gravity @ MCs	302.2.3.3		0.363	0.373	0.369	0.368	0.367
	Wall mass	302.2.3.7	psf	11.45	10.97	11.16	11.22	11.29
Weight	Log weight	302.2.3.8	Ref. 2.42 plf	10.98	10.52	10.7	10.76	10.82
	Estimated Settling	304						
Δ_{SL}	Due to slumping	304.2.2.1	Ref. 2.54 in./course	NA	NA	NA	NA	NA
Δc	Due to compaction	304.2.2.2	Ref. 2.53 in./course	NA	NA	NA	NA	NA
Δs	Due to shrinkage	304.2.2.3	Ref. 2.52 in./course	0	-0.065	-0.041	-0.033	-0.024
ΔT	Total settling, typ. wall	304.2	Hw=8.625 ft in./%	0"/0%	0.58"/0.6%	0.38"/0.4%	0.3"/0.3%	0.22"/0.2%
	Thermal Properties	305.3.3						
k	thermal transmittance		$Btu{\cdot}in/(h{\cdot}ft^2{\cdot}{}^oF)$	0.798372	0.73326	0.757776	0.766376	0.77492
R	Eastern White Pine		Ref. 2.43 R/in.	1.253	1.364	1.32	1.305	1.29
R_L		Avg. Log Thickness x R-value/inch		6.46	7.03	6.81	6.73	6.65
HC	Heat Capacity	305.4.3.2	$Btu/ft^2{\cdot}{}^oF$	4.8	4.1	4.4	4.4	4.5
			Climate Zone:		CZ-5	CZ-6	CZ1-3	CZ-4C
Um	Mass Enhanced U-Factor		Ref. 1.32	0.135	0.114	0.114	0.114	0.114

	Design Values	302.2.1	Grading Program:	Timber Products Inspection Grading Rules				
		302.2.3	Ref. 2.11	**Grade**	**Premium**	**Select**	**Rustic**	**Wall40**
Fb	bending, adj. for size	*Note: Size Factor (Cs) has been applied*		psi	1085	975	835	640
Fb	bending, adj. for size	*to Fb, bending stress value*		psi	985	885	755	580
Ft	tension			psi	675	575	500	375
Fv	shear			psi	125	125	125	125
Fc, perp.	Compression perp. to grain	Mean Stress at 0.04 in. Deformation		psi	350	350	350	350
Fc, para.	compression parallel to grain			psi	675	600	525	400
E	modulus of elasticity			psi	1,100,000	1,100,000	1,000,000	800,000
C_F	Size Factor (applicable to Fb, bending stress value)			1.010	1.112	*For SI: 1 lbf.in^2 (psi) =*		*6.894 kPa*
	Visual Grading Criteria			**Ref. 2.2**	**Category**	**Beams & Stringers**	**Posts & Timbers**	
SOG	Slope of Grain					1 in 12	1 in 10	1 in 8	1 in 6
	Maximum allowable knot size				4.63" Narrow Face	1-1/2"	2 "	2-1/4"	2-3/4"
	Unless otherwise noted, log grade is Wall40				11" Wide Face	2-1/2"	3-1/4"	4 "	6-1/2"
					Kerfed Face	NA	NA	NA	NA

	Fasteners	302.3				
	LogHog	x 15-in.	24" o/c	Countersink	5/16"	to conceal fastener head
S	Spacing	from end: 4"	from edge: 2"		from edge in 1-hr rated wall: 1.5"	

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Wall-Log Summary

NOTICE TO USER:

The calculations and references used in this estimate are from the Wood Handbook (Forest Products Lab), ASTM Standards, and other sources. The reference material is based on averages from physical testing, and the actual results are likely to vary from those estimated here. To gain accuracy, sample measurements of specific gravity and moisture content would be required from the actual logs used. This estimate is intended as a guide for construction allowances and not a specification of performance.

The tables that follow are intended as guidelines for the specification of logs and timbers used in the design and construction of a log structure. The calculations provided are for information purposes only and have not been engineered for specific use. The individual using these tables (User) is solely responsible for specifying the appropriate timber. User recognizes that TimberLogic LLC (TL) is not responsible to the specification or performance of any product as specified by User. By using the information presented herein, User agrees to indemnify and hold harmless TL their agents, employees, representatives, and assigns from any and all claims (including attorney fees), demands, actions, damages, losses, costs, liabilities, and judgments asserted against them arising or alleged to have arisen out of the use of this information. TL does not warrant compliance with all state or local building codes and ordinances, as these codes can vary significantly from the guidelines contained herein. It is recommended that a licensed structural engineer be consulted to review specific building designs for conditions specific to the intended building site before undertaking any construction.

TL reserves the right to update and/or modify this analysis without notice.

Definitions: **ICC400 202**

ICC400	*LOG WALL* . An assembly of individual structural logs for use as an exterior or interior load bearing wall, shear wall, or non-load bearing wall. *LOG*. Wood member that has been stress graded and grade marked or grade certified using rules of an accredited inspections agency in accordance with ASTM D 3957, ASTM D 3737, or ASTM D 245 and is incorporated into a structure.
ASTM D3957	*WALL-LOG*. Wood members which are normally stacked horizontally or laid-up vertically to form a load-bearing, solid-wood wall, in any building.

1.2 Wall-Log Capacities

Analysis in Horizontal Plane - Lateral Loads

Variable	Premium	Select	Rustic	Wall40
FvA	7402	7402	7402	7402
FbS	52886	47524	40700	31196
EI	138231500	138231500	125665000	100532000
$B_{LP}xFc_{perp}$	Bearing capacity			10500 plf

Analysis in Vertical Plane - Gravity Loads

Premium	Select	Rustic	Wall40
7402	7402	7402	7402
107470	96560	82376	63282
690101500	690101500	627365000	501892000

1.21 Maximum Allowable Loading (plf) on a Single Wall-Log, by Span

- The maximum allowable loads calculated below are for a single log. For multiple log course acting independently but collectively, multiply these loads by the number of logs involved.

Span (ft.)	Allowable loading (plf), horizontal (lateral)					Allowable loading (plf), vertical (gravity)				
3	shear*	***1645***	***1645***	***1645***	***1645***	shear*	***1645***	***1645***	***1645***	***1645***
	bending	3917	3520	3015	2311	bending	7961	7153	6102	4688
	l/240	11377	11377	10343	8274	l/240	56798	56798	51635	41308
	l/360	7585	7585	6895	5516	l/360	37866	37866	34423	27539
4.5	shear*	***1097***	***1097***	***1097***	1097	shear*	***1097***	***1097***	***1097***	***1097***
	bending	1741	1565	1340	***1027***	bending	3538	3179	2712	2083
	l/240	3371	3371	3065	2452	l/240	16829	16829	15299	12239
	l/360	2247	2247	2043	1634	l/360	11219	11219	10200	8160
6	shear*	***822***	***822***	822	822	shear*	***822***	***822***	***822***	***822***
	bending	979	880	***754***	***578***	bending	1990	1788	1525	1172
	l/240	1422	1422	1293	1034	l/240	7100	7100	6454	5163
	l/360	948	948	862	690	l/360	4733	4733	4303	3442
8	shear*	617	617	617	617	shear*	***617***	***617***	***617***	***617***
	bending	**551**	**495**	**424**	**325**	bending	1119	1006	858	659
	l/240	600	600	545	436	l/240	2995	2995	2723	2178
	l/360	***400***	***400***	***364***	***291***	l/360	1997	1997	1815	1452
12	shear*	411	411	411	411	shear*	***411***	***411***	411	411
	bending	245	220	188	144	bending	498	447	***381***	***293***
	l/240	**178**	**178**	**162**	**129**	l/240	887	887	807	645
	l/360	***119***	***119***	***108***	***86***	l/360	592	592	538	430
13.5	shear*	366	366	366	366	shear*	***366***	366	366	366
	bending	193	174	149	114	bending	393	***353***	***301***	***231***
	l/240	**125**	**125**	**114**	**91**	l/240	623	623	567	453
	l/360	***83***	***83***	***76***	***61***	l/360	416	416	378	302

* Where shear determines the maximum allowable load, the load may be a single point load at midspan or a uniform load along its length.

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Wall-Log Summary

1.3 Thermal Properties of Wall Assembly

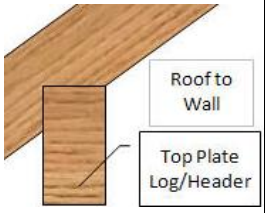
ICC400-2012 Section 305

1.31 Wall Assembly R-Value

1.311 Log Wall Configuration (clear, or opaque, wall area)

Height	Courses	Opaque Wall Section	% of assembly	Thickness (inches)	R-value/inch thickness (1/k)	For listed thickness (1/C)
		Air film-moving, outside at wall	100%			0.25
11.5 in.	9	Log wall: Avg. across climates zones	100%	5.15625	1.32	6.81
		Air film-vert.,still,horiz. heat flow	100%			0.69
103.5 in.		**U-Factor for opaque wall (Uw) is**	**0.1290**	**Rw: R-value of log wall**		**7.75**

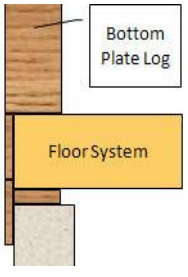
1.312 Roof to Wall Connection (Birdblock Course)



		Air film-moving, outside at wall	100%			0.25
		Exterior: Wood siding, Log Siding	100%	1.5	1.09	1.64
7 in.	1	Rigid Insul. - Foil faced polyurethane	100%	6	7.2	43.2
		Interior: Wood Paneling, 3/4" (softwd)	100%	0.75	0.94	0.71
		Air film-vert.,still,horiz. heat flow	100%			0.69
7 in.		**U-Factor for Birdblock =**	**0.0215**	**R-value of Birdblock =**		**46.49**

1.313 Bottom of Wall (Plate Log to floor or Sill Log to foundation)

Bottom log course is a Plate



		Air film-moving, outside at wall	100%			0.25
0.75 in.	1	Plywood (DF), 3/4" CDX	6.52%	5.5	0.94	0.34
9.25 in.	1	2x10, 16" oc	80.43%	3		0
9.25 in.	1	High performance fiber glass blanket or batt	80.43%	10	3.8	30.57
11.5 in.	1	Wood siding, Log Siding	100.00%	1.5	1.09	1.64
1.5 in.	1	Sill Plate: Softwood	13.04%	5.5	1.88	1.35
		Air film-vert.,still,horiz. heat flow	100%			0.55
11.5 in.	Floor depth	**U-Factor for floor perimeter =**	**0.0288**		**R-value at floor =**	**34.7**

1.32 Mass-enhanced U-Factors

1.321 REScheck: Input wall assembly as "Other"; enter U-factor.

	Assembly wall height	Assembly U-Factor	Assembly R-Value
Weighted average for eave walls	122 in.	0.080	12.51
Weighted average for rake walls	120 in.	0.100	10.01

- Wall defined as sill plate to roof deck aligned with wall.
- 2003 & 2015 IECC: Mass wall defined as having a heat capacity of 6 Btu/ft^2-^{o}F or greater.

ICC400-2012 Section 305.4.3.2

	Climate Zones (CZ)	Net (frame) whole-wall U-factor	Net (frame) whole-wall R-value	Mass wall U-factor	Mass wall R-value	Mass factor	Mass-enhanced R-W_L	Mass-enhanced U-Factor
14% EMC (warm-humid climate)	CZ 1	0.082	12.20	0.197	5.08	1.00	8.75	0.114
14% EMC (warm-humid climate)	CZ 2	0.082	12.20	0.165	6.06	1.00	8.75	0.114
14% EMC (warm-humid climate)	CZ 3	0.057	17.54	0.098	10.20	1.00	8.75	0.114
13% EMC (moist climate)	CZ 4	0.057	17.54	0.098	10.20	1.00	8.75	0.114
15% EMC (marine)	CZ 4C	0.057	17.54	0.082	12.20	1.00	8.75	0.114
10% EMC (dry)	CZ 5	0.057	17.54	0.082	12.20	1.00	8.75	0.114
13% EMC (moist climate)	CZ 6	0.048	20.83	0.06	16.67	1.00	8.75	0.114
13% EMC (moist climate)	CZ 7+8	0.048	20.83	0.057	17.54	1.00	8.75	0.114

1.33 Calculation of Thermal Envelope

1.331 Prescriptive Requirements of the ICC 2015 IECC

IECC=International Energy Conservation Code®

Required U-Factor, IECC Table 402.1.3

Climate Zones	1	2	3	4 exc. Mar.	5 & Mar.	6	7 & 8
Mass Wall U-Factor	0.75	0.5	0.45	0.35	0.35	0.35	0.35
Wood Frame Wall U-Factor	0.064	0.064	0.047	0.047	0.033	0.033	0.028
Ceiling U-Factor	0.035	0.035	0.035	0.03	0.03	0.026	0.026
Floor U-Factor	0.035	0.03	0.03	0.026	0.026	0.026	0.026
Fenestration U-Factor	0.5	0.4	0.35	0.35	0.32	0.32	0.32

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Wall-Log Summary

1.332 Example Building

■ **Sample building:**

			Area (sf)
Log walls	*28 ft. wide*	*48 ft. long*	1546
Log walls		*w/2-10:12 gables*	327
Roof area		*@ 10:12 roof pitch*	1750
Floor area			1344

Fenestration options in log wall

Rate	Area (sf)
10%	154.6
15%	231.9
18%	278.28

■ The standard U-factor for fenestration is 0.32

1.333 Sample U-Factor Packages

Climate Zones	1	2	3	4 exc. Mar.	5 & Mar.	6	7 & 8
Mass-enhanced Wall U-Factor	0.114	0.114	0.114	0.114	0.114	0.114	0.114
Max. Glazing U-Factor @ 10%	0.5	0.4	0.35	0.35	0.32	0.32	0.32
Max. Glazing U-Factor @ 15%	0.5	0.4	0.35	0.35	0.32	0.32	0.32
Max. Glazing U-Factor @ 18%	0.5	0.4	0.35	0.35	0.32	0.32	0.32
Ceiling U-Factor	0.035	0.035	0.035	0.03	0.03	0.026	0.026
Floor U-Factor	0.035	0.03	0.03	0.026	0.026	0.026	0.026
Wood Frame Wall U-Factor	0.064	0.064	0.047	0.047	0.033	0.033	0.028

1.34 Infiltration

ICC400-2012 Section 306

1.341 Horizontal Joint:

Joint Dimensions:	Width	Height	
Sealant dimensions	0.625	0.325	in.
Top/tongue:	1.375	0.375	in.
Bottom/groove:	1.75	0.5	in.
Initial Joint:		0.125	in.
Initial sealant compression:		61.50%	%

Sealant: Norseal V790 Log home foam

Test results reported by mfr.

% of height	Force
10%	1.8 psi
25%	3.4 psi
50%	6.3 psi
65%	14.9 psi
75%	37.3 psi
Recovery Rate	75%

1.342 Accomodating Settling

MC	Joint Hgt. (in.)	Sealant Compression (%)
Initial	0.125	61.50%
Dry	0.19	41.50%
Moist	0.166	48.90%
Hot-Humid	0.158	51.40%
Marine	0.149	54.20%

Horizontal joint design tolerance in service (worst case, Dry climate), 2 x [radial shrinkage+slumping-compaction]: 1/8 in.

Fastening force required initially to compress gasket: 6.3 psi / 47.25 plf

Std. log fastener: 15-in. LogHog

Fastening schedule to initially compress gasket: 24 in. o/c

Head of fastener to be set below log surface no less than 1/16 in.

1.342 Vertical Joint:

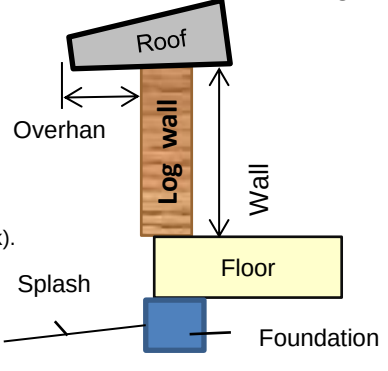
Vertical joint design tolerance for longitudinal shrinkage for Splined butt joints. 3/16 in.

1.4 Roof Overhang

ICC400-2012 Section 302.4

1.41 Calculate Roof Overhang Dimension

Fig. 1.41



■ Per requirements of ICC400-2012 Section 302.4, the overhang is used to limit potential backsplash from roof run-off to improve durability of lower log courses.

■ Overhang: Wall surface to drip edge (or edge of gutter)

■ Wall Height: Eave to bottom plate or sill log

■ **Exceptions:** A 12" minimum overhang is allowable if one of the following apply.

1. Logs within 24" of a splash surface comply with Section 302.2.5 for preservative treating.
2. Gutters are installed and the lowest log is 18" above a splash surface.
3. The splash surface permits roof runoff to pass unimpeded to finish grade (e.g., grating in deck).

Wall Height, O_H

9 log courses x Stack height, HL = Hw = 103.5 in.

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Wall-Log Summary

1.5 Maximum Allowable Simple Spans for Wall-Logs Supporting Vertical Load

- Header spans that follow are calculated based on uniform roof and floor loads.
- "Tributary Area" is the clear span that is bearing on headers over openings in loadbearing walls.
- A roof dead load of 15 psf has been included in all span
- Deflection is calculated at l/360.

1.51 Wall-logs Acting Independently Supporting Roof Load Only

	End Bearing	Tributary Area	Snow Load 100#LL	90#LL	80#LL	60#LL	50#LL
6x12 D-Log	3 "	12 feet	7 ft - 3 in	7 ft - 8 in	8 ft - 1 in	9 ft - 1 in	9 ft - 9 in
1 -ply	3 "	13 feet	7 ft - 0 in	7 ft - 4 in	7 ft - 9 in	8 ft - 9 in	9 ft - 5 in
Eastern White Pine	3 "	14 feet	6 ft - 9 in	7 ft - 1 in	7 ft - 6 in	8 ft - 5 in	9 ft - 1 in
Wall40	3 "	16 feet	6 ft - 4 in	6 ft - 7 in	7 ft - 0 in	7 ft - 11 in	8 ft - 5 in
	3 "	18 feet	5 ft - 11 in	6 ft - 3 in	6 ft - 7 in	7 ft - 5 in	8 ft - 0 in
	3 "	12 feet	8 ft - 4 in	8 ft - 9 in	9 ft - 2 in	10 ft - 5 in	11 ft - 2 in
1 -ply	3 "	13 feet	8 ft - 0 in	8 ft - 5 in	8 ft - 10 in	10 ft - 0 in	10 ft - 9 in
	3 "	14 feet	7 ft - 8 in	8 ft - 1 in	8 ft - 6 in	9 ft - 7 in	10 ft - 4 in
Rustic	3 "	16 feet	7 ft - 2 in	7 ft - 7 in	8 ft - 0 in	9 ft - 0 in	9 ft - 8 in
	3 "	18 feet	6 ft - 9 in	7 ft - 1 in	7 ft - 6 in	8 ft - 6 in	9 ft - 1 in
	3 "	12 feet	9 ft - 6 in	10 ft - 0 in	10 ft - 6 in	11 ft - 11 in	12 ft - 9 in
1 -ply	3 "	13 feet	9 ft - 2 in	9 ft - 7 in	10 ft - 1 in	11 ft - 5 in	12 ft - 3 in
	3 "	14 feet	8 ft - 10 in	9 ft - 3 in	9 ft - 9 in	11 ft - 0 in	11 ft - 10 in
Premium	3 "	16 feet	8 ft - 3 in	8 ft - 8 in	9 ft - 1 in	10 ft - 3 in	11 ft - 0 in
	3 "	18 feet	7 ft - 9 in	8 ft - 2 in	8 ft - 7 in	9 ft - 8 in	10 ft - 5 in
6x12 D-Log	3 "	12 feet	10 ft - 4 in	10 ft - 10 in	11 ft - 5 in	12 ft - 11 in	13 ft - 10 in
2 -ply	3 "	13 feet	9 ft - 11 in	10 ft - 5 in	11 ft - 0 in	12 ft - 5 in	13 ft - 4 in
	3 "	14 feet	9 ft - 7 in	10 ft - 0 in	10 ft - 7 in	11 ft - 11 in	12 ft - 10 in
Wall40	3 "	16 feet	8 ft - 11 in	9 ft - 4 in	9 ft - 11 in	11 ft - 2 in	12 ft - 0 in
	3-1/8"	18 feet	8 ft - 5 in	8 ft - 10 in	9 ft - 4 in	10 ft - 6 in	11 ft - 3 in
	3 "	12 feet	11 ft - 9 in	12 ft - 4 in	13 ft - 0 in	14 ft - 9 in	15 ft - 10 in
2 -ply	3 "	13 feet	11 ft - 4 in	11 ft - 10 in	12 ft - 6 in	14 ft - 2 in	15 ft - 2 in
	3-1/8"	14 feet	10 ft - 11 in	11 ft - 5 in	12 ft - 1 in	13 ft - 8 in	14 ft - 7 in
Rustic	3-3/8"	16 feet	10 ft - 2 in	10 ft - 8 in	11 ft - 3 in	12 ft - 9 in	13 ft - 8 in
	3-5/8"	18 feet	9 ft - 7 in	10 ft - 1 in	10 ft - 8 in	12 ft - 0 in	12 ft - 11 in
	3-3/8"	12 feet	13 ft - 6 in	14 ft - 1 in	14 ft - 8 in	15 ft - 11 in	16 ft - 0 in
2 -ply	3-1/2"	13 feet	12 ft - 11 in	13 ft - 7 in	14 ft - 3 in	15 ft - 6 in	16 ft - 0 in
	3-5/8"	14 feet	12 ft - 6 in	13 ft - 1 in	13 ft - 9 in	15 ft - 1 in	15 ft - 10 in
Premium	3-7/8"	16 feet	11 ft - 8 in	12 ft - 3 in	12 ft - 11 in	14 ft - 5 in	15 ft - 2 in
	4-1/8"	18 feet	11 ft - 0 in	11 ft - 6 in	12 ft - 2 in	13 ft - 9 in	14 ft - 7 in
6x12 D-Log	3-1/8"	12 feet	12 ft - 8 in	13 ft - 3 in	14 ft - 0 in	15 ft - 10 in	16 ft - 0 in
3 -ply	3-1/4"	13 feet	12 ft - 2 in	12 ft - 9 in	13 ft - 5 in	15 ft - 2 in	16 ft - 0 in
	3-3/8"	14 feet	11 ft - 8 in	12 ft - 3 in	12 ft - 11 in	14 ft - 8 in	15 ft - 8 in
Wall40	3-5/8"	16 feet	10 ft - 11 in	11 ft - 6 in	12 ft - 1 in	13 ft - 8 in	14 ft - 8 in
	3-7/8"	18 feet	10 ft - 4 in	10 ft - 10 in	11 ft - 5 in	12 ft - 11 in	13 ft - 10 in
	3-5/8"	12 feet	14 ft - 5 in	15 ft - 2 in	16 ft - 0 in	16 ft - 0 in	16 ft - 0 in
3 -ply	3-3/4"	13 feet	13 ft - 10 in	14 ft - 7 in	15 ft - 4 in	16 ft - 0 in	16 ft - 0 in
	3-7/8"	14 feet	13 ft - 4 in	14 ft - 0 in	14 ft - 9 in	16 ft - 0 in	16 ft - 0 in
Rustic	4-1/8"	16 feet	12 ft - 6 in	13 ft - 1 in	13 ft - 10 in	15 ft - 7 in	16 ft - 0 in
	4-3/8"	18 feet	11 ft - 9 in	12 ft - 4 in	13 ft - 0 in	14 ft - 9 in	15 ft - 10 in
	3-7/8"	12 feet	15 ft - 8 in	16 ft - 0 in	16 ft - 0 in	16 ft - 0 in	16 ft - 0 in
3 -ply	4-1/8"	13 feet	15 ft - 3 in	15 ft - 9 in	16 ft - 0 in	16 ft - 0 in	16 ft - 0 in
	4-1/4"	14 feet	14 ft - 11 in	15 ft - 5 in	15 ft - 11 in	16 ft - 0 in	16 ft - 0 in
Premium	4-1/4"	14 feet	14 ft - 11 in	15 ft - 5 in	15 ft - 11 in	16 ft - 0 in	16 ft - 0 in
	5 "	18 feet	13 ft - 6 in	14 ft - 1 in	14 ft - 8 in	15 ft - 11 in	16 ft - 0 in

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6x12 D-Log: 6x12 (Nominal) Tongue & Groove (T&G) D-Shape Wall-Log

Wall-Log Summary

1.52 Wall-logs Acting Independently Supporting Roof & Floor Load

■ Floor live load (FL): 40 psf

	End Bearing	Tributary Area	Snow Load 100#LL	90#LL	80#LL	60#LL	50#LL
6x12 D-Log	3 "	12 feet	6 ft - 4 in	6 ft - 7 in	6 ft - 10 in	7 ft - 6 in	7 ft - 10 in
1 -ply	3 "	13 feet	6 ft - 1 in	6 ft - 4 in	6 ft - 7 in	7 ft - 2 in	7 ft - 6 in
Eastern White Pine	3 "	14 feet	5 ft - 11 in	6 ft - 1 in	6 ft - 4 in	6 ft - 11 in	7 ft - 3 in
Wall40	3 "	16 feet	5 ft - 6 in	5 ft - 9 in	5 ft - 11 in	6 ft - 6 in	6 ft - 9 in
	3 "	18 feet	5 ft - 2 in	5 ft - 5 in	5 ft - 7 in	6 ft - 1 in	6 ft - 5 in
	3 "	12 feet	7 ft - 3 in	7 ft - 7 in	7 ft - 10 in	8 ft - 7 in	8 ft - 11 in
1 -ply	3 "	13 feet	7 ft - 0 in	7 ft - 3 in	7 ft - 6 in	8 ft - 3 in	8 ft - 7 in
	3 "	14 feet	6 ft - 9 in	7 ft - 0 in	7 ft - 3 in	7 ft - 11 in	8 ft - 3 in
Rustic	3 "	16 feet	6 ft - 4 in	6 ft - 6 in	6 ft - 10 in	7 ft - 5 in	7 ft - 9 in
	3 "	18 feet	5 ft - 11 in	6 ft - 2 in	6 ft - 5 in	7 ft - 0 in	7 ft - 4 in
	3 "	12 feet	8 ft - 4 in	8 ft - 7 in	9 ft - 0 in	9 ft - 9 in	10 ft - 3 in
1 -ply	3 "	13 feet	8 ft - 0 in	8 ft - 3 in	8 ft - 7 in	9 ft - 5 in	9 ft - 10 in
	3 "	14 feet	7 ft - 8 in	8 ft - 0 in	8 ft - 4 in	9 ft - 1 in	9 ft - 6 in
Premium	3 "	16 feet	7 ft - 2 in	7 ft - 6 in	7 ft - 9 in	8 ft - 5 in	8 ft - 10 in
	3 "	18 feet	6 ft - 9 in	7 ft - 0 in	7 ft - 4 in	8 ft - 0 in	8 ft - 4 in
6x12 D-Log	3 "	12 feet	9 ft - 0 in	9 ft - 4 in	9 ft - 9 in	10 ft - 7 in	11 ft - 1 in
2 -ply	3 "	13 feet	8 ft - 8 in	9 ft - 0 in	9 ft - 4 in	10 ft - 2 in	10 ft - 8 in
	3 "	14 feet	8 ft - 4 in	8 ft - 8 in	9 ft - 0 in	9 ft - 10 in	10 ft - 3 in
Wall40	3 "	16 feet	7 ft - 10 in	8 ft - 1 in	8 ft - 5 in	9 ft - 2 in	9 ft - 7 in
	3 "	18 feet	7 ft - 4 in	7 ft - 8 in	7 ft - 11 in	8 ft - 8 in	9 ft - 1 in
	3 "	12 feet	10 ft - 4 in	10 ft - 8 in	11 ft - 1 in	12 ft - 1 in	12 ft - 8 in
2 -ply	3 "	13 feet	9 ft - 11 in	10 ft - 3 in	10 ft - 8 in	11 ft - 8 in	12 ft - 2 in
	3 "	14 feet	9 ft - 6 in	9 ft - 11 in	10 ft - 3 in	11 ft - 2 in	11 ft - 9 in
Rustic	3 "	16 feet	8 ft - 11 in	9 ft - 3 in	9 ft - 7 in	10 ft - 6 in	11 ft - 0 in
	3-1/8"	18 feet	8 ft - 5 in	8 ft - 9 in	9 ft - 1 in	9 ft - 11 in	10 ft - 4 in
	3 "	12 feet	11 ft - 9 in	12 ft - 3 in	12 ft - 8 in	13 ft - 10 in	14 ft - 5 in
2 -ply	3 "	13 feet	11 ft - 4 in	11 ft - 9 in	12 ft - 2 in	13 ft - 4 in	13 ft - 11 in
	3-1/8"	14 feet	10 ft - 11 in	11 ft - 4 in	11 ft - 9 in	12 ft - 10 in	13 ft - 5 in
Premium	3-3/8"	16 feet	10 ft - 2 in	10 ft - 7 in	11 ft - 0 in	12 ft - 0 in	12 ft - 7 in
	3-5/8"	18 feet	9 ft - 7 in	10 ft - 0 in	10 ft - 4 in	11 ft - 3 in	11 ft - 10 in
6x12 D-Log	3 "	12 feet	11 ft - 1 in	11 ft - 6 in	11 ft - 11 in	13 ft - 0 in	13 ft - 7 in
3 -ply	3 "	13 feet	10 ft - 8 in	11 ft - 0 in	11 ft - 6 in	12 ft - 6 in	13 ft - 1 in
	3 "	14 feet	10 ft - 3 in	10 ft - 7 in	11 ft - 1 in	12 ft - 0 in	12 ft - 7 in
Wall40	3-1/8"	16 feet	9 ft - 7 in	9 ft - 11 in	10 ft - 4 in	11 ft - 3 in	11 ft - 9 in
	3-3/8"	18 feet	9 ft - 0 in	9 ft - 4 in	9 ft - 9 in	10 ft - 7 in	11 ft - 1 in
	3-1/8"	12 feet	12 ft - 8 in	13 ft - 1 in	13 ft - 8 in	14 ft - 10 in	15 ft - 7 in
3 -ply	3-1/4"	13 feet	12 ft - 2 in	12 ft - 7 in	13 ft - 1 in	14 ft - 3 in	14 ft - 11 in
	3-3/8"	14 feet	11 ft - 8 in	12 ft - 1 in	12 ft - 7 in	13 ft - 9 in	14 ft - 5 in
Rustic	3-5/8"	16 feet	10 ft - 11 in	11 ft - 4 in	11 ft - 10 in	12 ft - 10 in	13 ft - 5 in
	3-7/8"	18 feet	10 ft - 4 in	10 ft - 8 in	11 ft - 1 in	12 ft - 1 in	12 ft - 8 in
	3-1/2"	12 feet	14 ft - 4 in	14 ft - 9 in	15 ft - 1 in	16 ft - 0 in	16 ft - 0 in
3 -ply	3-3/4"	13 feet	13 ft - 10 in	14 ft - 4 in	14 ft - 9 in	15 ft - 7 in	16 ft - 0 in
	3-7/8"	14 feet	13 ft - 4 in	13 ft - 10 in	14 ft - 4 in	15 ft - 2 in	15 ft - 8 in
Premium	4-1/8"	16 feet	12 ft - 6 in	12 ft - 11 in	13 ft - 6 in	14 ft - 6 in	15 ft - 0 in
	4-3/8"	18 feet	11 ft - 9 in	12 ft - 3 in	12 ft - 8 in	13 ft - 10 in	14 ft - 5 in

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6x12 D-Log: 6x12 (Nominal) Tongue & Groove (T&G) D-Shape Wall-Log

Wall-Log Summary

1.53 Log Courses for Headers/Girders/Beams with Wall-Logs Acting Independently

- Based on the standard wall height/log coursing, door and window openings will be left with a header consisting of 1.5 log courses.

1.531 Minimum Number of CONTINUOUS Logs over Span (without bolting)

- Wall-logs to be continuous for the calculated span and required end bearing.

		Ground Snow Load, Pg							
Span	**Log Grade**	**100**	**90**	**80**	**70**	**60**	**50**	**20**	psf
Estimated load on header		1570 plf	1460 plf	1350 plf	1250 plf	1150 plf	1050 plf	730 plf	plf
3 ft.	Wall40 & Btr.	1	1	1	1	1	1	1	logs
4.5 ft.	Wall40 & Btr.	1.5	1.5	1.5	1.5	1.5	1	1	logs
6 ft.	Select & Btr.	2	2	2	2	1.5	1.5	1	logs
8 ft.	Select & Btr.	Use bolted header	Use bolted header	Use bolted header	Use bolted header	2	2	1.5	logs
10 ft.	Select & Btr.	Use bolted header	Use bolted header	Use bolted header	Use bolted header	Use bolted header	Use bolted header	1.5	logs
12 ft.	Select & Btr.	Use bolted header	Use bolted header	Use bolted header	Use bolted header	Use bolted header	Use bolted header	2	logs
13.5 ft.	Select & Btr.	Use bolted header	Use bolted header	Use bolted header	Use bolted header	Use bolted header	Use bolted header	Use bolted header	logs

1.54 Minimum Number of Wall-Logs Acting Collectively as a Beam

- Assume a bolt diameter = 0.75-in. installed in a predrilled hole (0.78125-in.), with first bolt located 5.25-in. from each end and minimum spacing of intermediate bolts (on center) to be 3-in.
- All wall-logs in bolted header to be Grade: Select & better and continuous full length.
- All logs in a 2-course header must be full length. For headers with more log courses, the top log course and all courses in the bottom half of the header must be full length. Only one log course in the top half of the header may have a butt joint.

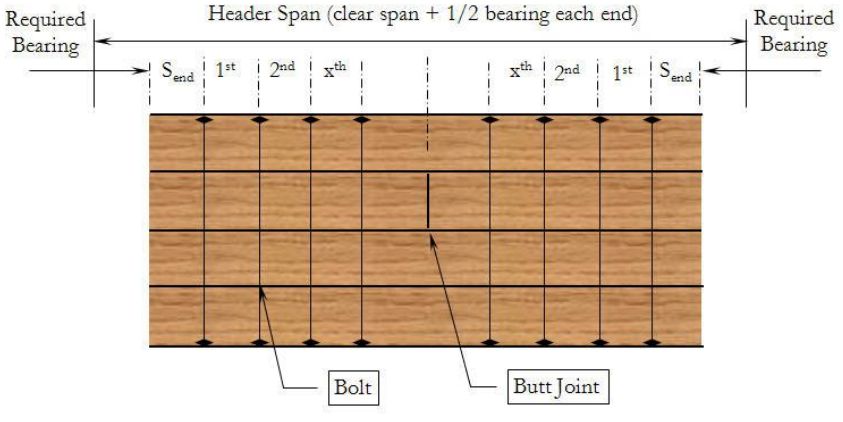
Minimum Number of Bolted Logs in Header

Ground Snow Load, Pg		**100**	**90**	**80**	**70**	**60**	**50**	**20**	psf
Estimated load on header		1570 plf	1460 plf	1350 plf	1250 plf	1150 plf	1050 plf	730 plf	plf
Header Span	3 ft.	--	--	--	--	--	--	--	logs
	4.5 ft.	--	--	--	--	--	--	--	logs
	6 ft.	2	2	2	2	--	--	--	logs
	8 ft.	2	2	2	2	2	2	--	logs
	10 ft.	2	2	2	2	2	2	--	logs
	12 ft.	3	3	2	2	2	2	2	logs
	13.5 ft.	3	3	3	3	2	2	2	logs

NDS: Bolts must meet or exceed structural quality, ASTM Standard A307, Grade A. **Ref. 5.32**

- S_{end} illustrated below is to the first bolt required at each end of the bolted header. Additional bolting shall be per Table 1.541.

Fig. 1.541 Bolting Pattern for Composite Log Headers



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Wall-Log Summary

1.541 Required Bolting Patterns for Table 1.531 with a SPLICED Log Course

Ground Snow Load		100	90	80	70	60	50	20	psf
Span	1/3-span	Required bolting in addition to end bolt:							
Based on header loading of:		1570	1460	1350	1250	1150	1050	730	plf
3 ft.	End	--	--	--	--	--	--	--	
	Mid	--	--	--	--	--	--	--	
4.5 ft.	End	--	--	--	--	--	--	--	
	Mid	--	--	--	--	--	--	--	
6 ft.	End	1 bolts @ 8-in. o/c	1 bolts @ 8-in. o/c	--	--	--	--	--	
	Mid	1 bolts @ 24-in. o/c	--	--	--	--	--	--	
8 ft.	End	4 bolts @ 6-in. o/c	4 bolts @ 6-in. o/c	3 bolts @ 7-in. o/c	3 bolts @ 7-in. o/c	2 bolts @ 8-in. o/c	2 bolts @ 9-in. o/c	--	
	Mid	1 bolts @ 18-in. o/c	1 bolts @ 19-in. o/c	1 bolts @ 21-in. o/c	1 bolts @ 22-in. o/c	1 bolts @ 24-in. o/c	1 bolts @ 26-in. o/c	--	
10 ft.	End	6 bolts @ 5-in. o/c	6 bolts @ 5-in. o/c	6 bolts @ 5-in. o/c	5 bolts @ 6-in. o/c	5 bolts @ 6-in. o/c	4 bolts @ 7-in. o/c	2 bolts @ 10-in. o/c	
	Mid	2 bolts @ 14-in. o/c	2 bolts @ 15-in. o/c	2 bolts @ 16-in. o/c	2 bolts @ 18-in. o/c	2 bolts @ 19-in. o/c	1 bolts @ 21-in. o/c	1 bolts @ 30-in. o/c	
12 ft.	End	8 bolts @ 5-in. o/c	6 bolts @ 6-in. o/c	8 bolts @ 5-in. o/c	8 bolts @ 5-in. o/c	8 bolts @ 5-in. o/c	6 bolts @ 6-in. o/c	4 bolts @ 8-in. o/c	
	Mid	2 bolts @ 16-in. o/c	2 bolts @ 17-in. o/c	3 bolts @ 14-in. o/c	3 bolts @ 15-in. o/c	2 bolts @ 16-in. o/c	2 bolts @ 18-in. o/c	1 bolts @ 25-in. o/c	
13.5 ft.	End	9 bolts @ 5-in. o/c	9 bolts @ 5-in. o/c	9 bolts @ 5-in. o/c	7 bolts @ 6-in. o/c	9 bolts @ 5-in. o/c	9 bolts @ 5-in. o/c	6 bolts @ 7-in. o/c	
	Mid	3 bolts @ 14-in. o/c	3 bolts @ 15-in. o/c	3 bolts @ 16-in. o/c	3 bolts @ 17-in. o/c	3 bolts @ 14-in. o/c	3 bolts @ 16-in. o/c	2 bolts @ 22-in. o/c	

1.6 Maximum Allowable Simple Spans for Wall-Logs Supporting Horizontal Load

- **Compliance with Ch. 6 - Wall Construction, ICC International Residential Code**

  This report provides analysis for log walls comprised of individual logs laid up horizontally. Wall-logs replace wood wall framing recognized in Section R602.

- **Compliance with Section 2304 - Wall Construction, ICC International Building Code**

  Bottom plate requirements are satisfied by the log course that is connected directly to the subfloor or to the sill plate/foundation. Framing over openings is provided by one or more log courses (including allowance for notching into logs above the opening). Floor and roof framing are not addressed in this report and are assumed to be capable of resisting applicable forces. Wall sheathing is not applicable. Code requirements shall apply for protection against decay and termites.

- Loads, connections, or other criteria not described in this report are to be specifically engineered for each design.
- Unless otherwise noted, all calculations in this section are based on Wall40 wall-logs with a stack height of 11.5-in.
- For a complete list of assumptions used to generate the tables in this section, see Section 3.5

1.61 Log Wall Length (Lw) Limited by Wind Loads: Ref. 3.52

- Wind Loads (WL) are calculated on basis of Exposure B, mean roof height = 20-ft., and wind speeds noted below.

Wind	85	90	100	110	120	130	140	150	mph
Design WL	11.26	12.62	15.58	18.85	22.43	26.34	30.53	35.06	psf
WL * H_L	11	13	15	19	22	26	30	34	plf, log
Log Grade	Maximum Allowable Sidewall Span (Lw, max. per Log Grade) per Wind Load								
Premium	53	49	46	40	38	35	32	30	ft.
Select	51	46	43	38	36	33	30	28	ft.
Rustic	47	43	40	35	33	30	28	26	ft.
Wall40	41	37	35	31	29	26	24	23	ft.

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Wall System Summary

1.7 Log Wall Fastening Schedule

- Specified fastener spacings do not account for fastening at or frequency of butt joints within the wall segment.
- The fastening schedule is the standard spacing or the minimum required for the wall span, whichever is less.
- Where results = "Use bolts", standard fasteners are limited by spacing requirements. Case-specific design of the connection will apply loads that may change the fastening schedule, especially at the ends of shear wall segments (T=C).
- vh = wind load (WL) x log wall height (Hw, not including

1.71 Typical Log Wall Fastening Specifications

- Std. log fastener: **LogHog x 15 in. @ 24-in. o/c** Penetration (p): 3 in.
- Fastener design values:

Z, parallel	Z, perpendicular	W, direct withdrawal	
207	207	366	lbs.
166	166	NA	plf per log course

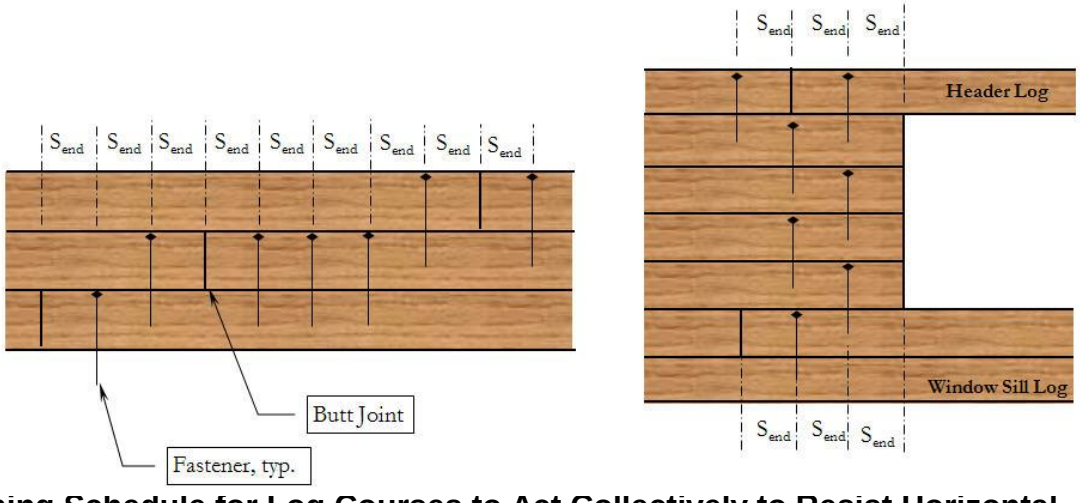
Fastening schedule to initially compress gasket: 24 in. o/c

1.711 End, Edge, and Spacing Requirements for Log Wall Fasteners: Ref. Fig.1.711

- The following minimum requirements are in accordance with the NDS.

Minimum	Requirements / Limitations	
2 in.	Edge distance, loaded edge (edge of inscribed rectangle to centerline of fastener)	
	1 Maximum allowable number of fasteners aligned in width of wall; otherw	
4 in.	S_{end} = End distance (end of log to first fastener, e.g., either side of a butt joint) and sp	
12 in.	Log length controlled by fastening (a fastener is required at each end to eliminate pote	
8 in.	Log header length beyond edge of opening (required bearing due to	1 fastener(s)
12 in.	the number of fasteners required at endwall/openings to resist	2 fastener(s)
16 in.	overturning, Fig. 1.73 and 1.742).	3 fastener(s)
12 in.	Distance between butt joints in consecutive rows	
8 in.	Distance to either side to next fastener in log directly above and below a butt joint	

Fig. 1.711 Fastener Spacing at Butt Joints, Openings / Minimum Overlap of Logs



1.72 Fastening Schedule for Log Courses to Act Collectively to Resist Horizontal Lateral Loads

- Fastener lateral design values (Z) for single shear are used to resist the horizontal lateral load; C_D x Z,perpendicular for sidewalls.
- Reported spacing is the minimum of standard fastener spacing, withdrawal capacity, or shear resistance.

Minimum fastening schedule along Sidewalls

Wind	85	90	100	110	120	130	140	150	mph
	24	24	24	24	24	24	24	24	in. o/c

- Based on the analysis taken for log shear walls, the seismic response modification coefficient is at least equal to the highest value given to any wood assembly by codes and standards (R=4.5).

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Wall System Summary

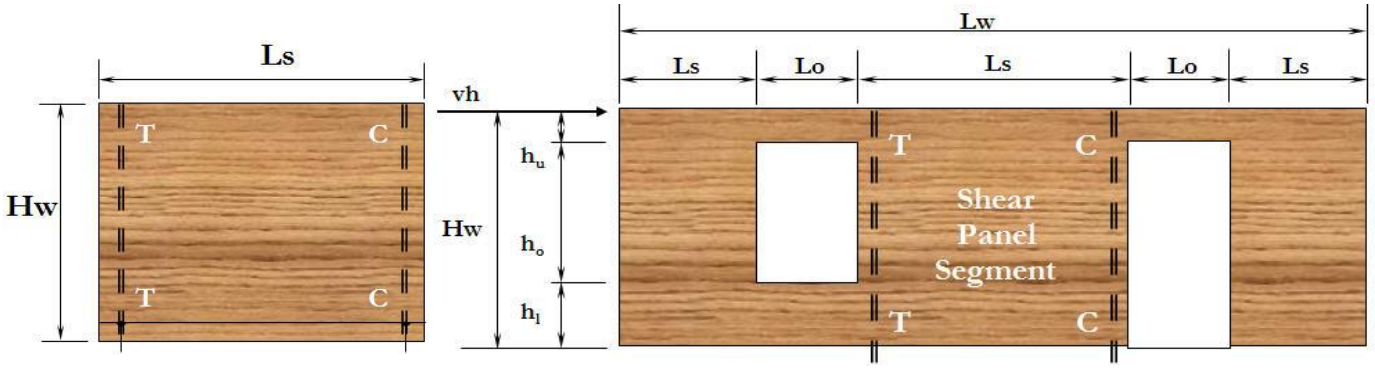
1.73 Fastening Schedule for Log Courses to Act Collectively to Resist Horizontal Lateral Loads

Assumptions and notes below correspond to Fig. 1.73:

- **Log walls are bearing walls that act as part of the Lateral Force Resisting System** (LFRS). Sidewalls resist lateral loads placed perpendicular to them with the horizontal members acting as a beam over a single span, simply supported with reaction points at shear wall locations. Log shear walls resist loads parallel to them, or in line with the logs.
- The maximum allowable log wall span equals that of an individual log acting as a beam, with maximum deflection set at l/360.
- Neither wind loading on the roof or dead load resisting an overturning force has been accounted for in this analysis.
- Neither friction or horizontal joinery connecting the consecutive logs has been included in this analysis.
- Log shear wa
  - 1 -- Continuous log courses above (header) and below (sill) wall openings act as boundary elements (drag struts) to distribute the horizontal shear force to shear elements within the wall. In multiple course headers/sills, the fastening schedule shall be determined by the horizontal shear so that log courses act collectively.
  - 2 -- Each log course has a shear capacity perpendicular to grain (vertical shear in a log wall) of 7402 lbs. per log.
  - 3 -- The shear wall segment beside a wall opening and between the header and sill log courses defines the aspect ratio for that segment. Therefore, the shear wall height is equal to the wall opening height; the width is a factor of the compressive capacity of the wood and the withdrawal capacity of the tensile connections.
  - 4 -- The tensile force at the corners of a wall opening is resisted by the withdrawal capacity of mechanical fastening and extends from the header to sill logs.
  - 5 -- The compressive force at the corners of a wall opening is resisted by the perpendicular to grain bearing capacity of the header/sill log.
  - 6 -- Gable end wall area above the log header is not used to resist shear loads.
- 2006 IBC 2305.1.1 Shear resistance based on principles of mechanics. -- Fastener lateral design values (Z) for single shear are used to resist the shear load; C_D x Z,parallel for shear walls or Z,perpendicular for sidewalls. Fastening schedules are uniformly applied without considering additional fasteners occurring due to other assembly requirements (e.g., restraint of log ends at butt
- Wind loads are horizontal and acting perpendicular to the loaded wall (topography and wind directionality factors =1).
- **Aspect Ratio** = Wall Height (H_w) to Wall Length (Ls with openings, Lw without openings) H_w for the standard log wall = 8.625 ft.
- **Ls = Length of log wall used as a shear panel.**
  T = Tension chord force, lbs.; C= Compression chord force, lbs.; v = Induced unit shear, lbs./ft.; h = Shear wall height, ft.
- For wind/seismic loading, LogHog design values = Direct withdrawal, WxPxCD = 586 lbs.
- The shear force (vh) is distributed within the first wall segment (L1) from the corner to the first wall opening or shear wall. Where the aspect ratio of L1 is insufficient to distribute the shear force, the next panel after the wall opening is assumed to do so.
- Based on column analysis (Ref. 3.55), the minimum wall length is assumed to be 2-feet.

Fig. 1.73 Shear Wall Fastening Zones

- The fastening schedule presented in this section provides the most stringent criteria developed in tables **3.53 and 3.54.**



1.74 Shear Wall Fastening Schedule

- Wall Height = Log stack 11-1/2 " x log courses 9 wall height (H_w) of 103.5 in. or 8'-7.5" (8.625-ft.)

Wind	85	90	100	110	120	130	140	150	mph
Lw, max.	41 ft.	37 ft.	35 ft.	31 ft.	29 ft.	26 ft.	24 ft.	23 ft.	**Ref. 1.61**

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Wall System Summary

1.741 Fastening Schedule Required to Resist Horizontal Loading

for Wall40 grade wall-logs.
Ref. 3.53

- Fastener spacing for log walls of lengths (Ls) at wall height (Hw)
- LogHog fasteners

Wind	85	90	100	110	120	130	140	150	mph
Ls = Lw	24	24	24	24	24	24	24	24	in. o/c
17.25 ft.	24	24	24	24	24	24	24	24	in. o/c
8.63 ft.	24	24	24	24	20	20	20	17	in. o/c
6.9 ft.	20	20	20	20	16	16	16	13	in. o/c
4.31 ft.	12	12	12	12	10	10	10	8	in. o/c
2.88 ft.	8	8	8	8	6	6	6	5	in. o/c
2.16 ft.	6	6	6	6	5	5	5	4	in. o/c

1.742 Fastening Schedule for Endwall Conditions: T_{OT} & C_{OT} (column at each end of Shear Walls)

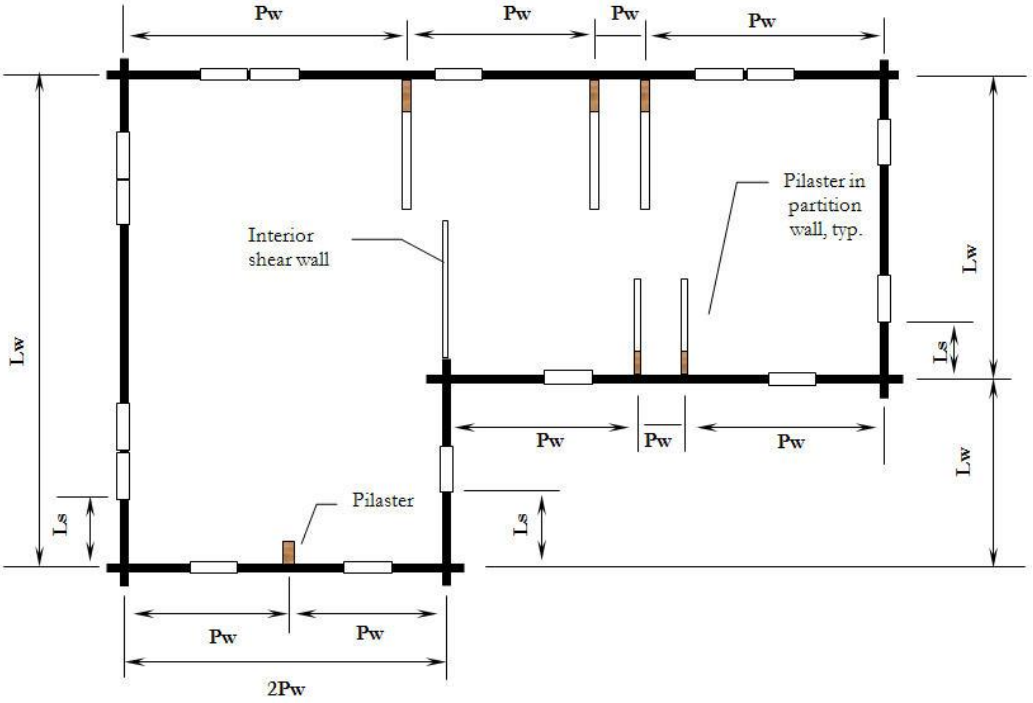
- The number of fasteners refers to quantity repeated at each end of each log in the wall, effectively forming a column.

Hw : Ls	Ls = Lw	Shear Wall fastening controls over Segment fastening at end of wall.								
	Ls = Lw	1	1	1	1	1	1	1	1	fasteners
1:2	17.25 ft.	1	1	1	1	1	1	1	2	fasteners
1:1	8.63 ft.	2	2	2	2	3	3	3	3	fasteners
1.3 : 1	6.9 ft.	2	3	3	3	3	Use bolts	Use bolts	Use bolts	fasteners
	4.31 ft.	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	fasteners
	2.88 ft.	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	fasteners
2:1	2.16 ft.	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	fasteners
Through-bolt connections:	4.31 ft.	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	bolt dia.
		3 sq.in.	3 sq.in.	3.5 sq.in.	3.75 sq.in.	4.25 sq.in.	4.5 sq.in.	4.75 sq.in.	5.25 sq.in.	washer
36000 psi tensile strength	2.88 ft.	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	bolt dia.
		3 sq.in.	3 sq.in.	3.5 sq.in.	3.75 sq.in.	4.25 sq.in.	4.5 sq.in.	4.75 sq.in.	5.25 sq.in.	washer
	2.16 ft.	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	bolt dia.
		6 sq.in.	6 sq.in.	7 sq.in.	7.5 sq.in.	8.5 sq.in.	8.75 sq.in.	9.5 sq.in.	10.5 sq.in.	washer

- Bolts are to be ASTM F1554 Grade 36 All Thread Rod or better.
- At sides of openings not in shear panel segments, ends of log shall be fastened as follows:

2	2	2	2	2	3	3	3	fasteners

Fig. 1.73 Lw = the maximum allowable distance between supports (e.g., log corner, shear wall).
Pw = the maximum allowable distance between pilasters/posts in the ends of partitions.
Ls = the distance from a support (e.g., log corner, shear wall) to an opening.



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Wall System Summary

1.75 Effect of Stiffeners (Pilasters) on Wall Span

Ref. 3.56

- Stiffeners may be in the form of pilasters (vertical beams) or posts embedded in partition walls. The pilaster spacing shown (Pw) is equivalent to the maximum allowable tributary wall area, limited by maximum wall span per 3.52.
- For fastening of pilaster to log wall, see **1.751**
- Lumber is Spruce-Pine-Fir #1, timber is Eastern White Pine, Rustic Grade & Btr.
- Shear panels include 2-2x pilaster at connection to log wall. Design values for wood-frame shear panels are taken from Table 4.3A, page 31, ANSI/AF&PA SDPWS-2008 Special Design Provisions for Wind and Seismic. **Ref. 3.57**

		85	90	100	110	120	130	140	150	mph
Design Wind Load		11.26	12.62	15.58	18.85	22.43	26.34	30.53	35.06	psf
Lw		41 ft.	37 ft.	35 ft.	31 ft.	29 ft.	26 ft.	24 ft.	23 ft.	**Ref. 1.61**
Pilaster, Capacity		**Maximum spacing of Pilaster = Wall span supported by pilaster (Pw)**							Vert. span =	8.63 ft.
2-2x6	118 plf	10	9	7.5	6	5	4	3.5	3	ft.
2-2x6 w/2-ft. shear panel	253 plf	22	20	16	13	11	9.5	8	7	ft.
2-2x6 w/4-ft. shear panel	389 plf	34.5	30.5	24.5	20.5	17	14.5	12.5	11	ft.
4x8	277 plf	24.5	21.5	17.5	14.5	12	10.5	9	7.5	ft.
6x6	242 plf	21	19	15.5	12.5	10.5	9	7.5	6.5	ft.
6x8	435 plf	38.5	34	27.5	23	19	16.5	14	12	ft.
8x8	593 plf	41	37	35	31	26	22.5	19	16.5	ft.
6.75x7.5 GLB	1359 plf	41	37	35	31	29	26	24	23	ft.
6.75x10.5 GLB	2628 plf	41	37	35	31	29	26	24	23	ft.
			Vert. span =	20.3 ft.						
8x8	73 plf	6	5.5	4.5	3.5	3	2.5	2	2	ft.
6.75x7.5 GLB	113 plf	10	8.5	7	5.5	5	4	3.5	3	ft.
6.75x10.5 GLB	311 plf	27.5	24.5	19.5	16	13.5	11.5	10	8.5	ft.

1.751 Pilaster Connection to Log Wall

- # Fasteners: Based on pilaster design capacity, this is the number of fasteners to be installed per pilaster.
- Minimum installation of fasteners shall be at top, midpoint and base log courses. Vertical spacing (courses o/c) in table below indicates equal spacing of fasteners along height of pilaster.
- Connection of pilaster to log wall with 1/2" lag 2-7/8 " into log wall W= 693 lbs./fastener

Pilaster:	2-2x6	2-2x6 w/2-ft. shear panel	2-2x6 w/4-ft. shear panel	4x8	6x6	6x8	8x8	6.75x7.5 GLB	6.75x10.5 GLB	
Fastener Lgth:	9	9	9	11	9	11	11	11	14	in.
Recommended Fastening:				Vert. span =	8.63 ft.					
# Fasteners:	3	3	3	3	3	5	7	10	10	per pilaster
Vert. spacing	3	3	3	3	3	1	1	1	1	courses o/c
				Vert. span =	20.3 ft.					
# Fasteners:	3	3	3	3	3	3	3	3	9	per pilaster
Vert. spacing	3	3	3	3	3	3	3	3	1	courses o/c

1.752 Force at Ends of Pilaster to be Resisted by Floor and Roof at Pilaster Spacing above.

Pilaster:	2-2x6	2-2x6 w/2-ft. shear panel	2-2x6 w/4-ft. shear panel	4x8	6x6	6x8	8x8	6.75x7.5 GLB	6.75x10.5 GLB	
8.63 ft.	511	511	511	1195	1044	1878	2560	3480	3480	lbs.
20.3 ft.	135	NA	NA	347	226	545	744	1152	3160	lbs.
If connected only to log wall, fastening to top/bottom log and to floor/roof diaphragms:										
8.63 ft.	1	1	1	2	2	3	4	6	6	fasteners
20.3 ft.	1	NA	NA	1	1	1	2	2	5	fasteners

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Wall System Summary

1.752 Interior Shear Wall Construction — Ref. 3.57

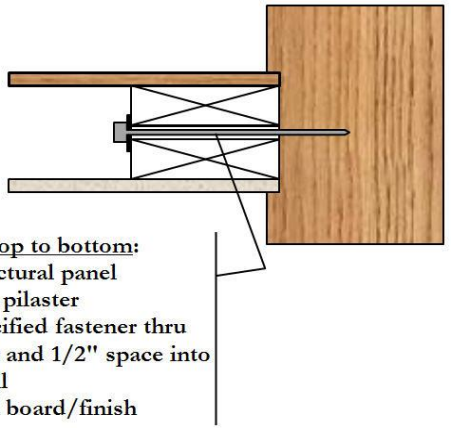
- This analysis follows the specifications set forth in ANSI/AF&PA SDPWS-2008 Special Design Provisions for Wind and Seismic. Unadjusted design values for wood-frame shear panels are taken from Table 4.3A, page 31.
- Shear walls include the specified 2-2x pilaster as end post connection to log wall.
- 15/32" minimum nominal thickness, OSB or 3-ply plywood structural panels conforming to std. PS1 or PS2.
- Values are based on stud spacing of 16" o/c and panel installed with long dimension vertical.
- Double top and bottom plates required, with specified sheathing overlapping both plates top and bottom. Specified nailing pattern is required into each plate.
- Min. 8d nails penetrating minimum 1-3/8" into framing member or blocking, 6" o/c on edge and in field. Minimum 3/8" edge distance required. Adhesive attachment of shear wall sheathing is not considered part of this report
- Options for Providing Support for Shear Wall
  - Option 1: Install foundation wall full length of shear wall
  - Option 2: Install post to footing beneath end post of shear wall
  - Option 3: Install beam in floor under shear wall

2-ft panel	4-ft. panel
2-2x10	2-LVL 9.25
1	2

fasteners

- Connection to floor: No deadload assumed to be imposed on shear wall. Recommended fastener:
  1/2" lag x 6-in. length
  through 2-2x bottom plate at ends into floor beam
  with a minimu

Fig. 1.73 Pilaster to log wall connection



1.8 Calculation of Fire-Resistance Rating — ICC400-2012 Section 303.2.2

Variable	At maximum burn, the cross-section less char suggests a design fire-rating of		0.7	hour(s)
d	Log wall height =	9 log courses x stack height of 11.5 in.	103.5	in.
Wa	average width (from log properties calculations = 5.982-in.)		5.15625	in.
b, Wn	narrowest dimension (from log properties calculations = 4.125-in.)		3.875	in.
Z	load factor		1.5	
2.54 Zb [4-(b/d)]	Calculation of fire-resistance ratings for minimum log width:		59	min.
t	exposure time	Estimated maximum length of burn, one face:	0.75	hour(s)
1.2 x 1.5	nominal char rate assumed for softwood timbers and glu-lams		1.8	
t^0.187			0.94762488	
CR	$=(1.2x1.5)/t^{0.187}$	Calculation of effective char rate	1.9	in./hr.
CL	= CR x t	Calculation of effective char layer thickness	1.425	in.
		Percentage Reduction in Width due to Charring:	36.77%	
t-Wa		Calculation of fire-resistance ratings for average log width:	78	min.
		Calculation of effective char layer thickness if burned for time (t-Wa):	2.469	in.
Wmin		minimum log width less associated char layer =	2.45	in.
Wavg		average log width less associated char layer =	2.68725	in.
2.54 Z b [4-(b/d)]	Calculation of fire-resistance ratings for the average of Wmin and Wavg:		39	min.

NDS CH.16 Fire Design of Wood Members:

Req'd. Fire Endurance	Effective Char Rate (in/hr)	Layer Thickness
1 hrs.	1.8	1.8 in.
1.5 hrs.	1.67	2.5 in.
2 hrs.	1.58	3.2 in.

NDS Table 16.2.2

	Adj. Factors
bending, Fb	2.85
tensile, Ft	2.85
comp., Fc	2.58

1.81 Fire Resistance Summary:

Min. dimension across log profile:	3.875	in.
Calculated fire-resistance rating:	0.7	hrs.
Char layer thickness at rated burn:	2.469	in.

Per ICC400: Log walls are 1-hr. rated when the least horizontal dimension is 6".

1.81 Fastener Protection

Fasteners shall be protected by 1-1/2" (38mm) of wood or other approved covering.

Required Edge Distance becomes the greater of fire or splitting (2.6) requirement:	2	in.
Maximum allowable number of fasteners across width of wall otherwise use staggered pattern.	1	fasteners

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Physical Properties of Wall-Logs

2.1 Design Stress Values are per Timber Products Inspection Grading Rules

2.11 Calculation of Wall-Log Design Stress Values per ASTM D3957

Strength Ratios (ASTM D245, Table 1), Quality Factors (ASTM D245, Table 5)				ASTM D2555 clear woo						
				4972	4972	4972	598	459	2206	1328
				adj. for size	adj. for size	Per Timber Products Inspection Grading Rules				
Slope of Grain	Bending/ Tension (%)	Fc, para. Adjust (%)	E Adjust	1	1	Cf is incorporated in design value				
				Fb, Ft	Fb, Ft	Ft	Fv	Fc, perp.**	Fc, para.	E
1 in 4	27	50	0.8	0	0	0	0	0	0	0
1 in 5	30	50	0.8	0	0	0	0	0	0	0
1 in 6	40	56	0.8	575	575	375	125	400	350	800000
1 in 8	53	66	0.9	750	750	500	125	525	350	1000000
1 in 10	61	74	1	875	875	575	125	600	350	1100000
1 in 12	69	82	1	975	975	675	125	675	350	1100000
1 in 14	74	87	1	0	0	0	0	0	0	0
1 in 15	76	100	1	0	0	0	0	0	0	0
1 in 16	80	100	1	0	0	0	0	0	0	0
1 in 18	85	100	1	0	0	0	0	0	0	0
1 in 20	100	100	1	0	0	0	0	0	0	0
Wall30	30	50	0.8	425	425	275	125	350	300	800000
Wall40	40	56	0.8	575	575	375	125	350	400	800000
Rustic	53	66	0.9	750	750	500	125	350	525	1000000
Select	61	74	1	875	875	575	125	350	600	1100000
Premium	69	82	1	975	975	675	125	350	675	1100000

Design Value Adjustment Factors	Fb	Ft	Fv	Fc, perp.	Fc, para.	E X 10^6
Wall-Log Softwood Factors (ASTM D245 Table 8)	2.1	2.1	2.1	1.67	1.9	NA
SRTB Softwood Factors (ASTM D245 Table 8)	2.1	2.1	2.1	1.67	1.9	NA
Density Factors (ASTM D245 Table 6)	1.17	1.17	1	1.13	1.17	1.05
SRTB Adjustment	0.91	0.5005	0.99	1.5	1.001	1.06
Fv Strength Ratio = 0.5 Wall-Log Adjustment	1	0.55	1	1.5	1.1	1.06

2.12 Calculation of Sawn Round Timber Beam Design Stress Values per ASTM D3957

Slope of Grain	Bending/ Tension	Fc, para. Adjust	E Adjust
1 in 14	73	73	1
1 in 10	61	61	1
Unsawn	73	73	1

Form Factor 1.18

ASTM D2555 clear wood values			0.38		1
4823	4823	592	440	2164	1167
Fb, Ft	Ft	Fv	Fc, perp.**	Fc, para.	E
1350	750	115	350	800	1100000
1100	600	115	350	650	1100000
925	500	115	350	550	1100000

The adjustment factor for Fv = 0.5

**Fc, perp. Values taken as Mean Stress at 0.04 in. Deformation, psi

2.2 Calculation of Allowable Knot Sizes for Wall-Logs (ASTM D245)

- Vertical loads rotate around x-axis. Horizontal loads rotate around y-axis.

Calculations are accurate for face width down to 3-1/4 inches using the X1.1 version.

For 2.5 smaller than 3-1/4 inches, the X1.3 version controls, as it does for 4 on a 2-in face.

Strength Ratios	X1.3 version 69	61	X1.1 version 69	61	53	40	X1.2 Version 69	61	X1.3 version 61
Inscribed Rectangle	Premium	Select	Max. Allowable Knot in Narrow Face Premium	Select	Rustic	Wall40	Premium	Select	Select
4 5/8 "	2 1/2	4	1 1/2	2	2 1/4	2 3/4	1 1/2	2	4
11 "	13	20 1/2	2 1/2	3 1/4	4	6 1/2	3 1/2	4 1/2	20 1/2

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Physical Properties of Wall-Logs

2.3 Section Properties for Wall-Logs

Variable	H = lesser of (IRvert+groove) or Hlog.		loaded face:	vertical	horizontal	
A	area	BH+profile area		59.212		$in.^2$
S	section modulus	BH^2/6		109.107	48.743	$in.^3$
I	moment of inertia	BH^3/12		627.365	125.665	$in.^4$

Log Height: Actual overall (H): 11.875 in.

Log Course Height (H_L): 11.5 in.

SF Conversion: 1.043 LF of log per SF wall

Log Width: Actual overall (B or D): 5.75 in.

Shape Factor: 0.822 x nominal callout

2.31 Analysis of Profiled Sections

	Exterior Reductions		Bearing		Joinery		Interior Reductions		
Pattern @ Top	Width	1.5	Width	2.5	Width	1.375	Width	0.375	in.
	Height	1.84375			Height	0.375	Height	0.375	in.
	Area	-3.136063			Area	0.515625	Area	-0.140625	$in.^2$
Core section	Width	1.34375	Width	2.46875	Width	1.5625	Width	0.375	in.
	Stack Hgt.	11.5	Stack Hgt.	11.5	Stack Hgt.	11.5	Stack Hgt.	11.5	in.
	Area	15.4531		28.3906		17.9688		4.3125	$in.^2$
Pattern @ Bottom	Width	1.1875	Width	2.4375	Width	1.75	Width	0.375	in.
	Height	1.421875			Height	0.5	Height	0.375	in.
	Area	-3.136063			Area	-0.875	Area	-0.140625	$in.^2$
A	59.212	9.181	+	28.391	+	17.609	+	4.031	$in.^2$
I-vert	627.365	75.307	+	312.888	+	191.643	+	47.527	$in.^4$
I-horiz	based on W_L (avg. log width) and stack height less depth of joinery							125.665	$in.^4$
S-vert	109.107								$in.^3$
S-horiz								48.743	$in.^3$
IRvert	vertical dimension of the inscribed rectangle							11	in.
IRhoriz	horizontal dimension of the inscribed rectangle							4.625	in.
vv_L	average width				Area (A = 59.212 sq. in.) / stack height (11.5-in)			5.15625	in.
Wn	narrowest width							3.875	in.

2.32 Analysis of Circular Sections

- Grading criteria: Inscribed Square: NA Bearing area+ 0.5

NA Max. profiling into log without affecting the inscribed square
NA Limited by maximum sawing depth (0.3r) for sawn round timber beams NA

- For a round log with a notch or cope removed, the horizontal axis is referenced as x; vertical as y.

Variables	Full Circle		- Segment	= SRTB	- Notch	= Log	- Cope	= Log	Wall-Log	
Geometries:	chord, c = width of seat =		NA		NA		NA			in.
height	h = r - sqrt(r^2 - c/2^2) =		NA		NA		NA	=r-sqrt(r^2-(c/2)^2)		
angle			NA		NA		NA			degrees
			A, Segment =		Cos A =	NA				
radius		NA	PI()r^2(angle/360)-(c(r-h)/2)		r, hypot.	NA	0	*cope*		
Area (A)	**PI*D^2/4**				*A, Cope=PI*r^2 (angle/360)-(c(r-h)/2)*					
	A	NA	0	**NA**	0	**NA**	0	**NA**	NA	$in.^2$
Centroid (x,y)	d/2	NA	--	--	--	--	--	--		
	c/2	--	NA	--	NA	--	NA	--		
	rh/c	--	--	--	--	--	NA	--		
	y=0.425r	--	--	--	--	--	NA	--		
	Ax	NA	NA	NA	NA	NA	NA	NA		
	Ay	NA	NA	NA	NA	NA	NA	NA		
	h/3	--	NA		NA		NA	NA		
	Ax/A	NA	NA	NA	NA	NA	NA	NA		
	Ay/A	NA	NA	NA	NA	NA	NA	NA		
Moment (I)	**PI*D^4/64**		**I, segment**							
Ix	I, vert.	NA	0	NA	0	NA	0	NA	NA	$in.^4$
		--	**PI*c^4/128**	--	**PI*c^4/128**	--	**PI*c^4/128**	--		
Iy	I, horiz.	NA	0	NA	0	NA	0	NA	NA	$in.^4$
Section (S)	**PI*D^3/32**		**I / (Ax/A)**		**I / (Ax/A)**		**I / (Ax/A)**			
Sx	S, vert.	NA	NA	NA	0	NA	0	NA	NA	$in.^3$
Sy	S, horiz.	NA	NA	NA	0	NA	0	NA	NA	$in.^3$

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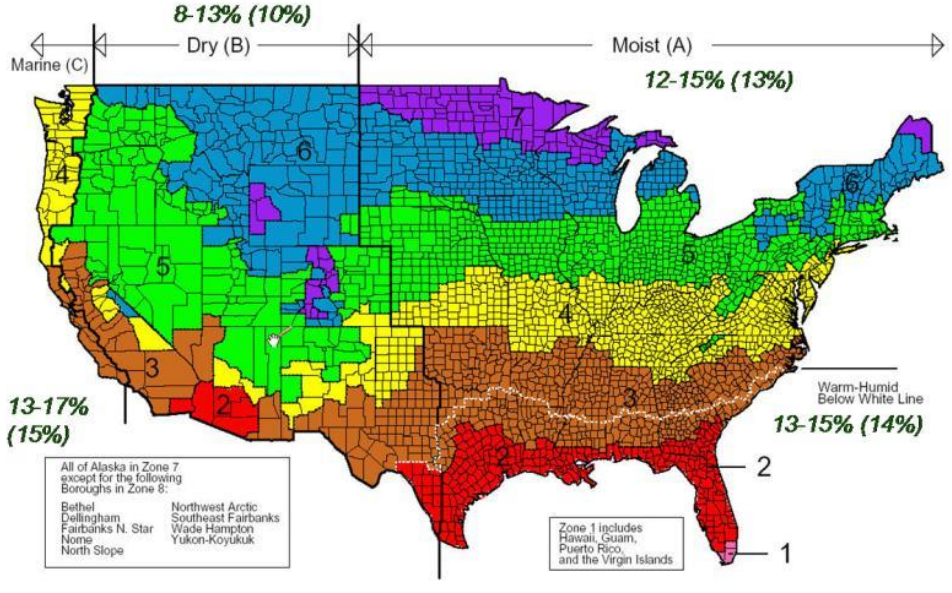
6x12 D-Log: 6x12 (Nominal) Tongue & Groove (T&G) D-Shape Wall-Log

Physical Properties of Wall-Logs

2.4 Calculation of Log Characteristics Relating to Moisture Content

*Calculated using methods described in FPL-RN-0268, *Equilibrium Moisture Content of Woods in Outdoor Locations in the United States and Worldwide* , William T. Simpson, Aug. 1998, as related to the US DOE climate zone map in the IECC. Equations per Wood Handbook, FPL.

Fig. 2.73 Climate zone map, 2005 ICC International Energy Conservation Code (US DOE).



2.41

Variables								
MC_{FSP}	moisture content at fiber saturation						30	%
M_I	moisture content at time of milling						18	%
	Shrinkage coefficients are per Table 3-5 Wood Handbook:					radial	tangential	volumetric
S	*Shrinkage (%) from green to oven dry moisture content*					2.1	6.1	8.2
Gu	unseasoned specific gravity based on green volume (ASTM D2555)							0.35
Anticipated Equilibrium Moisture Contents (EMC) by Climate Zone*		Climate Zone (ref. Fig.2.73)		**Initial**	**Dry**	**Moist**	**Warm-Humid**	**Marine**	
		Exterior	Indoor		6	8	11	11	%
			Minimum		8	12	13	13	%
MC_D	18% MC		Maximum		13	15	15	17	%
MCs	Service Moisture Content = EMC		Average	18	10	13	14	15	%
Gm	ICC400 302.2.3.3.3:	Gu/(1-(0.265 a Gu))		where a=	$(MC_{FSP}-MC_S)/MC_{FSP}$				
G		Specific Gravity at Exterior EMC		0.363	0.373	0.369	0.368	0.367	

2.42 Calculation of Log Weight

	Density at MC_D, per value, G, above		26.71	25.59	26.01	26.17	26.32	pcf
	ICC400 302.2.3.7: Density (lb/ft3) = 62.4 * [G/(1+(0.009*G*MC_S/100))] *(1+MC_S/100)							
	Log weight	Density x A/144	10.98	10.52	10.7	10.76	10.82	plf
w	Wall mass	Log weight * SF conversion	11.45	10.97	11.16	11.22	11.29	psf
Ww	Weight of log wall	9 courses typ.	98.82	94.68	96.3	96.84	97.38	plf

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Physical Properties of Wall-Logs

2.43 Calculation of Thermal Properties

Climate Zone (ref. 2.73) REScheck(R) nominal width = 6-in.

Variables	Coefficients A, B and C are based on SG >0.3, design temperature at 75°F, and MC <25%:	Initial	Dry	Moist	Warm-Humid	Marine	
k	Wood Handbook Eq.3-7: thermal transmittance Gm[B+ C(EMC)] +A	0.798372	0.73326	0.757776	0.766376	0.77492	Btu·in / (h·ft$^{2.0}$F)
	A= *0.129*		***B=*** *1.34*		***C=*** *0.028*		
R	thermal resistance = 1/k	1.253	1.364	1.32	1.305	1.29	R/in.
R_L	Avg. Log Thickness x R-value/inch	6.46	7.03	6.81	6.73	6.65	
R_S	Logs bear on one another						
Rw	0.17 outside air film+R_L+0.68 inside air film	7.31	7.88	7.66	7.58	7.5	
Uw	u-factor of wall assembly (1/Rw)	0.137	0.127	0.131	0.132	0.133	
t	degrees Fahrenheit	65	65	65	65	65	
c_{p0}	WH Eq.3-8b: $0.2605+0.0005132t$, for EMC=0.	0.294	0.294	0.294	0.294	0.294	
A_c	Eq.3-10: $MCs(b_1+b_2t+b_3MCs)$	0.019	0.013	0.016	0.016	0.017	
	b_1= -4.23x10^{-4}, b_2= 3.12x10^{-5}, b_3= -3.17x10^{-5}						
c_p	WH Eq.3-9: c_{pw} = 1 Specific heat $(c_{p0}+0.01MCs*c_{pw})/(1+0.01MCs)+A_c$, for EMC>0.	0.42	0.37	0.39	0.39	0.4	Btu/lb-°F
HC	Heat Capacity (w,psf x c_p)	4.8	4.1	4.4	4.4	4.5	Btu/ft^2-°F
	2015 IECC compliance for thermal mass	No	No	No	No	No	

2.5 Settling Properties for Wall-Logs

- In this analysis, the verifiable (repeatable) measurement of wall settling has been found to be significant to 1/16" or 1 mm.

2.51 Estimated Total Settling

			At time of profiling	Dry	Moist	Hot-Humid	Marine	
Δs	**Ref. 2.52**	Estimated settling due to shrinkage	0	-0.065	-0.041	-0.033	-0.024	in.
Δc	**Ref. 2.53**	Estimated settling due to compaction			NA			in.
$Δ_{SL}$	**Ref. 2.54**	Estimated settling due to slumping			NA			in.
		Total estimated settling per log course	0	-0.065	-0.041	-0.033	-0.024	in.
82.5		Above door (height, in.) with 2x buck above	0 "	1/2 "	21/64"	1/4 "	11/64"	in.
N		9 courses Theoretical wall height	8 ft - 8 in					
		Estimated tot	0	-0.578125	-0.375	-0.296875	-0.21875	in.
		Percentage of final to initial log height:	0	0.6	0.4	0.3	0.2	%
MCs		Service Moisture Content = EMC	18	10	13	14	15	%
MC_D		To minimize settling, MC at time of millng should be	**18% MC**	**18% MC**	**18% MC**	**18% MC**	**18% MC**	

2.52 Calculation of Dimensional Change Due to Seasoning (Ds, inches)

- Boxed heart timbers experience primarily radial shrinkage.

Δs	ICC400 304.2.2.3.4:	$(H_L*(MC_D-MC_S))/(MC_{FSP}*100/S - MC_{FSP}+MC_D)$; H_L = stack height						
S_R	2.1%	Radial change	0	-0.065	-0.041	-0.033	-0.024	in.
		log stack height after seasoning to EMC	11.5	11.435	11.459	11.467	11.476	in.
S_V	8.2%	Volumetric change	0	-0.266	-0.165	-0.131	-0.098	
	Shrinkage coefficients are per Table 3-5 Wood Handbook: Shrinkage (%) from green to oven dry moisture content							
	0.1	Longitudinal shrinkage coefficient		0.096 in.	per mean log length of		8	ft.

2.53 Calculation of Compression in Exterior Wall due to Gravity Loads

Fc, perp.	design stress value for compression perpendicular to grain	350	psi
CL	Compression load from weight of walls + floor + roof	1663	plf
	Required bearing width (load imposed on a log course/12 = lbs./in.; /Fc^ = min. width) =	13/32	in.
B_{LP}	Width of log-to-log bearing	2.5	in.
	Fc,perp. (psi) x log bearing (in.) x 12 Max. Log bearing capacity =	10500	plf

Ref. 3.4

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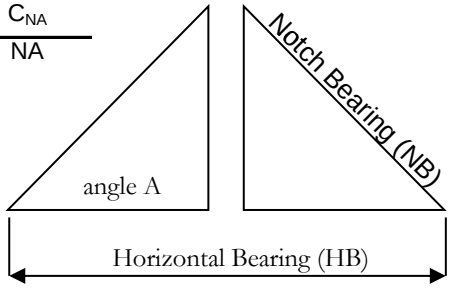
2.531 Calculation of compaction for notched/coped profiles

■ Assumes compaction occurs until sufficient bearing area, normalized to the angle of the notch, is achieved.

	HB/2	H	Angle A	CosA	SinA	NB	C_{NA}	
Cope/notch:	NA	NA	NA	NA	NA	NA	NA	
Log:	NA	NA	NA	NA	NA	NA		in.
Min. bearing:	1.25	NA	0	NA	NA	NA		

Settling potential due to notch/cope: NA in. per course
Settling potential due to bearing width: NA in. per course
Initial joint - settling due to compaction = NA in. per course



2.54 Calculation of Settlement Due to Slumping

Tests for Slumping Analysis: *Test for slump not required.*

Does the profile provide continuous contact or have horizontal bearing surfaces?	Yes
Is the moisture content at profiling greater than that in service?	Yes
Is a seasoning kerf cut opposite of the cope?	No
Is the kerf depth + the cope height >/= (log height/4)?	NA
Is the kerf depth + cope height > distance between the kerf and cope?	NA
Does $MC_D = MC_{FSP}$?	No
Is the cope width > log diameter x 3/8?	NA
Is the cope height/depth > log height/4?	NA

2.541 Calculating Slump

Slump, per course = Height of void between logs x the slumping coefficient

Variables								
H_{CA}	Height of void in groove	1/8 "	less settling due to compression	NA	0	in.		
Wc	width of cop				1.75	in.		
p	log circumference = PI x diameter =				NA	in.		
			Dry	Moist	Hot-Humid	Marine		
MC_D	To minimize settling, MC at time of millng should be		18% MC	18% MC	18% MC	18% MC	18% MC	
S_T	6.1%	Tangential change	NA	NA	NA	NA	NA	in.
			$(p*(MC_S - MC_D))/((MC_{FSP}*100/S - MC_{FSP}) + MC_D)$					
C_{SL}	Slumping Factor	D/ (p - Wc - ST)	NA	NA	NA	NA	NA	
D_{SL}	$H_{CA} * N * C_{SL}$	Per log course:	NA	NA	NA	NA	NA	in.

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Wall-Log Verification to Codes & Standards

3.1 Design Criteria

Compliance with Ch. 3 - Building Planning, ICC International Residential Code

- Climatic and geographic conditions covered in this report. Conditions beyond those noted require specific engineering.
- Loads (psf) tied to basic wind speed are the greater of the pressures acting toward and away from the building surfaces from Table R301.2(2) of the 2003 IRC, zone 5. Tabulated loads assume a building located in Exposure B with a mean roof height of 30 feet.

3.11 Design Conditions Used for Analysis

Variables The following design conditions are used to model responses to loading in appropriate tables.

		Roofs/Ceilings	Floors	Walls above grade (Log)		
DL	Dead Load	15 psf	10 psf	11.5 psf	(log weight at time of milling)	
	Building width				28	ft.
	Roof pitch				10	:12
	Gable height at endwall				11.667	ft.
Hw	1st floor wall height	9 log crs.	x 11.5-in. log stack height = overall wall height		8.63	ft.
		8 log crs.	required to provide a minimum 7-foot ceiling height.			
Hw_2	2nd floor wall				0	ft.
Hmr	The mean roof height (assumes 10" subfloor, 1.5" sill plate, 12" to grade; rounded up in 5-ft. increments)				20	ft.

3.12 Roof Snow Loads

Pg	Ground Snow Load	100	90	80	70	60	50	20	psf

3.13 Design Wind Pressures for Main Wind-Force Resisting Systems

3.131 ASCE Zone 5 Load Calculations (end zone of wall) Enclosure classification (6.5.9): Partially Enclosed

- Per IRC R301.2.1.1 Design Criteria. Opt. 3 Minimum Design Loads for Buildings and Other Structures (ASCE-7)
- See ASCE 7-05 (IBC 2006) for Basic Wind Speed maps showing nominal design 3-second gust wind speeds (mph) at 33 ft. above ground for Exp. C.
- **Wind Exposure Categories:**

A: Large city centers with at least 50% of buildings with height over 70 ft.

B: Urban/suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions ≥ the size of single-family dwellings.

C: Open terrain with scattered obstructions having heights generally less than 30 feet; includes flat open country and grasslands.

D: Flat, unobstructed areas exposed to wind flowing over large bodies of water.

Variables	Calculation of WL, wind load on the Main Wind Force Resisting Structure (MWFRS)					ASCE 7-05 Section		
V	Basic wind speed	Exposure category (6.5.6):	B			6.5.4		
Kd	Wind Directionality Factor					6.5.4.4, Table 6-4	0.85	
I	Occupancy Importance Factor					6.5.5, Table 6-1	1	
Kz	Velocity Pressure Coefficient for Exposure B and 33-ft. above grade.					6.5.6.6, Table 6-3	0.624	
	Kz=2.01(z/zg)^(2/a)	a= 7		zg= 1200		z=	20	
Kzt	Topographic Factor					6.5.7.2, Fig. 6-2	1	
qz	Effective velocity pressure (psf) = q =0.00256*Kz*Kzt*Kd*I*V^2					6.5.10		psf
G	Gust Effect Factor for Rigid Structures					6.5.8	0.85	
Cp	External pressure coefficient/force coefficient					6.5.11, Fig. 6-6	0.8	
Cpi	Internal pressure coefficient					6.5.11.1, Fig. 6-5	-0.55	
Pe	Design Wind Load	p=qz*G*Cp - qz*GCpi				6.5.12.2		psf

Wind	85	90	100	110	120	130	140	150	mph
qz	9.81	11	13.58	16.43	19.55	22.95	26.61	30.55	mph
Pe	11.26	12.62	15.58	18.85	22.43	26.34	30.53	35.06	psf

3.133 Lateral Loading Use

Design WL	***11.26***	***12.62***	***15.58***	***18.85***	***22.43***	***26.34***	***30.53***	***35.06***	psf

3.14 Seismic Design Category

Calculated S_{DS}:	$S_{DS} \le 0.17g$	$0.17g < S_{DS} \le 0.33g$	C	$0.17g < S_{DS} \le 0.33g$	D1	$0.83g < S_{DS} \le 1.17g$	D2	E
				$0.50g < S_{DS} \le 0.83g$		$1.17g < S_{DS}$		

Note: Detached 1- & 2-family dwellings located in Seismic Design Category C are exempt from seismic requirements.

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Wall-Log Verification to Codes & Standards

3.2 Establish Typical Roof Loads

- For gravity loads acting on the roof structure, a simplified approach was used with all loads assumed to be acting on the horizontal projection.

3.21 Load Adjustment Factors

3.211 Snow Load (SL) Development

Variables										
Pg		ASCE Standard: ANSI/ASCE 7-98, Eq. 7-2: $P_s = Cs * P_f$					Eq. 7-1: $P_f = 0.7\ Ce\ Ct\ I\ P_g =$	0.77 *pg		
		Ground Snow Load								
Ce	1	ASCE Table 7-2: Snow Exposure Factor = Terrain categories B-D. For sheltered Exp. A, multiply load by 1.3.								
Ct	1.1	ASCE Table 7-3: Thermal Factor; 1.0=heated, 1.1=kept just above free								
I	1	ASCE Table 7-4: Occupancy Importance Factor for category II							Horiz. To Pitch Conversion Factor	Wind Pressure Coefficient
		Cs, roof slope adjustment factor where: Roof angle<30=1, >70=0, other=(angle-30)/40								
		Roof Pitch	Rise/Run TAN a	Degrees, Angle a	Cos a	COS a ^{2}	Cs * COS a^2	DL / COS a		Cp
Cs	**1.00**	3:12	0.250	14.04	0.970	0.941	**0.941**	15.46	1.031	-0.9
	1.00	5:12	0.417	22.62	0.923	0.852	0.726	16.25	1.083	-0.75
	0.99	7:12	0.583	30.26	0.864	0.746	0.553	17.37	1.158	-0.2
	0.91	8:12	0.667	33.69	0.832	0.692	0.435	18.03	1.202	-0.2
	0.75	10:12	0.833	39.81	0.768	0.590	0.263	19.53	1.302	-0.2
	0.63	12:12	1.000	45.00	0.707	0.500	0.156	21.21	1.414	0.3
Ps	**0.77**	**Ps = Cs * Pf = Cs*(0.7*Ce*Ct*I) when Cs=1.0 for a pitch of 3:12, and Pg = 1.**								

3.22 Calculation of Total Vertical Load on Horizontal Projection

Variables									
	2000 IBC 1605.3 Load combinations using allowable stress design:								
Cd	**1.15**	2 mo. load duration factor					Design Snow Load (SL) =	$Ps * Cu * Pg / C_D$	
Cu	**1.5**	Unbalanced snow load coefficient (ASCE 7-98 7.2) / Ce							
Pg	**Ground Snow Load**	**100**	**90**	**80**	**70**	**60**	**50**	**20**	psf
SL	Snow Load	115.5	103.95	92.4	80.85	69.3	57.75	23.1	psf
DL	Dead Load	15	15	15	15	15	15	15	psf
LL	Live Load (min. 20 psf)	20	20	20	20	20	20	20	psf
DL + LL		35	35	35	35	35	35	35	psf
DL + SL		130.5	118.95	107.4	95.85	84.3	72.75	38.1	psf
TL	Max. Horiz. Load	131	119	107	96	84	73	38	psf
TL (flat)	Use for bending/shear	131	119	107	96	84	73	38	psf
SL, flat	Use for deflection	116	104	92	81	69	58	23	psf

* Unbalanced snow load factor for slopes exceeding 5^0 (Para. 7.6.1)

3.221 Calculation of Design Load Perpendicular to Roof Structure

- The following is presented for informational and comparative purposes only and is not used elsewhere in this analysis.
- When applying the total load below, the rafter length must be calculated at actual length rather than horizontal span.

Variables	Pitch			3:12	5:12	7:12	8:12	10:12	12:12	
DL	Adjusted dead load	DL/Cos a		15.46	16.25	17.37	18.03	19.53	21.21	psf
Cos a^2	Snow load adjustment			0.941	0.852	0.746	0.692	0.590	0.500	
		Pg	SL	Total Load adjusted to roof pitch:						
TL	Pg =	100	115.5	124.17	114.66	103.55	97.99	87.69	78.96	psf
		90	103.95	113.3	104.82	94.93	90	80.88	73.19	psf
		80	92.4	102.42	94.98	86.31	82	74.06	67.41	psf
		70	80.85	91.55	85.14	77.69	74	67.24	61.64	psf
		60	69.3	80.68	75.3	69.08	66.01	60.43	55.86	psf
		50	57.75	69.81	65.46	60.46	58.01	53.61	50.09	psf

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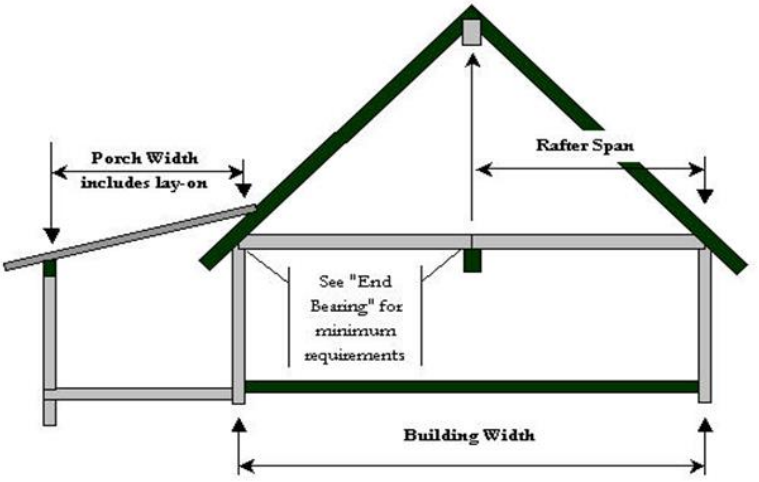
3.23 Effective Roof Load on Log Wall

3.231 Establish Dead Load of Log Gable Endwall

- Assumption: A point load acting on a wall-log is distributed over a wall-log length equal to twice the depth of the wall-log (distributed 45-degrees in each direction in the plane of the wall-log). A point load acting on a log wall is distributed over a wall length equal to twice the height of the wall.

Building width is	28 ft.
and roof pitch is	10:12
gable/ridge height:	11.6667 ft.
gable area:	163 sq.ft.
# of log courses to build gable:	1844 lbs.
total weight of wall:	12 log crs.
Log height*45-deg. Distribution =	23 "
Gable height * 45-deg. distribution =	23 ft.
Uniformly distributed gable dead load:	**81 plf**



3.232 Establish roof area contributing load

Contributing roof width:	14 ft.
Roof overhang, at eave:	24"
at rake:	24"
Contributing width	
at eave:	9 ft.
at rake:	14 ft.
Ridge Beam Span:	24 ft.
Purlin Span:	NA

Roof framing type: Rafters/joists with center bearing
Purlin Spacing: NA
Point Loads on Gable: 1

Ground Snow Load	100	90	80	70	60	50	20	psf
Rafter/truss load on sidewall:	1179	1071	963	864	756	657	342	plf
Ridge beam, point load on endwall:	25676	23324	20972	18816	16464	14308	7448	lbs.
Purlin, point load on endwall:	0	0	0	0	0	0	0	lbs.

3.233 Estimate Roof Point Load Distribution Down the Endwall

Total weight from ridge + gable =	27520	25168	22816	20660	18308	16152	9292	lbs.
Total weight from purlins + gable =	0	0	0	0	0	0	0	lbs.
Total weight / distributed length =	1197	1094	992	898	796	702	404	plf

3.3 Establish Typical Floor Loads

40	psf, Live load (for this analysis, assumed to apply to all floor areas)		Contributing joist length:	Point Loads on Endwall:	1
			on interior beam(s) 14 ft.	Contributing length:	12 ft.
15	psf, Dead load	Typ. Joist spacing, "o/c	on sidewall 7 ft.	Point load on endwall:	4620 lbs.
55	psf Total Floor Load	24	Load on sidewall: 385 plf	Load on endwall:	256 plf

It is highly recommended that a girder point load be supported by a column of logs or a post.

3.4 Establish Typical Uniform Vertical Loads on the Log Wall

- For calculation of loads summarized in this table, refer to preceeding tables.

	Ground Snow Load	100	90	80	70	60	50	20	psf
On Sidewalls	Roof only	1179	1071	963	864	756	657	342	plf
	Roof + Floor framing	1564	1456	1348	1249	1141	1042	727	plf
On Endwalls	Roof + Gable wall	1197	1094	992	898	796	702	404	plf
	Roof + Gable + Floor	1453	1350	1248	1154	1052	958	660	plf
On Headers						2 log course header =		21.96	plf
To Foundation	max. sidewa	1663	1555	1447	1348	1240	1141	826	plf
	max. endwall	1552	1449	1347	1253	1151	1057	759	plf

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6x12 D-Log: 6x12 (Nominal) Tongue & Groove (T&G) D-Shape Wall-Log

Wall-Log Verification to Codes & Standards

3.5 Establish Lateral Load on the Log Wall

3.51 Lateral Load Acting on Log Wall

3.511 Wind Load Applied to the Windward Log Vertical Face

Variables	Wind	85	90	100	110	120	130	140	150	mph
WL	Design wind	11.26	12.62	15.58	18.85	22.43	26.34	30.53	35.06	psf
$WL*H_L$	H_L=Log hgt.	11	13	15	19	22	26	30	34	plf, log
WL*Hw	wall hgt.=Hw	97.12	108.85	134.38	162.58	193.46	227.18	263.32	302.39	plf, wall

3.512 Seismic Loading

See section 3.14

- Based on the analysis taken for log shear walls, the seismic response modification coefficient is at least equal to the highest value given to any wood assembly by codes and standards (R=4.5).

3.52 Sidewall Analysis

3.521 Reaction at Each End of Each Wall-log at Maximum Log Wall Span (Lw)

V_L = WL * H_L * Lw/2 = reaction at each end of the wall-log

	Wind	85	90	100	110	120	130	140	150	mph
Shear load per log course	Premium	292	319	345	380	418	455	480	510	lbs.
	Select	281	299	323	361	396	429	450	476	lbs.
	Rustic	259	280	300	333	363	390	420	442	lbs.
	Wall40	226	241	263	295	319	338	360	391	lbs.
Log Grade	**Fc, perp.**	**Required bearing area to transfer load from sidewall log to endwall log**								
Premium	350 psi	0.83	0.91	0.99	1.09	1.19	1.30	1.37	1.46	sq. in.
Select	350 psi	0.80	0.85	0.92	1.03	1.13	1.23	1.29	1.36	sq. in.
Rustic	350 psi	0.74	0.80	0.86	0.95	1.04	1.11	1.20	1.26	sq. in.
Wall40	350 psi	0.65	0.69	0.75	0.84	0.91	0.97	1.03	1.12	sq. in.

3.53 Shear Walls without Openings

3.531 Design Shear Force at Each End of the Sidewall

vh = WL * Hw/2 * Lw, max./2 **Hw = 8.625 ft.**

- vh = wind load (WL) x log wall height (Hw, not including gable, 2nd floor, or half of 1st floor) x log wall span (Lw).

	Wind	85	90	100	110	120	130	140	150	mph
vh, per wall-log grade	Premium	1287	1333	1545	1626	1838	1988	2107	2268	lbs.
	Select	1238	1252	1445	1545	1741	1874	1975	2117	lbs.
	Rustic	1141	1170	1344	1423	1596	1704	1843	1966	lbs.
	Wall40	995	1007	1176	1260	1403	1477	1580	1739	lbs.

3.532 Shear Wall Fastening Schedule (without openings)

- Maximum allowable fastener spacing will insure logs act collectively as a beam, resist shear [Lw,max./(vh/Z)], or default to the company standard fastener spacing.
- Fastener lateral design values (Z) for single shear are used to resist the shear load; C_D x Z,parallel for shear walls

Wind	85	90	100	110	120	130	140	150	mph
Log Grade	Minimum number of fasteners required per log course to resist shear force (vh).								**Ref. 3.52**
Premium	4	5	5	5	6	7	7	7	fasteners
Select	4	4	5	5	6	6	6	7	fasteners
Rustic	4	4	5	5	5	6	6	6	fasteners
Wall40	4	4	4	4	5	5	5	6	fasteners

Fastener Spacing in Header/Sill Log Courses (above and below wall openings) for Wall40 grade wall-logs.

Lw, max.	41 ft.	37 ft.	35 ft.	31 ft.	29 ft.	26 ft.	24 ft.	23 ft.	**Ref. 1.61**
Lw, max.	24	24	24	24	24	24	24	24	in. o/c
17.25 ft.	24	24	24	24	24	24	24	24	in. o/c
8.63 ft.	24	24	24	24	20	20	20	17	in. o/c
6.9 ft.	20	20	20	20	16	16	16	13	in. o/c
4.31 ft.	12	12	12	12	10	10	10	8	in. o/c
2.88 ft.	8	8	8	8	6	6	6	5	in. o/c
2.16 ft.	6	6	6	6	5	5	5	4	in. o/c

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Wall-Log Verification to Codes & Standards

3.533 Overturning Force in Corners of Shear Walls (T_{OT} & C_{OT})

$T_{OT} = C_{OT} = vh * Hw/Lw$, max.

	Wind	85	90	100	110	120	130	140	150	
Wall-Log	Premium	209	235	290	351	417	490	568	652	lbs.
	Select	209	235	290	351	417	490	568	652	lbs.
	Rustic	209	235	290	351	417	490	568	652	lbs.
	Wall40	209	235	290	351	417	490	568	652	lbs.

3.534 Overturning force by wall length for Wall40 grade wall-logs.

In Fig. 3.73, overturning force is denoted as $T_{OT} = C_{OT}$

Hw : Lw	Lw, max.	41 ft.	37 ft.	35 ft.	31 ft.	29 ft.	26 ft.	24 ft.	23 ft.	**Ref. 1.61**
	Lw, max.	209	235	290	351	417	490	568	652	lbs.
1:2	17.25 ft.	498	504	588	630	702	739	790	870	lbs.
1:1	8.63 ft.	994	1006	1175	1259	1402	1476	1579	1738	lbs.
1.3 : 1	6.9 ft.	1244	1259	1470	1575	1754	1846	1975	2174	lbs.
2:1	4.31 ft.	1991	2015	2353	2521	2808	2956	3162	3480	lbs.
3:1	2.88 ft.	2980	3016	3522	3773	4202	4423	4732	5208	lbs.
4:1	2.16 ft.	3973	4021	4696	5031	5602	5898	6309	6944	lbs.

3.535 Required Length of Wall-Logs to Resist Compressive Forces (C_{OT})

Fc, perpendicular x Bearing Area = 875 lbs. per sill wall-log.

Lw, max.	15/64	17/64	21/64	13/32	31/64	9/16	21/32	3/4	in.
17.25 ft.	9/16	37/64	43/64	23/32	51/64	27/32	29/32	1	in.
8.63 ft.	1- 9/64	1- 5/32	1-11/32	1- 7/16	1-39/64	1-11/16	1-51/64	1-63/64	in.
6.9 ft.	1-27/64	1- 7/16	1-11/16	1-51/64	2	2- 7/64	2- 1/4	2-31/64	in.
4.31 ft.	2- 9/32	2-19/64	2-11/16	2- 7/8	3-13/64	3- 3/8	3-39/64	3-63/64	in.
2.88 ft.	3-13/32	3-29/64	4- 1/32	4- 5/16	4-51/64	5- 1/16	5-13/32	5-61/64	in.
2.16 ft.	4-35/64	4-19/32	5-23/64	5- 3/4	6-13/32	6-47/64	7-13/64	7-15/16	in.

3.536 Reduction of Overturning Force due to Applied Dead Loads

Ref. 3.4

- Lw,max. is assumed to be taken at 90 mph for Wall40 Grade logs = 37 ft.

Lw	Reduction 25	Log Gable 90	Floor Only 105	Roof Only 140	Floor+Roof 245	All 335	plf
Lw, max.	462.5	1665	1942.5	2590	4532.5	6197.5	lbs.
17.25 ft.	215.625	776.25	905.625	1207.5	2113.125	2889.375	lbs.
8.63 ft.	107.875	388.35	453.075	604.1	1057.175	1445.525	lbs.
6.9 ft.	86.25	310.5	362.25	483	845.25	1155.75	lbs.
4.31 ft.	53.875	193.95	226.275	301.7	527.975	721.925	lbs.
2.88 ft.	36	129.6	151.2	201.6	352.8	482.4	lbs.
2.16 ft.	27	97.2	113.4	151.2	264.6	361.8	lbs.

3.537 Fastening Schedule for T_{OT} & C_{OT} (column at each end of Shear Walls)

- Overturning force is permitted to be reduced based on 25 pound per lineal foot dead load.
- The number of fasteners refers to quantity repeated at each end of each log in the wall, effectively forming a column.
- For wind/seismic loading, LogHog design values = Direct withdrawal, $WxPxC_D$ = 586 lbs.

	Wind	85	90	100	110	120	130	140	150	mph
	Lw	41 ft.	37 ft.	35 ft.	31 ft.	29 ft.	26 ft.	24 ft.	23 ft.	**Ref. 1.61**
	Lw, max.	1	1	1	1	1	1	1	1	fasteners
	17.25 ft.	1	1	1	1	1	1	1	2	fasteners
	8.63 ft.	2	2	2	2	3	3	3	3	fasteners
	6.9 ft.	2	3	3	3	3	Use bolts	Use bolts	Use bolts	fasteners
	4.31 ft.	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	fasteners
	2.88 ft.	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	fasteners
	2.16 ft.	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	Use bolts	fasteners
Through-bolt connections: 36000 psi tensile strength	4.31 ft.	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	bolt dia.
		3 sq.in.	3 sq.in.	3.5 sq.in.	3.75 sq.in.	4.25 sq.in.	4.5 sq.in.	4.75 sq.in.	5.25 sq.in.	washer
	2.88 ft.	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	bolt dia.
		3 sq.in.	3 sq.in.	3.5 sq.in.	3.75 sq.in.	4.25 sq.in.	4.5 sq.in.	4.75 sq.in.	5.25 sq.in.	washer
	2.16 ft.	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	bolt dia.
		6 sq.in.	6 sq.in.	7 sq.in.	7.5 sq.in.	8.5 sq.in.	8.75 sq.in.	9.5 sq.in.	10.5 sq.in.	washer

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Wall-Log Verification to Codes & Standards

3.54 Shear Walls with Openings

$vh = vh_1 + vh_2$

- Wall openings break the shear wall into segments that are defined by the header logs at the upper and sill logs at the lower boundaries. Wall segment height = total log wall height less height of header above and sill below the opening.
- See Fig. 3.73 Shear wall segments, L1 and L2, are analyzed per the aspect ratio provided by their boundaries.

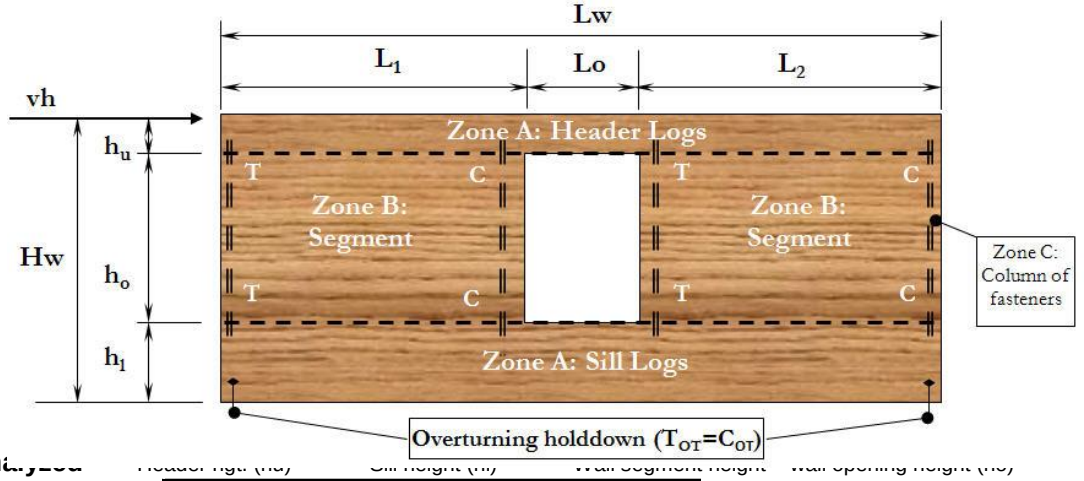
In the figure,

Zone A follows the fastening patterns defined in **3.53 Shear Walls without Openings**

Zone B defines Ls, which is the length of the shear segment defined by an opening and a corner, between openings, etc.

Zone C The Zone C fastening schedule (a column of fasteners full height of the wall) resists overturning at the ends of the wall and at the log ends next to wall openings. The number of fasteners required at each end of each log is the greater of that specified for overturning (T_{OT}, C_{OT}) or in Segments L1, L2 (T & C).

Fig. 3.73 Shear Wall Segments



3.541 Wall Openings Analyzed

Door	2 log crs.	**0 log crs.**	0 in.	**7.19 ft.**
Egress Window	17.25 in.	**2 log crs.**	23 in.	**6.71 ft.**
Kitchen Window		**3 log crs.**	34.5 in.	**5.75 ft.**

3.542 Overturning Force in Corners of Wall Segments L1 and L2

Wind	85	90	100	110	120	130	140	150	mph
Ls = ho = L1 = L2	**When $vh_1 = vh_2$, shear force = vh/2 = T = C**						for Wall40 grade wall-logs.		
8.625 ft.	498	504	588	630	702	739	790	870	lbs.
7.19 ft.	498	504	588	630	702	739	790	870	lbs.
6.71 ft.	498	504	588	630	702	739	790	870	lbs.
5.75 ft.	498	504	588	630	702	739	790	870	lbs.
2 ft.	498	504	588	630	702	739	790	870	lbs.

3.543 Check Maximum Fastener Spacing in Shear Wall Segments assuming L1 = L2

- The results shown in this table reflects the company standard wall-log specification.

Ls	Zone B	Fastener Spacing within Shear Wall Segments L1, L2 (L1=L2)							
9 : Lw, max	24	24	24	24	24	24	24	24	in. o/c
17.25 ft.	24	24	24	24	24	24	24	24	in. o/c
8.625 ft.	24	24	24	24	24	24	24	24	in. o/c
7.19 ft.	24	24	24	24	24	24	24	24	in. o/c
6.71 ft.	24	24	24	24	24	24	24	24	in. o/c
5.75 ft.	24	24	24	24	23	23	23	23	in. o/c
2 ft.	12	12	12	12	8	8	8	8	in. o/c

3.544 Zone C Fastening Schedule for T & C (column at each end of Segments L1, L2)

- T = Tension chord force, lbs.; C= Compression chord force, lbs.; v = Induced unit shear, lbs./ft.; h = Shear wall height, ft.
- The number of fasteners refers to quantity repeated at each end of each log in the wall, effectively forming a column.

Aspect Ratio	1:1	2	2	2	2	2	3	3	3	fasteners

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Wall-Log Verification to Codes & Standards

3.55 Check Capability of Log Wall Acting as a Column

- Wall segment equal in length to fastener spacing behaves as a column fixed at the bottom and pinned at the top.
- Fasteners are centered on log profile or are staggered either side to provide symmetry. Eccentricity = 1

Variables				
Le*Ke/(t/Cf)	Check slenderness ratio: Not exceed 50		49.7	
Hw = Le	standard wall height = wall unsupported height		8.63	ft.
Ke	buckling constant		1.2	
t	Log bearing = effective thickness		2.5	in.
Cf	1 = rectangular 1.18 = round (NDS 3.7.3)		1	
Fc, para.	Compression parallel to grain for Wall40-grade wall-log.		400	psi
Fc, perp.	Compression perpendicular to grain		350	psi
E	Modulus of elasticity for Wall40-grade wall-log.		800000	psi
Fyb	Bending yield strength of fasteners	**Ref: 5.1**	185900	psi
Cp	(1+(FcE/Fc))/2c -sqrt(((((1+(FcE/Fc))/2c)^2 -((Fce/Fc)/c))	where c = 0.8	0.5888901	
Bc	Column capacity Cp * Fc, para.		13948	plf
KcE			0.65	
FcE	KcE * E/(le/d)2		303.04	
b	Design width = column length = standard fastener spacing		24	in. o/c
T	Tributary dead load Roof + Floor framing on sidewall at 100psf-snow, section	3.4	1564	plf
Pw	weight of the wall at mid-height		1186	lbs.

3.56 Check Effect of Pilasters

3.561 Allowable loading (plf), on pilaster

- Pilaster is fully supported at top by roof member(s), at bottom by floor member(s), with appropriate connections to each.
- Timbers are placed with narrow face against log wall. Fasten through post through slotted holes to permit required settling.
- Lumber posts assume placement on a 2x4 sole plate with narrow face to wall and 1/2" sheathing as spacer between.

Pilaster properties:	2-2x6	2-2x6 w/2-ft. shear panel	2-2x6 w/4-ft. shear panel	4x8	6x6	6x8	8x8	6.75x7.5 GLB	6.75x10.5 GLB	
Grade	**Spruce-Pine-Fir #1**			**Eastern White Pine, Rustic Grade & Btr.**				**SP, 24F-V3 GLB**		
Actual Width	1.5	1.5	1.5	3.5	5.5	5.5	7.5	6.75	6.75	in.
Actual Depth	5.5	5.5	5.5	7.375	5.5	7.375	7.375	7.5	10.5	in.
FvA	2228	2228	2228	3227	3781	5070	6914	12150	17010	psi
FbS	13234	13234	13234	30935	27036	48612	66289	151875	297675	psi
EI	49912500	49912500	49912500	128696151	83880729	202236808	275777466	427148438	1.17E+09	psi

3.562 Allowable loading (plf), on Pilaster

Governed by: Vertical span = 8.63 ft.

shear*	344	344	344	499	584	783	1068	1877	2628	plf
bending	118	118	118	277	242	435	593	1359	2665	plf
l/240	173	173	173	445	290	699	953	1477	4052	plf
	Vertical span =	20.3 ft.								
shear*	146	NA	NA	212	248	333	454	798	1117	plf
bending	21	NA	NA	50	44	79	107	246	482	plf
l/240	13	NA	NA	34	22	54	73	113	311	plf

3.57 Check Lateral Force-Resisting System: Shear Panels

- This analysis follows the specifications set forth in ANSI/AF&PA SDPWS-2008 Special Design Provisions for Wind and Seismic. Unadjusted design values for wood-frame shear panels are taken from Table 4.3A, page 31.
- Shear walls include the specified 2-2x pilaster as end post connection to log wall.
- Double top and bottom plates required, with specified sheathing overlapping both plates top and bottom. Specified nailing pattern is required into each plate.
- 4.3.3.2 Calculated as an unblocked wood structural panel shear wall with a maximum height of 16 feet.
- 4.3.6.1 Framing Requirements: Lumber to be nominal 2" or greater
- 15/32" minimum nominal thickness, OSB or 3-ply plywood structural panels conforming to std. PS1 or PS2.
- Values are based on stud spacing of 16" o/c and panel installed with long dimension vertical.
- Min. 8d nails penetrating minimum 1-3/8" into framing member or blocking, 6" o/c on edge and in field. Minimum 3/8" edge distance required. Adhesive attachment of shear wall sheathing is not considered part of this report.

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3.571 Shear Panel Properties

■ Eq. 4.3-1 $dsw = ((8vh^3)/(EAb))+((vh)/(1000Ga))+(hDa/b)$

Variables					2-ft panel	4-ft. panel	
		Diaphragm deflection, wind			1.3370293	2.42408653	in.
b		shear wall length			2	4	ft.
Da		total vertical elongation of wall anchorage		l/240	0.035938	0.035938	in.
E		modulus of elasticity of end posts			1200000	1200000	psi
A		area of end post cross-section			17	17	$in.^2$
Ga	Table 4.3A	apparent shear wall shear stiffness from	A - Seismic		14	14	kips/in.
		nail slip an panel shear deformation	B - Wind		1	1	
h		shear wall height			8.6250	8.6250	ft.
v		induced unit shear	A - Seismic	560	96	193	lbs./panel
			B - Wind	785	135	270	lbs./panel
	4.3.3	Shear value adjustment:	ASD reduction factor		2.00	2.00	
	Table 4.3A, footnote 3	SG Adjustment Factor (modifies tabulated "v" to SG of framing lumber)			0.86	0.86	[1-(0.5-G)]
C_{ub}	Table 4.3.3.2	Unblocked shear wall adjustment factor			0.80	0.80	

■ 4.3.6.4.1 The specified pilaster and connecton to the log wall is required to transfer the induced unit shear force into and out of the shear wall.

Uplift Anchorage at Shear Wall Ends (SDPWS 4.3.6.4.2)

			2-ft panel	4-ft. panel	
■ Tension and Compression Chords	Eq. 4.3-7	T=C=vh	A - Seismic	830.76	1661.52	lbs.
			B - Wind	1164.55	2329.10	lbs.
■ Table 4.4.1 Nominal Uplift Capacity of 7/16" Minimum Wood Structural Panel Sheathing or Siding When Used for Both Shear Walls and Wind Uplift Simultaneously over Framing with a Specific Gravity of 0.42 or Greater			Wood structural panel sheathing is used simultaneously to resist shear and uplift from wind forces.			
Tabulated uplift capacity	432 plf / ASD adjustment factor of 2 =		216	432	864	lbs.
-- for alternate nail spacing at top and bottom plates			A - Seismic	398.76	797.52	lbs.
■ Connection to floor: No deadload assumed to be imposed on shear wall.			B - Wind	732.55	1465.10	lbs.
Recommended fastener: 1/2" lag	through 2-2x bottom plate at ends into floor beam			1	2	fasteners
W = 241 lbs./inch	x 3 in.	penetration x $C_{D\text{-}wind}$	1.6	1157	lbs. / fastener	

■ Options for Providing Support for Shear Wall

Option 1: Install foundation wall full length of shear wall
Option 2: Install post to footing beneath end post of shear wall
Option 3: Install beam in floor under shear wall — Joist Span = typ. Building width/2 — 14 | 14 ft.
Joists o/c = 16 in. DL+LL = 55 psi — 73.333 plf — 2-2x10 | 2-LVL 9.25

Table 4: Framing Options for Built-Up Beam in Floor to Support a Shear Wall

Member		depth	width	A*Fv*Cd	S*Fb*Cd	E*I
#1 Grade						
Spruce-Pine-Fir	2x8	7-1/4"	1-1/2"	1688	15867	57161719
Spruce-Pine-Fir	2x10	9-1/4"	1-1/2"	2154	23677	118717969
Spruce-Pine-Fir	2x12	11-1/4"	1-1/2"	2620	31838	213574219
SCL	LVL 7.5	7-1/2"	1-3/4"	2868	45281	123046875
#N/A	LVL 9.25	#N/A	#N/A	#N/A	#N/A	#N/A
SCL	LVL 11.875	11-7/8"	1-3/4"	4541	113518	488413493
SP	GLB 6x12	12-3/8"	6-3/4"	23055	453431	1918804175

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Wall-Log Verification to Codes & Standards

4.1 Calculation of Thermal Envelope

4.11 Check actual thermal values for floor, roof

4.111 Floor U-Factor:

Size of Opaque Floor Panel: 28 ft. wide 48 ft. long 1344 sq. ft.

UA, floor = 47

16 " o/c joists	132	sf
add'l. rim (corner, blocking)	6	sf
double rim	7	sf
blocking over bearing	3.5	sf

Cavity: 1195.5 sf

Opaque Floor Section	Width (in.)	Area (sf)	% of Floor Area	Resistance (R) Per inch thickness (1/k)	Resistance (R) For listed thickness (1/C)	Effective R-value
Air film-moving, outside		1344	100%		0.167	0.17
2x10, 16" oc	1.25	148.5	11%	1.88	0	0.26
R-30 FG batt		1195.5	89%		30	26.69
Plywood (DF), 3/4" CDX	0.75	1344	100%	0.94		0.71
Air film-horiz.,still,downward heat flow		1344	100%		0.926	0.93
U-Factor of Opaque Floor (U_F) =			**0.035**		**Total R-value**	**28.76**

4.112 Roof U-Factor:

Size of Opaque Roof Panel: 28 ft. wide 48 ft. long 1750 sq. ft. 10:12 roof

UA, roof = 18

24 " o/c rafters	90	sf
ridge	7	sf
blocking over bearing	3.5	sf

Cavity: 1649.5 sf

Opaque Roof Section	Width (in.)	Area (sf)	% of Floor Area	Resistance (R) Per inch thickness	Resistance (R) For listed thickness	Effective R-value
Air film-sloping,still,upward heat flow		1750	100%		0.625	0.63
2x pine decking		1750	100%		1.875	1.88
4x8 W. Hemlock, 24" o/c		100.5	6%		8.391	0.48
Building Felt, 15#		1750	100%		0.06	0.06
Rigid Insul. - Foil faced polyurethane	14	1750	100%	7.2		100.8
2x pine strapping		100.5	6%		1.875	0.11
Plywood (DF), 5/8" CDX		1750	100%		0.775	0.78
Building Felt, 15#		1750	100%		0.06	0.06
Asphalt Shingles		1750	100%		0.441	0.44
U-Factor of Opaque Roof (U_R) =			**0.01**		**Total R-value**	**105.24**

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5.1 Analysis of Specified Fastener

■ Fastener specifications: **LogHog** **x 15 in.** **at 24" o/c** F1554 Grade 36 All Thread Rod

Adjustment factors:		C_D	C_M	C_t	Ceg	C_{di}	C_{tn}	C_g	C_{delta}	
Product =	**1.6**	1.6	1.0	1.0	NA/0.67	NA/1.1	NA/0.83	1.0	1.0	
Variable		Load Duration	Wet Service	Temp. Factor	End Grain Factor	Diaphragm Factor	Toe Nail (30^o angle)	Group Action	End/Edge Distance	
W	**Direct Withdrawal per Fastener in Connection:**								122	lbs.
	LogHog design values for direct withdrawal						x adj. factors x penetration (p)		586	lbs.
Z, para.	**Lateral Value (Z) per Fastener in Connection:**							parallel to grain	207	lbs.
Z, perp.								perpendicular to grain	207	lbs.
	LogHog design values for lateral withdrawal				, parallel to grain			x adj. factors	331	lbs.
	LogHog design values for lateral withdrawal				, perpendicular to grain			x adj. factors	331	lbs.
p	Required minimum penetration (p):				$WxPxC_D$ =		NDS factor:	13.157895	3	in.
								Minimum lead hole, threaded section:	NA	in.
D	Shank diameter								0.228	in.
Dr	thread minor (root) diameter								0.202	in.
L	fastener length (tip to underside of head)						NDS minimum length=	15	15	in.
T	thread length								3	in.
Fyb	dowel bending yield strength								185900	psi
Ah	area of fastener head/washer (for pull-through resistance)								0.12	sq. in.
P	Pull-down force: Lesser of pull-through testing (lbs. per inch), withdrawal, or head/washer bearing)								1432	lbs.
	Size washer under head to match W =				0 in. dia. w/hole dia. of 0.353 in.				0	sq. in.
	thickness of side member								11.5	in.
	thickness of main member								11.5	in.
	fastener countersink depth into side member								0.3125	in.
theta	fastener installation angle relative to load to grain (0-90):								5	degrees
G	specific gravity of wood when dry					Eastern White Pine			0.370625298	at 12% MC
Gb	specific gravity of wood when unseasoned								0.35	green
Fe	dowel bearing strength Per Table 4, AF&PA TR12, Equations used to derive tabulated Dowel Bearing Strengths, Fe, 5% Offset									
	For lumber (nail, wood screw), where D< 0.25" = 16600G^1.84								2650	psi
	For lumber (bolt, drift pin, lag screw), where D=> 0.25" =									
	for parallel to grain =						11200G =		4150	psi
	for perp. to grain =						6100G^1.45/D^0.5 =		3050	psi
W	**Direct Withdrawal**					NDS Equation 11.2-1, lags:		$W=1800G^{(3/2)}D^{(3/4)}$	134	lbs./in.
	in end grain					NDS Equation 11.2-2, screws:		$W=2850G^2D$	89	lbs./in.
	101 lbs./in.					NDS Equation 11.2-3, nails:		$W=1380G^{(5/2)}D$	26	lbs./in.
Z	**Lateral Design Value for single shear (two-member) connections**									
Re	when the main and side members are of the same wood species (Fem/Fes)								1	
lm	length of fastener bearing on the main member								3.8125	in.
ls	length of fastener bearing on the side member								11.1875	in.
Rt	lm / ls = 0.3407821							**Parallel**	**Perp.**	
Fem=Fes	Dowel Bearing strength used in calculations					**Rd, para**	**Rd, perp**	2650	2650	
Mode Im	D lm Fem / Rd					2.52	2.52	2376		
Mode Is	D ls Fes / Rd					2.52	2.52	876	876	
Mode II	(k1 D ls Fem) / Rd					2.52	2.52	793	793	
k1	$(\sqrt{(Re+2Re^2(1+Rt+Rt^2)+Rt^2 Re^3)}-Re(1+Rt)) / (1+Re)$							0.3336		
Mode IIIm	(k2 D lm Fem) / ((1+2Re) Rd)					2.52	2.52	316	316	
k2	Mode IIIm -- $(-1 +SQRT(2(1+Re)+((2 Fyb(1+2 Re) D^2) / (3 Fem lm^2))))$							1.0824	1.0824	
Mode IIIs	(k3 D ls Fem) / ((2+Re) Rd)					2.52	2.52	801	801	
k3	Mode IIIs -- $(-1 +SQRT((2(1+Re) / Re)+((2 Fyb(2+Re) D^2) / (3 Fem ls^2))))$							1.0114	1.0114	
Mode IV	(D2 / Rd)*SQRT((2 Fem Fyb) / (3(1+Re))					2.52	2.52	207	207	

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Notes to 5.1

Where:
lm = main member dowel bearing length, in.; at minimum, the length of thread and tip portion of the fastener
ls = side member dowel bearing length, in.
Fem = main member dowel bearing strength, psi; also the equivalent of F_{es} = side member dowel bearing strength, psi
Rd = the Reduction Term Adjusting $P_{5\%}$ Values to Nominal Design Values (AF&PA TR12 Table 2) = 10D + 0.25 for 0.17"<D< 0.25", where D is the minor thread diameter
Re = the ratio of main to side member dowel bearing strength; set at 1 - both members of same species.
Design values shown above shall be multiplied by all applicable adjustment factors per NDS.

NDS Appendix J: When members or when fasteners are loaded in bearing at an angle to grain between 0 and 90 degrees, design values at an angle to grain shall be determined using the Hankinson formula.

for angle: 5 deg.

sin	sin^2	cos	cos^2
0.08715574	0.007596123	0.9961947	0.99240388

Fc, para (#3 grade)= 350
Fc, perp = 350

For wood-to-wood connections with side members (e.g., rafters) loaded parallel to grain; main member perpendicular to grain.

Appendix J.5: Z_q =	(Z, para. * Zc, perp)/(Z,para * sin^2 + Z,perp*cos^2)	207
Check Compression: Appendix J.5: F_q =	(Fc, para. * Fc, perp)/(Fc,para * sin^2 + Fc,perp*cos^2)	350
Check Dowel Bearing: Appendix J.5: F_q =	(Fe, para. * Fe, perp)/(Fe,para * sin^2 + Fe,perp*cos^2)	2650

5.2 Application of Hankinson's Formula

NDS Appendix J: When members or when fasteners are loaded in bearing at an angle to grain between 0 and 90 degrees, design values at an angle to grain shall be determined using the Hankinson formula.

Equivalent Roof Pitch:			3:12	7:12	10:12	12:12
for angles:	0	5	14.04	30.26	39.81	45
sin	0	0.09	0.24	0.50	0.64	0.71
sin^2	0	0.01	0.06	0.25	0.41	0.50
cos	1	1.00	0.97	0.86	0.77	0.71
cos^2	1	0.99	0.94	0.75	0.59	0.50

5.21 Adjusted Lateral Withdrawal Design Values with Loads Applied at Varying Angles

For wood-to-wood connections with side members (e.g., rafters) loaded parallel to grain; main member perpendicular to grain.

Fastener	Length	Z, para.	Z, perp.	Appendix J.5: Z_q = (Z, para. * Zc, perp)/(Z,para * sin^2 + Z,perp*cos^2)					
LogHog	15 in.	217	189	217	217	215	209	205	202
3/8" spike	15 in.	347	209	347	345	334	297	273	261
3/8" lag	15 in.	173	104	173	172	166	148	136	130
5/8" lag	15 in.	547	292	547	543	520	448	403	381

5.22 Adjusted Compression Strength:

Appendix J.5:				Fq = (Fc, para. * Fc, perp)/(Fc,para * sin^2 + Fc,perp*cos^2)					
	Wall40	**Fc, perp =**	350						
	Premium	**Fc, para =**	675	675	670	640	546	489	461
	Select		600	600	597	576	508	464	442
	Rustic		525	525	523	510	466	436	420
	Wall40		400	400	400	397	386	378	373

5.23 Adjusted Dowel Bearing Strength:

				Appendix J.5: F_q = (Fe, para. * Fe, perp)/(Fe,para * sin^2 + Fe,perp*cos^2)					
	D<0.25"	**Fe, para =**	2650						
	D>=0.25"	**Fe, para =**	4150						
D=	0.172	**Fe, perp =**	2650	2650	2650	4016	3628	3368	3235
	0.202		2650	2650	2650	2650	3628	3368	3235
	3/8 "		2400	4150	2648	2634	3502	3195	3041
	1/2 "		2150	4150	2645	2614	3357	3004	2833
	5/8 "		1900	4150	2642	2590	3191	2794	2607
	3/4 "		1550	4150	2636	2544	2910	2459	2257

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5.3 Log Fastening Capacities: Bolts

5.31 Lateral Design Value, Z: Bolts

Per NDS Yield Mode Equations:

Variable	3/4" bolt						
D	Fastener Diameter:		0.75	in.	F1554 Grade 36 All Thread Rod		
Dr	Minor thread diameter:		0.627	in.			
Fyb	F_{yb} = dowel bending yield strength, psi:		45000	psi			
	Required lead hole (NDS11.1.2):		0.78125	in.			
	Min. Edge Distance: 4D=Perp., loaded edge		3 in.		**Shear Plane**		
	Min. End Distance: 7D=Para.-Tension		5.25 in.		**Single**	**Double**	**9 crs.**
L	Overall Length				23	34.5	103.5 in.
lm*	Main/Holding member				11.5	11.5	11.5 in.
ls **	Side member thickness				11.5	11.5	11.5 in.
G	Wood Specific Gravity @EM		12%		0.3706253	0.3706253	0.3706253
Fe	Dowel Bearing Strength,	11200G	, parallel		4150	4150	4150 psi
	Fem = Fes ^	6100G^1.45/D^0.5	, perp.		1650	1650	1650 psi
Re	F_{em}/F_{es}				1	1	1
Rt	l_m / l_s		Rd		1	1	1
Mode Im	$D\ l_m\ F_{em} / R_d$	, parallel	4		8948	8948	8948 lbs.
		, perp.	5		2846	2846	2846 lbs.
Mode Is	$D\ l_s\ F_{es} / R_d$	, parallel	4		8948	17896	71588
		, perp.	5		2846	5692	22770
$k_1=(\sqrt{(R_e+2R_e^2(1+R_t+R_t^2)+R_t^2 R_e^3)}-R_e(1+R_t)) / (1+R_e)$					0.4142		
Mode II	$(k_1\ D\ l_s\ F_{em})$	, parallel	3.6		4118		lbs.
		, perp.	4.5		1310		lbs.
$k_2= -1 +\sqrt{(2(1+R_e)+((2\ F_{yb}(1+2\ R_e)\ D^2) / (3\ F_{em}\ l_m^2)))}$		, parallel			1.0229		
		, perp.			1.0572		
Mode IIIm	$(k_2\ D\ l_m\ F_{em}) / ((1+2R_e)\ R_d)$	, parallel	3.2		3814		lbs.
		, perp.	4		1254		lbs.
$k_3= -1 +\sqrt{((2(1+R_e) / R_e)+((2\ F_{yb}(2+R_e)\ D^2) / (3\ F_{em}\ l_s^2)))}$		, parallel			1.0229		1.0229
		, perp.			1.0572		1.0572
Mode IIIs	$(k_3\ D\ l_s\ F_{em}) / ((2+R_e)\ R_d)$	, parallel	3.2		3814	7628	30512 lbs.
		, perp.	4		1254	2508	10030 lbs.
Mode IV	$(D^2 / R_d)*\sqrt{((2\ F_{em}\ F_{yb}) / (3(1+R_e)))}$	, parallel	3.2		1387	2774	11095
		, perp.	4		700	1400	5597
	Lateral Design Value, Z	, parallel			**1390**	**2770**	**8950** lbs.
		, perp.			**700**	**1400**	**2850** lbs.

Where:

* lm = main member dowel bearing length, in.; at minimum, the length of thread and tip portion of the fastener

** ls = side member dowel bearing length, in.

^ Fem = main member dowel bearing strength, psi; also the equivalent of Fes = side member dowel bearing strength, psi

^^ Rd = the Reduction Term Adjusting P5% Values to Nominal Design Values (AF&PA TR12 Table 2) = 10D + 0.25 for 0.17"<D< 0.25", where D is the minor thread diameter

Design values shown above shall be multiplied by all applicable adjustment factors per NDS.

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5.32 Required Bolting Patterns for Minimum Number of Wall-Logs Acting Collectively as a Beam

- The following analysis assumes a rectangular cross-section as defined by the inscribed rectangle.

Wall-Log		Grade: Select	**Bolt Values**	**3/4" bolt**	Bolt hole dia.(D_h) =	25/32"
Width	5.15625	= b (in.) A, wall-log = 59.2 sq.in.	Z, parallel, single bolt	1390 lbs.	* 1.15 (C_D) =	**1599 lbs.**
Log Height	11.5 in.	= t_m, t_s (H_L) = y	Assume a bolt diameter =	3/4 "	Cg =	1
Ft =	375 psi	Q=yA = 680.94 in^2	End distance to 1st bolt =	7	diameters =	5 1/4 "
Fv =	125 psi	627.365 Ivert, wall-log	Distance to next bolt =	4	diameters =	3 " = $s_{critical}$
	103.37 psi	= Allowable shear stress with bolts	Max. shear strength =	533	lbs./lin. inch of header	

5.321 Determine the Section Properties for Multiple-Log Lintels:

Crs = # of logs in lintel:	2	3	4	5	6	7	8	9	logs
Neutral axis of lintel (c):	11.5	17.25	23	28.75	34.5	40.25	46	51.75	in.
Distance to centroid (y):	5.75	8.625	11.5	14.375	17.25	20.125	23	25.875	in.
Total Area of lintel (A_L):	118.424	177.636	236.848	296.06	355.272	414.484	473.696	532.908	$in.^2$
A above neutral axis (A_{NA}):	59.212	88.818	118.424	148.03	177.636	207.242	236.848	266.454	$in.^2$
$Q=yA_{NA}$	340.469	766.055	1361.876	2127.931	3064.221	4170.745	5447.504	6894.497	$in.^3$
Moment of Inertia (I, lintel):	5228.008	17644.526	41824.063	81687.622	141156.211	224150.84	334592.5	476402.212	$in.^4$
S=I/c	454.6094	1022.8711	1818.4375	2841.3086	4091.48438	5568.9648	7273.75	9205.83985	$in.^3$
V, shear capacity, lb/Q:	8184	12277	16369	20461	24553	28645	32738	36830	lbs.

5.322 Calculate number of logs in header to support load based on shear capacity:

Ground		**100**	**90**	**80**	**70**	**60**	**50**	**20**	psf
Based on header loading of:		1570	1460	1350	1250	1150	1050	730	plf
Header Span	3 ft.	1	1	1	1	1	1	1	logs
	4.5 ft.	1.5	1.5	1.5	1.5	1.5	1	1	logs
	6 ft.	2	2	2	2	1.5	1.5	1	logs
	8 ft.	2	2	2	2	2	2	1.5	logs
	10 ft.	2	2	2	2	2	2	1.5	logs
	12 ft.	3	3	2	2	2	2	2	logs
	13.5 ft.	3	3	3	3	2	2	2	logs

5.323 Calculate number of logs in header to support load based on moment capacity: Fb= 885 psi psi

Based on header loading of:		1570	1460	1350	1250	1150	1050	730	plf
Header Span	3 ft.	1	1	1	1	1	1	1	logs
	4.5 ft.	1.5	1.5	1.5	1.5	1.5	1	1	logs
	6 ft.	2	2	2	2	1.5	1.5	1	logs
	8 ft.	2	2	2	2	2	2	1.5	logs
	10 ft.	2	2	2	2	2	2	1.5	logs
	12 ft.	2	2	2	2	2	2	2	logs
	13.5 ft.	3	2	2	2	2	2	2	logs

5.324 Determine maximum single shear stress between logs in lintel over header span (psi)

See Table and footnotes from 1.53 (VQ/Ib), V=span/2*w, plf Fv, wall-log = 125 psi psi

Header Span									
	3 ft.	--	--	--	--	--	--	--	psi
	4.5 ft.	--	--	--	--	--	--	--	psi
	6 ft.	17.782	16.536	--	--	--	--	--	psi
	8 ft.	23.709	22.048	20.387	18.877	17.366	15.856	--	psi
	10 ft.	29.636	27.56	25.483	23.596	21.708	19.82	13.78	psi
	12 ft.	26.673	24.804	30.58	28.315	26.05	23.784	16.536	psi
	13.5 ft.	30.007	27.904	25.802	23.891	29.306	26.757	18.603	psi

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5.325 Shear force (lbs. per linear inch) in the header

Ground		100	90	80	70	60	50	20	psf
Header Span	3 ft.	--	--	--	--	--	--	--	lbs./in.
	4.5 ft.	--	--	--	--	--	--	--	lbs./in.
	6 ft.	204	190	--	--	--	--	--	lbs./in.
	8 ft.	273	254	234	217	200	182	--	lbs./in.
	10 ft.	341	317	293	271	250	228	158	lbs./in.
	12 ft.	307	285	352	326	300	274	190	lbs./in.
	13.5 ft.	345	321	297	275	337	308	214	lbs./in.

5.326 Bolt spacing for the outer third of the header (Z parallel, lbs. / VQ/I, lbs. per inch)

Header Span	3 ft.	--	--	--	--	--	--	--	in. o/c
	4.5 ft.	--	--	--	--	--	--	--	in. o/c
	6 ft.	8	8	--	--	--	--	--	in. o/c
	8 ft.	6	6	7	7	8	9	--	in. o/c
	10 ft.	5	5	5	6	6	7	10	in. o/c
	12 ft.	5	6	5	5	5	6	8	in. o/c
	13.5 ft.	5	5	5	6	5	5	7	in. o/c

5.327 Number of bolts per end (1/3 of header span)

Header Span	3 ft.	--	--	--	--	--	--	--	bolts
	4.5 ft.	--	--	--	--	--	--	--	bolts
	6 ft.	2	2	--	--	--	--	--	bolts
	8 ft.	5	5	4	4	3	3	--	bolts
	10 ft.	7	7	7	6	6	5	3	bolts
	12 ft.	9	7	9	9	9	7	5	bolts
	13.5 ft.	10	10	10	8	10	10	7	bolts

5.328 Bolt spacing for the middle third of the header (Z parallel, lbs. / VQ/I, lbs. per inch)

Header Span	3 ft.	--	--	--	--	--	--	--	in. o/c
	4.5 ft.	--	--	--	--	--	--	--	in. o/c
	6 ft.	24	--	--	--	--	--	--	in. o/c
	8 ft.	18	19	21	22	24	26	--	in. o/c
	10 ft.	14	15	16	18	19	21	30	in. o/c
	12 ft.	16	17	14	15	16	18	25	in. o/c
	13.5 ft.	14	15	16	17	14	16	22	in. o/c

5.329 Number of bolts per middle third (1/3 of header span)

Header Span	3 ft.	--	--	--	--	--	--	--	bolts
	4.5 ft.	--	--	--	--	--	--	--	bolts
	6 ft.	1	--	--	--	--	--	--	bolts
	8 ft.	1	1	1	1	1	1	--	bolts
	10 ft.	2	2	2	2	2	1	1	bolts
	12 ft.	2	2	3	3	2	2	1	bolts
	13.5 ft.	3	3	3	3	3	3	2	bolts

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