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UNIVERSITY OF ALASKA FAIRBANKS
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Allowable Loads for Round Timber Poles

The following publication is a major upgrade of information for calculating and understanding the allowable loads for round timbers based on wood type. It includes the allowable load, allowable shear, allowable bending and modulus of elasticity for four different types of Alaska woods: birch, cottonwood, Alaska hemlock and Alaska spruce. Both Sitka spruce and white spruce are categorized as one spruce type.

What follows is a description of the basic analysis and parameters used in calculating uniform loads for round timbers.

Hulsey has provided an enormous service in this publication and we thank him both personally and professionally for an extensive effort benefiting all the shelter industry of Alaska and anyone who wants to build with our native woods.

— *Richard D. Seifert*

Introduction

Beam span tables are provided for five species* of Alaska timber logs (poles): white spruce, Sitka spruce, Alaska hemlock, birch and cottonwood. The material properties for white spruce and Sitka spruce are treated the same; therefore, there are four tables (one for each species) that provide allowable uniform loads versus span and pole diameter. Each table includes spans from 6 feet to 33 feet and pole diameters of 6 inches to 24 inches. Because logs are normally tapered, the diameter listed in these tables is the smallest diameter found on the log. Uniform loads and support conditions are illustrated in Figure 1.

*National Grading Rules designations

Loads

Each pole (log) beam is assumed to carry a uniform load that is composed of dead load, live load and weight of the log. Distributed live loads, LL, and superimposed dead loads, DL, apply pressure to an area of the roof or floor. These loads are in pounds per square foot (psf). Except for the weight of the log, the portion of load carried by each log consists of the uniform pressure times the beam spacing (s) or tributary width (feet) (see Figure 2). The result is a value (w_{net}) in pounds per linear foot (plf) that can be used in the design selection tables provided in this document.

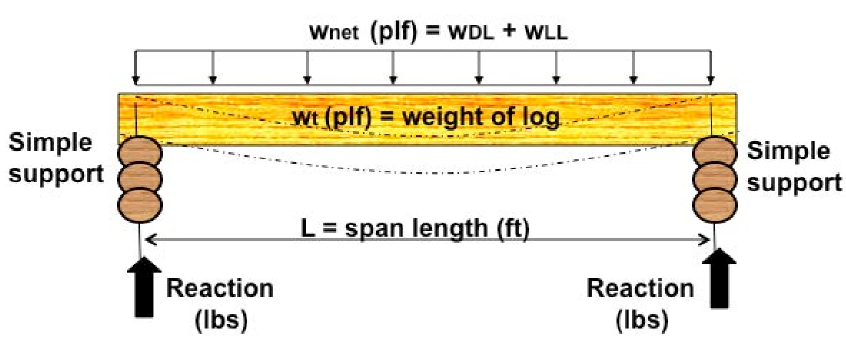

Figure 1. Timber log beam span.

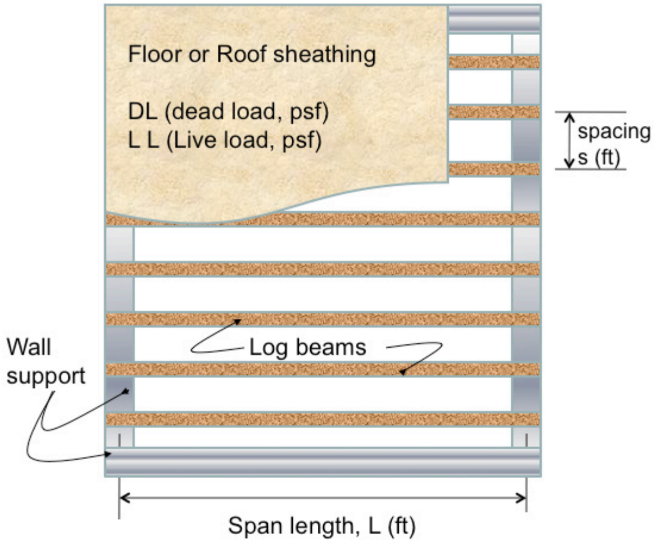

Figure 2. Beam load from floor or roof increases with the spacing (s).

Residential construction
Uniform dead load pressures are typically 15 psf for roofs and 10 psf for floors. You should verify these numbers for each application. Data on roof snow loads for each location in the state is available from the local building code or by contacting the local building department. If the log or pole is used as a roof beam, the amount of live load is the larger of either 20 psf or the code specified snow load. If your log is a floor beam, the live load is 40 psf for residential construction. The size of log needed to span the opening is different for each timber species, and log diameter and size is controlled by either strength or deflection. For example, the log may be strong enough but deflect too much or it may not deflect much but is not strong enough. The net uniform load to be carried by each log is given in Table 1.

Materials

Is a cottonwood log as strong as a white spruce log of the same diameter? This is answered by studying the material properties for each. The size of log depends on loading, span, spacing and species. Allowable stresses for each species are different (this affects strength) and modulus is also different for each species (this controls deflection). Table 2 provides the round timber strength and stiffness properties for five different Alaska species that may be used as pole (log) beams: white spruce, Sitka spruce, Alaska hemlock, birch and cottonwood.

The round timber strength and stiffness properties listed in Table 2 are based on small clear values as reported by the American Society for Testing and Materials (ASTM) in ASTM D2555 (white spruce, cottonwood and birch) or on the results of small clear testing conducted according to ASTM standards (Sitka spruce and Alaska hemlock). Allowable bending values were determined in accordance with ASTM D2899, section 16.1., allowable shear values were determined in accordance with ASTM D2899 section 17.1 and the modulus of elasticity was determined in accordance with ASTM D2899, section 18.1.

Beam strength and deflection comparisons
Beams carry load through shear and bending. Some species will carry more load than others. Table 3 provides a list of the best to the worst of the four species used in this document. Table 3 shows that in relation to cottonwood, birch is 144 percent stronger in shear, 174 percent stronger in bending and is stiffer, so for the same diameter and span, a birch log will deflect 65 percent better than a cot-

Table 1. Net Uniform Load (W_{net}) that is to be carried by the log

	Uniform floor or roof pressures (psf)								
	DL	LL	DL+LL	DL	LL	DL+LL	DL	LL	DL+LL
	10	40	50	15	50	65	15	60	75
Spacing (s)	Superimposed Uniform Beam Loads (plf)								
(ft)	WDL	WLL	Wnet	WDL	WLL	Wnet	WDL	WLL	Wnet
2	20	80	100	30	100	130	30	120	150
4	40	160	200	60	200	260	60	240	300
6	60	240	300	90	300	390	90	360	450
8	80	320	400	120	400	520	120	480	600
10	100	400	500	150	500	650	150	600	750

Note: W_{net} = WDL+WLL. It excludes beam weight

Table 2. Material Properties for Alaska Timbers			
	Allowable Stresses		
	Shear F_v	Bending, F_b	Modulus of Elasticity, E
Species	(psi)	(psi)	(psi)
Alaska Spruce (White & Sitka)	164	1,285	1,180,000
Alaska Hemlock	145	1,589	1,130,000
Birch	191	2,021	1,590,000
Cottonwood	133	1,160	1,028,000

Table 3. Species Comparison for Strength and Deflection						
	Shear F_v		Bending, F_b		Modulus, E	
	Coefficient	%	Coefficient	%	Coefficient	%
Species	C_v	stronger	C_b	stronger	C_E	as flexible
Birch	1.436	144	1.742	174	0.647	65
Alaska Hemlock	1.090	109	1.370	137	0.910	91
Alaska Spruce (White & Sitka)	1.233	123	1.108	111	0.871	87
Cottonwood	1.000	100	1.000	100	1.000	100

These species are compared to cottonwood.

tonwood log. If you compare Alaska hemlock with Alaska spruce, hemlock is stronger in bending, but spruce is better in shear and will not deflect as much (see the circled values).

Allowable Beam Selection Tables

The design selection tables in this document provide allowable net load for simply supported poles (logs). Net load (plf) needed for these tables is the sum of the applied dead load and the applied live load ($w_{net} = w_{DL}+w_{LL}$). Tables for each timber species (Tables 4 to 7) include span lengths from 6 feet to 33 feet and log diameters from 6 inches to 24 inches. The net loads in these tables do not exceed allowable shear stresses or allowable bending stresses and are within a roof deflection limit of L/240.

Strength (allowable stress check)

Pole (log) beams carry a portion of floor load or roof load, and that value depends on the pressure loads to be carried and the beam spacing. Simply supported beams experience shear stresses and bending stresses. Typically, shear stresses are greatest near wall supports and bending stresses are greatest at midspan. Shear stresses and bending stresses are calculated by formula (see the technical section) for a uniform load (plf) that is supported by the beam that is to span an opening.

Beams are strong enough provided the calculated stresses are within the species-dependent allowable stresses. Shear stress will sometimes control where the span is short and the log diameter is large. Typically, bending stress controls for most spans. The allowable load selection tables provide pole (round log) diameters that are within both the allowable shear stress and allowable bending stress for each species.

Flexibility (limiting deflection check)

Once a beam is selected for strength it must be checked for deflection. Deflection is calculated by formula (see the technical section) using modulus of elasticity for the timber species. Net applied load ($w_{DL}+w_{LL}$) given in the allowable selection tables was checked for a roof span deflection limit of L/240. This is conservative, in that deflection limits typically apply to live load deflections.

Calculated Deflections. Table 9 is provided to help evaluate alternative deflection limit choices. This table provides calculated beam deflections for a load of 200 plf acting on cottonwood with spans of 4 feet to 34 feet and log diameters of 6 inches to 24 inches. Information in Tables 1, 3 and 8 may be used to calculate midspan deflections for different loads and species.

$$\Delta = C_E \left(\frac{w}{200\text{plf}}\right)\Delta_C$$

Where w is the uniform applied load (plf) on your beam. C_E is a coefficient to correct the deflection to your species type (see Table 3). Deflection in Table 9 was calculated using cottonwood and a uniform load of 200 plf. This deflection is given in inches and may be described by (Δ_C).

Deflection limits. If a beam is too flexible, brittle finishes such as plaster or gypsum board may crack and doors and windows may become inoperable. Therefore, we must keep the maximum expected live load deflection within an acceptable limit. The general rule of thumb is that beams supporting brittle finishes such as gypsum board or plaster should be limited to a live load deflection not to exceed the span length divided by 360. For members supporting less brittle finishes such as tongue-and-groove paneling, the deflection limit is relaxed to L/240. Added floor stiffness is now considered important to floor performance. For example, in 3-Star homes, the floor live load deflection limit is L/480 and in 4-Star homes, floor live load deflections are limited to L/960. These deflection limits are illustrated in Figure 3.

Beam Sizing Procedure

The following describes how beam selection information may be used for your application. In every case, you should seek the assistance of an engineer.

Step 1. Determine floor or roof dead load (DL) and the superimposed floor or roof live load (LL).

Step 2. Find the acting beam load (plf). Multiply log spacing by sum of (DL+LL) or use Table 1.

Step 3. Use the appropriate allowable selection table (Tables 4 to 7) and determine the allowable net uniform load for your span, log diameter and species. If the table value is equal to or larger than the acting load from step 2, your pole or log beam will be within the allowable shear and bending stresses (it is strong enough) and deflection for the net applied load will be within the limiting deflection of L/240.

Step 4. If you believe the deflection limit is sufficient, you are finished; otherwise use Table 9 and determine for your span and log diameter the midspan deflection for a cottonwood with a 200 plf acting load. The calculated deflection is to be corrected for the species and the applied load as discussed above. Now check the deflection versus the deflection limit. If it is within the limit, you are done. Otherwise, enlarge the diameter and repeat.

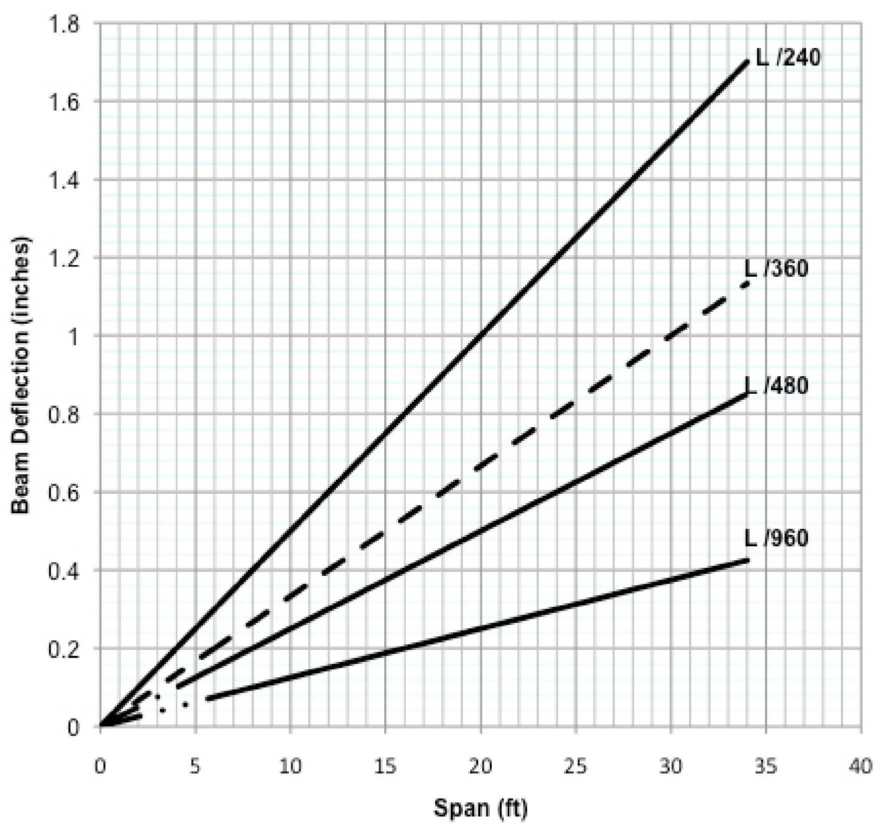

Figure 3. Deflection Limits versus Span.

Examples

Example 1

Consider that we want to install a roof on a 20-foot-by-30-foot building near Fairbanks, Alaska. We want a roof that will carry the IBC 2006 snow loads with a L/480 live load deflection limit. We will use white spruce timber poles spaced at 4 feet on center to span the 20-foot width. The roof system dead load (DL), including insulation and lights, is assumed to be 15 psf. The roof live load (LL) is a 50 psf snow load.

Step 1. The loads acting on the roof are: DL = 15 psf, and LL = 50 psf; DL+LL = 65 psf

Step 2. Determine the amount of load that each log is to carry. Except for its own weight, the load carried by each log may be found from Table 1. It can be seen that for a DL of 15 psf, and a LL of 50 psf, with a spacing of 4 feet, the load that will be applied to the log is 260 plf (circled). The allowable uniform load must be equal or greater than the applied load.

Alternatively, the load carried by each log could have been calculated by multiplying log spacing and the pressure load to give

$$w_D = 4(15 \text{ psf}) = 60 \text{ plf}$$

$$w_{LL} = 4(50 \text{ psf}) = 200 \text{ plf}$$

$$w_{net} = w_{DL} + w_{LL} = 60 + 200 = 260 \text{ plf}$$

Step 3. Select the required log diameter. Use Selection Table 6 and select the 20-foot span vertical column until you find an allow-

Table 1. Net Uniform Load (W_{net}) that is to be carried by the log

Spacing (s)	Uniform floor or roof pressures (psf)								
	DL	LL	DL+LL	DL	LL	DL+LL	DL	LL	DL+LL
	10	40	50	15	50	65	15	60	75
	Superimposed Uniform Beam Loads (plf)								
(ft)	WDL	WLL	Wnet	WDL	WLL	Wnet	WDL	WLL	Wnet
2	20	80	100	30	100	130	30	120	150
4	40	160	200	60	200	260	60	240	300
6	60	240	300	90	300	390	90	360	450
8	80	320	400	120	400	520	120	480	600
10	100	400	500	150	500	650	150	600	750

Note: W_{net} = WDL+WLL. It excludes beam weight.

TABLE 6. ALASKA SPRUCE ROUND TIMBER BEAMS (AS TM D2899) ALLOWABLE DESIGN LOADS, L/1240

(D)	(A)	(w)	(S)	(I)	(r)	Span (feet)						
Dia (in)	Area (sq in)	Weight/ft (lbs/ft)	Section Modulus (in^3)	Moment of Inertia (in^4)	Radius of gyration (in)	20	21	22	23	24	25	26
						Allowable uniform load in pounds per feet						
6	28.3	5.7	21.2	64	1.5	15	12	10	8	6	5	4
7	38.5	7.8	33.7	118	1.75	31	26	21	18	15	12	10
8	50.3	10.1	50.3	201	2	56	47	39	33	28	24	20
9	63.6	12.8	71.6	322	2.25	93	78	66	57	48	41	35
10	78.5	15.8	98.2	491	2.5	145	123	105	90	77	67	57
11	95.0	19.1	130.7	719	2.75	216	184	158	136	117	101	88
12	113.1	22.8	169.6	1,018	3	311	265	228	197	170	148	129
13	132.7	26.7	215.7	1,402	3.25	433	370	319	275	239	209	182
14	153.9	31.0	269.4	1,886	3.5	546	492	433	375	327	285	250
15	176.7	35.6	331.3	2,485	3.75	674	608	551	500	436	381	335
16	201.1	40.5	402.1	3,217	4	821	741	671	611	558	499	439
17	227.0	45.7	482.3	4,100	4.25	987	891	808	735	672	615	566
18	254.5	51.2	572.5	5,153	4.5	1,175	1,061	962	876	800	734	674
19	283.5	57.1	673.4	6,397	4.75	1,385	1,251	1,135	1,033	944	866	796
20	314.2	63.3	785.4	7,854	5	1,619	1,462	1,327	1,209	1,105	1,013	932

able load that is equal to or larger than 260 plf. The result is a 12-inch diameter that is controlled by the deflection limit of L/240. The allowable uniform load for an Alaska spruce 12-inch diameter log with a 20-foot span is 311 plf. Values in light grey mean it is controlled by the L/240 deflection limit. An 11-inch log only carries 216 plf, which is less than the acting load and will not be sufficient.

Step 4. Stiffen roof beams so the live load deflection is within the L/480 limit. The roof live load from Step 2 is w_{LL} = 200 plf. The midspan live load deflection is determined from Tables 3 and 8. In Table 8 the load is 200 plf. Enter with a 20-foot span and a 12-inch diameter log. The deflection for this cottonwood log is 0.69 inches. Spruce is 87 percent as flexible as cottonwood (see Table 3). Therefore, the midspan deflection is

$$\Delta = (0.871)(0.69 \text{ inches}) = 0.6 \text{ inches}$$

The deflection limit from Figure 3 is 0.5 inches. Therefore, increase the diameter to 13 inches. Now, check the answer. A 13-inch cottonwood log deflects 0.5 inches (see Table 8). White spruce will deflect 87 percent of this value or 0.44 inches.

Alternatively, the deflection could be checked by formula (see the technical section for details). Modulus of elasticity for white spruce is given in Table 1 of the text and is E =1,180,000 psi. The moment of inertia for a 12-inch diameter log is given in Design

Table 3. Species Comparison for Strength and Deflection

	Shear F_v		Bending, F_b		Modulus, E	
	Coefficient	%	Coefficient	%	Coefficient	%
Species	C_v	stronger	C_b	stronger	C_E	as flexible
Birch	1.436	144	1.742	174	0.647	65
Alaska Hemlock	1.090	109	1.370	137	0.910	91
Alaska Spruce (White & Sitka)	1.233	123	1.108	111	0.871	87
Cottonwood	1.000	100	1.000	100	1.000	100

These species are compared to cottonwood.

Table 8. Maximum deflections for a 200 plf uniform load acting on cottonwood logs

Span (ft)	Pole Diameter (inches): 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Maximum midspan deflection (inches)															
6	0.09	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.28	0.15	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
10	0.69	0.37	0.22	0.14	0.09	0.06	0.04	0.03	0.02	0.02	0.01	0.01	001	0.01	0.01	0.00
12	1.43	0.77	0.45	0.28	0.18	0.13	0.09	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01
14	2.64	1.43	0.84	0.52	0.34	0.28	0.17	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02
16	4.51	2.43	1.43	0.89	0.58	0.40	0.28	0.20	0.15	0.12	0.09	0.07	0.06	0.04	0.04	0.03
18	7.22	3.90	2.29	1.43	0.94	0.64	0.45	0.33	0.24	0.18	0.14	0.11	0.09	0.07	0.06	0.05
20	11.01	5.94	3.48	2.17	1.43	0.97	0.69	0.50	0.37	0.28	0.22	0.17	0.14	0.11	0.09	0.07
24	22.83	12.32	7.22	4.51	2.96	2.02	1.43	1.04	0.77	0.58	0.45	0.35	0.28	0.23	0.18	0.15
26	31.44	16.97	9.95	6.21	4.08	2.78	1.97	1.43	1.06	0.80	0.62	0.49	0.39	0.31	0.25	0.21
28	42.29	22.83	13.38	8.35	5.48	3.74	2.64	1.92	1.43	1.08	0.84	0.66	0.52	0.42	0.34	0.28
30	55.74	30.09	17.64	11.01	7.22	4.93	3.48	2.53	1.88	1.43	1.10	0.86	0.69	0.55	0.45	0.37
32	72.15	38.95	22.83	14.25	9.35	6.39	4.51	3.27	2.43	1.85	1.43	1.12	0.89	0.72	0.58	0.48
34	91.95	49.63	29.09	18.16	11.92	8.14	5.75	4.17	3.10	2.35	1.82	1.43	1.14	0.91	0.74	0.61

Tables 4 – 7 and is I = 1,018 in^4. Use the uniformly loaded simple beam deflection equation to check if this will be satisfactory (see the technical section).

$$\Delta_{max} = \frac{5w_{LL} L(12L)^3}{384EI} = \frac{5(200)(20)(12 \times 20)^3}{384(1{,}180{,}000)(1{,}018)} = 0.599 \text{ in.}$$

The allowable deflection is given by

$$\Delta_{(limit)} = \frac{12L}{480} \text{ inches} = \frac{12(20f)}{480} = 0.5 \text{ inches}$$

The calculated deflection at midspan exceeds 0.5 inches; therefore, we need to increase pole diameter to 13 inches. The moment of inertia for a 13-inch diameter log is I=1,402. This gives

$$\Delta_{max} = 0.599 \left(\frac{1{,}018}{1{,}402} \right) = 0.44 \text{ inches}$$

This calculated maximum deflection of 0.44 inches is below the 0.5-inch deflection limit. Thus, we may use 13-inch diameter logs spaced at 4 feet on center for a roof span of 20 feet.

Structural Engineering Concepts and Commentary (technical section)

Mechanical Sectional Properties for Round Beams

A pole or log's sectional properties are dependent upon the diameter (D). Calculations and tabulated data found in this document are based on minimum diameter or diameter at the top of the log. Mechanical (geometric) sectional properties needed to design a round timber beam (pole or log) are area (A), moment of inertia (I) and section modulus (S). The cross sectional area (A) for a round timber pole is given by the following equation:

$$A = \frac{\pi D^2}{4}$$

D is the minimum diameter of the pole, or the diameter at the top, and $\pi = 3.14$. Moment of inertia (I) is used to determine stiffness of the pole. This property is given by the following equation:

$$I = \frac{\pi D^4}{64}$$

Section modulus (S) is used to determine a log's ability to resist bending. This property is given by the following equation:

$$S = \frac{\pi D^3}{32}$$

Structural Considerations

Design tables in this document were developed using an Allowable Stress Design (ASD) approach. Consider a simply supported uniformly loaded beam. Once loaded, it experiences shear stresses, bending stresses and deflects (see Figure 4). Since beams must be both strong enough and stiff enough, the design process consists of two parts. First, we must check to ensure that both shear stresses and bending stresses do not exceed the allowable stresses for the selected timber species. Second, once a beam has been selected that is strong enough, the midspan deflection must be calculated for the selected timber species. This deflection must be within allowable deflection limits.

Strength. Shear attempts to distort the cross section, which causes stress in the timber section. Moment causes the beam top to shorten and the beam bottom to lengthen. These length changes cause internal bending-type stresses. Typically, shear is greatest at end supports and moment and deflection is greatest at midspan. The maximum shear stresses (near end supports) are calculated and compared with the timber species allowable shear stresses. The maximum bending stresses (midspan) are calculated and compared to the timber species allowable bending stresses. The calculated shear stresses and calculated bending stresses shall not exceed the allowable stresses for the timber species given in Table 2.

Stiffness. The beam may be sufficiently strong but too flexible. For example, in a floor, excessive movement may occur as people wall across the floor. If a beam supports a ceiling or is used to frame over a door or window opening, excessive deflections may cause brittle finishes to crack or cause doors and windows to bind or become inoperable. Therefore, maximum midspan deflections are calculated and compared to building code recommended allowable limits.

Loads, Stresses and Deflections

Loads. Typically, log beams support uniform loads such as those illustrated in Figures 1, 2 and 4. The

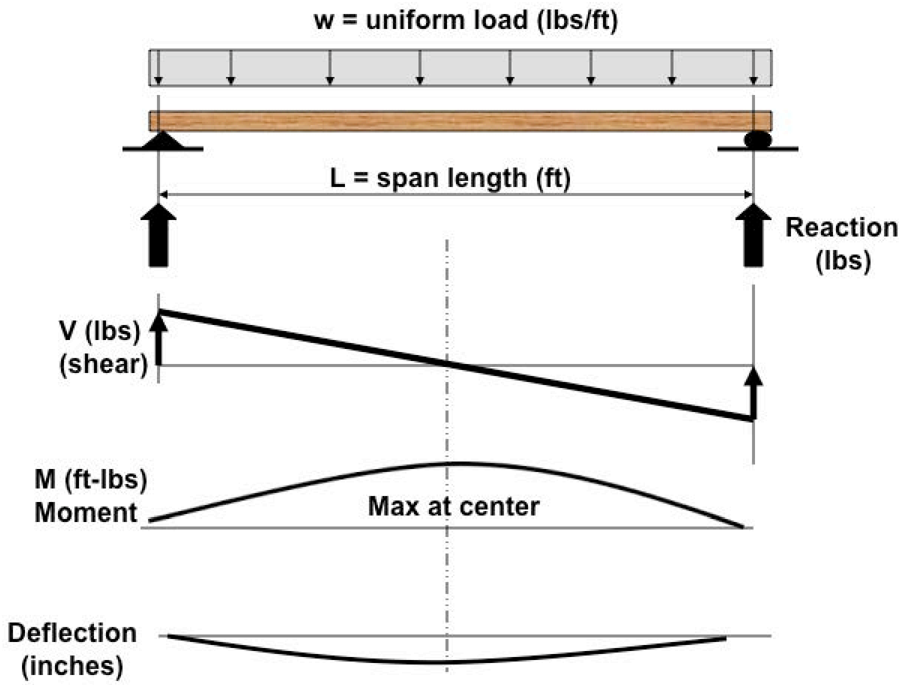

Figure 4. Reaction, Shear, Moment and Deflection.

total uniform load (w) is composed of beam self weight (w_t), superimposed dead loads (w_{DL}) and non-permanent loads such as snow and people (live load, w_{LL}). These loads are expressed in pounds per linear foot (plf).

Distributed live loads (LL) and superimposed dead loads (DL) apply pressure to an area (see Figure 2). These loads are expressed in pounds per square foot (psf). Uniform loads acting on the beams are a combination of beam self weight and the superimposed loads. The load carried by each beam is determined by multiplying pressure loads (psf) by the beam spacing (s) or tributary width (feet). The result is a value in pounds per linear foot (plf) that can be used in the following tables to determine the minimum diameter required for a particular beam span and species. Typically, uniform dead load pressures are approximately 15 psf for roofs and 10 psf for floors. However, designers should verify these numbers for their own particular application. Code requires a floor live load of 40 psf for residential construction. Roof snow loads can be determined for various locations in the state by contacting the local building department, reviewing the current edition of ASCE-7, *Minimum Design Loads for Buildings and Other Structures*, or studying the current edition of the building code that has been adopted for your region. The total uniform load is given by the following equation:

$$w = w_t + w_{DL} + w_{LL}$$
$$w = w_t + w_{net}$$

where
w = Total uniform load, plf;
w_t = Beam self weight, plf;
w_{DL} = Superimposed dead load, plf;
w_{LL} = People or snow loads, plf; and
w_{net} = $w_{DL} + w_{LL}$ = Combination of superimposed dead load and live loads.

The beam self weight is found by this equation:

$$w_t = \frac{\gamma A}{144}$$

Timber density, γ(pcf)), is multiplied by the cross-sectional area of the pole, A (square inches). Uniform superimposed dead and live loads are obtained by these formulas:

$$w_{DL} = DL \times s$$
$$w_{LL} = LL \times s$$

Uniform dead load (w_{DL}) carried by the beam, is found by multiplying floor or roof pressure, DL (psf), by beam spacing, s (feet). The uniform beam live load, w_{LL}, is found by multiplying floor or roof live load pressure, LL (psf), by beam spacing, s (feet) (see Figure 2).

Reactions. Reactions are needed to size columns, hanger brackets and other structural elements that support the beam ends. Reactions for a simply supported uniformly loaded log beam can be determined with the following equation:

$$R = \frac{wL}{2}$$

L is span length (feet), w is uniform load in pounds per linear foot (plf) and R is the end of beam reactions expressed in pounds.

Shear Stress. The cross sections of all loaded beams resist shear. Shear stress usually governs short beams: however, shear stresses for all spans must be checked and compared to the allowable values presented in Table 2. Shear stresses can be approximated with sufficient accuracy by the following equation:

$$f_v = \frac{V}{A} \leq F_v$$

Here, f_v (psi) is the calculated shear stress, F_v (psi) is the allowable shear stress from Table 2, A is the member cross-sectional area (square inches) of the member and V (pounds) is the shear which is conservatively equal to the reaction determined above (see Figures 2 and 4). Note that shear stresses are typically greatest at supports or locations where concentrated loads are applied.

Flexure or bending stress. When a beam is subjected to a transverse load, it deflects. As a beam deflects, the top of the beam shortens (compression) and the bottom stretches (tension); this is known as bending. The extreme upper and lower surfaces of the member are where the compression and tension stresses in the beam are greatest. In order to prevent a flexural failure of a beam, bending stresses must be checked and compared with the allowable values in Table 2. One way to determine the bending stress in a member is to first determine the maximum bending moment (see Figure 4). For a simply supported beam, this moment is in the middle of the span and is obtained by using the following equation:

$$M = \frac{wL^2}{8} \text{ (ft - lbs)}$$

Here, w (plf) is the total uniform load, L (feet) is the span and M (foot-pound) is the maximum moment (located at midspan). This maximum bending moment is then used to calculate the expected maximum bending stress which is obtained by using the following equation:

$$f_b = \frac{M}{S} \leq F_b$$

$$= \left[\frac{12wL^2}{8}\right] \leq F_b$$

M (foot-pound) is the bending moment, S expressed in cubic inches is the section modulus given in the tables at the end of this document, f_b (psi) is the calculated bending stress and F_b (psi) is the allowable bending stress from Table 1. Please note that the above equation converted the bending moment units from foot-pounds to inch-pounds, so no additional unit conversion is necessary. As can be seen from the bending moment diagram in Figure 4, moment in simply supported beams varies from zero at the ends to maximum at the midspan. It is the midspan moment that we must account for.

Deflection. There are two different properties that control the size of a structural beam member: one is strength and the other is deflection (serviceability). Strength is checked by selecting size so that the actual shear stresses and the actual bending stresses do not exceed the tabulated allowable stresses given in Table 2.

Serviceability, on the other hand, is based on limiting deflection to maintain the functionality of building elements such as doors, windows and finishes. Consider a beam that meets the allowable shear and bending stress criteria but exceeds the maximum defection limits. Brittle finishes such as gypsum board and plaster may crack and doors and windows may become inoperable. Therefore, it is important to keep deflection within acceptable limits based on building code requirements.

$$\Delta_{max} = \frac{5w_{LL}L(12L)^3}{384EI} \leq \Delta_{allowable}$$

Δ_{max} = Maximum live load midspan deflection (inches);

$\Delta_{allowable}$ = Limiting live load midspan deflection (inches);

w_{LL} = Uniform live load acting on the beam (plf);
L = Span length (feet);
E = Modulus of the timber species (psi), see Table 2; and
I = Moment of inertia (inches^4), see Tables 4 to 7. Cross section values are provided for pole diameters.

The general rule of thumb is that structural elements supporting brittle finishes such as gypsum board or plaster be limited to a deflection not to exceed the span length of the beam divided by 360. This is expressed by $\Delta_{allowable} = L/360$ where $\Delta_{allowable}$ is the maximum deflection and L is the span length in inches. For members supporting less brittle finishes such as tongue and groove paneling, deflection limits are relaxed to $\Delta_{allowable} = L/240$. These deflection limits are considered minimal requirements. If you want a stiffer roof or floor, you can limit the deflections to smaller deflections such as L/480 or L/960.

<u>Development of the Allowable Load Tables</u>

The allowable load tables provided in this document are based on applying a uniform load to simply supported beams with round timber cross sections. The ASD method was used to find an allowable load that would not exceed an allowable shear stress or an allowable bending stress. The tables provide for Alaska white spruce, Sitka spruce, Alaska hemlock, birch and cottonwood.

In the ASD method, when a beam size is controlled by strength, the member selected does not exceed allowable stress levels for shear or for bending. Typically, short spans are controlled by shear and long spans are controlled by bending. The tabulated uniform loads, in pounds per foot, are given based on the controlling values of shear and flexure and checked for a deflection limit for roofs of $\Delta_{allowable} = L/240$. Allowable loads were calculated for shear, bending and the deflection limit of L/240. The lesser uniform load of these three is shown in the table. The condition that led to the least allowable uniform load (plf) is shown by color. Once you find the net available uniform load, the available uniform live load is:

$$w_{LL} = w_{net} - w_{DL}$$

Here, w_{LL} is the allowable uniform live load (plf), w_{net} is the allowable uniform load (plf) that can be carried by the log beam and w_{DL} is the superimposed dead load in addition to the log self weight (plf) that is acting on the log beam. Remember that w_{DL} is typically determined using tributary width (beam spacing) times the weight of the structural framing that is to be carried by the beam. This is:

$$w_{DL} = 15s; \text{ (residential roofs)}$$
$$= 10s; \text{ (residential floors)}$$

Here, s (feet) is beam spacing or tributary width (feet) that is carried by the beam. The allowable load that can be carried by any given pole (log) beam was calculated to meet both strength and serviceability criteria. The strength criteria means the section will be within allowable shear and allowable flexure stresses. Allowable deflection limits depend on the type of application.

Shear. Allowable loads were calculated to not exceed the allowable shear stress, F_v (psi), for the timber species (see Table 1). This was done by:

$$w_{net} = \left(\frac{2F_vA}{L}\right) - w_t$$

Here, w_{net} is the allowable uniform design load (plf) that can be applied to the round timber pole, which is given by this formula:

$$w_{net} = w_{DL} + w_{LL}$$

w_{DL} = Dead load supporting structure excluding pole weight in pounds per linear foot (plf)
w_{LL} = Allowable uniform live load that can be applied to the round timber pole in pounds per linear foot (plf)
w_t = Self weight of the log in pounds per linear foot (plf)
A = Cross-sectional area of the round pole in square inches
L = Span of the pole in feet

Flexure. Allowable loads were calculated to not exceed the allowable bending stress, F_b (psi) for the timber species (see Table 1). This was done by this equation:

$$w_{net} = \left(\frac{8F_bS}{12L^2}\right) - w_t$$

Again, w_{net} is the allowable uniform design load (plf) that can be applied to the round timber pole and, as for shear, is given by this formual:

$$w_{net} = w_{DL} + w_{LL}$$

w_{DL} = Dead load supporting structure excluding pole weight in pounds per linear foot (plf)
w_{LL} = Allowable uniform live load that can be applied to the round timber pole in pounds per linear foot (plf)
w_t = Self weight of the log in pounds per linear foot (plf)
A = Cross-sectional area of the round pole (square inches)
L = Span of the pole (feet)
S = Section modulus (cubic inches)

Deflection. The following tables were prepared for structural members associated with roof framing where the allowable deflection is limited to L/240. If the allowable load based on deflection is smaller than either the value for shear strength or the value for bending strength, the table will provide the allowable based on the deflection. The allowable uniform load based on the deflection limit is given by:

$$w_{net} = \left(\frac{384}{5}\right)\left(\frac{EI}{144L^4}\right)(\Delta_{allowable}) - w_t$$

Again, w_{net} is the allowable uniform design load (plf) that can be applied to the round timber pole and is given by this equation:

$$w_{net} = w_{DL} + w_{LL}$$

w_{DL} = Dead load supporting structure excluding pole weight in pounds per linear foot (plf);
w_{LL} = Allowable uniform live load that can be applied to a round timber pole in pounds per linear foot (plf)
w_t = Self weight of the log in pounds per linear foot (plf)
E = Modus of elasticity (psi)
I = Moment of inertia (in^4)
L = Span of the pole (feet)
$\Delta_{allowable}$ = L/240 = The allowable roof beam deflection limit (feet)

The allowable deflection for roof beams when corrected to units of inches is given by:

$$\Delta_{allowable} = \frac{12L}{240}$$

Note: the allowable loads for deflection were calculated to be keep net weight within the deflection limits. This is conservative in that the net weight includes some dead load of the superimposed structure. If you want to determine allowable live load (plf) for more restrictive deflection limits, use the following equation:

$$w_{net} = \left(\frac{384}{5}\right)\left(\frac{EI}{144L^4}\right)(\Delta_{allowable}) - w_t$$

w_{LL} = Allowable uniform live load that canbe applied to a round timber pole in pounds per linear foot (plf)
w_t = Self weight of the log in pounds per linear foot (plf)
E = Modus of elasticity (psi)
I = Moment of inertia ($inches^4$)
L = Span of the pole(feet)
$\Delta_{allowable}$ = Allowable roof beam deflection limit (feet)

If the pole (log) beam is to be used to support brittle finishes such as gypsum board, plaster or tile, the maximum allowable live load deflection prescribed by code is $\Delta_{allowable}$ = L/360. So, to check your beam using the tables for your span and allowable uniform load, select your size and use the above equation with the more restrictive deflection. If you wish to use the 3-Star or 4-Star requirements, use L/480 or L/960 for the allowable deflection in the above equation.

Use of the Allowable Load Tables

Allowable design loads (plf) are provided for simply supported roof timber pole roof beams. The tables provide for 6-inch to 24-inch diameter poles and span lengths from 6 feet to 33 feet. Allowable loads were calculated for white spruce, Sitka spruce, Alaska hemlock, birch and cottonwood.

Member sizes were selected by the allowable stress design method (ASD) and checked for deflections so that it the beam did not exceed L/240. The table provides the user with a net allowable load in pounds per linear foot (plf) which is:

$$w_{net} = w_{DL} + w_{LL}$$

If you wish to determine if your member will carry the acting live load, use the table allowable net uniform load and deduct the acting superimposed dead load that is being carried by the beam. The resulting allowable live load in pounds per linear foot (plf) will be:

$$w_{LL} = w_{net} - w_{DL}$$

w_{net} is the allowable uniform load provided by the table and w_{DL} is the dead load (excluding beam weight, w_t) carried by the beam. If you wish to make the deflection limit more restrictive, you may check the acting uniform live load, w_{LL}, in pounds per linear foot (plf) so as to not exceed your deflection limit such as $\Delta_{allowable} = L/480$. This is done as follows:

$$\Delta_{max} = \frac{5w_{LL}(12L)^2(L)^2}{384EI} \leq \Delta_{allowable} \text{ (ft)}$$

w_{LL} = Acting uniform live load that can be applied to a round timber pole in pounds per linear foot (plf);
E = Modus of elasticity (psi)
I = Moment of inertia (inches^4)
L = Span of the pole (feet)
Δ_{max} = Calculated live load deflection

References

American Society for Testing and Materials (ASTM). 2003. *Annual Book of ASTM Standards 2003*, Section 4: Construction, Volume 04.10: Wood. ASTM, West Conshohocken, Pennsylvania. Referenced Standards: D2899-03, D2555-98.

Forest Products Lab, USDA 1963. *Characteristics of Alaska Woods*. FPL-RP-1, USDA Forest Serv., Forest Prod. Lab., Madison, Wisconsin.

Warning

Be sure to consult the current local building code and the appropriate building department that is responsible for buildings erected in your location. If your situation is other than simply supported (more than two supports), you should seek assistance from an engineer. For this condition, shears, moment and deflections are different than discussed in this document. We recommend before construction that you have your design reviewed by a professional engineer.

TABLE 4: ALASKA BIRCH ROUND TIMBER BEAMS (ASTM D2899) ALLOWABLE DESIGN LOADS, L240 DEFLECTION

(D)	(A)	(w_t)	(S)	(I)	(r)	Span (feet)													
Dia (in)	Area (sq in)	Weight/ft (lbs/ft)	Section Modulus (in³)	Moment of Inertia (in⁴)	Radius of gyration (in)	6	7	8	9	10	11	12	13	14	15	16	17	18	19
						Allowable uniform load in pounds per feet													
6	28.3	5.9	21.2	64	1.5	607	444	336	235	169	126	96	74	58	46	37	30	24	20
7	38.5	8.0	33.7	118	1.75	965	707	540	425	317	236	180	140	110	88	71	58	48	39
8	50.3	10.5	50.3	201	2	1,443	1,057	807	635	513	406	310	242	191	154	125	102	85	70
9	63.6	13.3	71.6	322	2.25	2,056	1,507	1,150	906	732	602	500	391	310	250	203	167	139	116
10	78.5	16.4	98.2	491	2.5	2,822	2,069	1,580	1,245	1,005	828	693	588	477	384	314	259	216	181
11	95.0	19.8	130.7	719	2.75	3,758	2,755	2,105	1,659	1,340	1,104	925	785	674	567	464	383	320	269
12	113.1	23.6	169.6	1,018	3	4,880	3,579	2,735	2,156	1,742	1,435	1,202	1,021	877	761	661	547	457	385
13	132.7	27.7	215.7	1,402	3.25	6,207	4,553	3,480	2,743	2,217	1,827	1,531	1,301	1,118	970	849	749	635	536
14	153.9	32.1	269.4	1,886	3.5	7,357	5,689	4,348	3,429	2,771	2,285	1,915	1,627	1,398	1,214	1,063	938	833	726
15	176.7	36.8	331.3	2,485	3.75	8,445	7,000	5,351	4,220	3,411	2,813	2,358	2,003	1,722	1,496	1,310	1,156	1,027	918
16	201.1	41.9	402.1	3,217	4	9,609	8,230	6,497	5,124	4,143	3,417	2,864	2,434	2,093	1,818	1,593	1,406	1,250	1,117
17	227.0	47.3	482.3	4,100	4.25	10,848	9,291	7,796	6,150	4,972	4,101	3,438	2,923	2,514	2,184	1,913	1,690	1,502	1,343
18	254.5	53.0	572.5	5,153	4.5	12,161	10,416	9,108	7,303	5,905	4,871	4,085	3,473	2,987	2,595	2,274	2,009	1,786	1,597
19	283.5	59.1	673.4	6,397	4.75	13,550	11,606	10,148	8,592	6,949	5,732	4,807	4,087	3,516	3,055	2,678	2,366	2,104	1,882
20	314.2	65.4	785.4	7,854	5	15,014	12,860	11,244	9,988	8,108	6,689	5,610	4,771	4,105	3,567	3,127	2,763	2,457	2,199
21	346.4	72.2	909.2	9,546	5.25	16,553	14,178	12,397	11,011	9,389	7,747	6,498	5,526	4,755	4,133	3,624	3,202	2,848	2,549
22	380.1	79.2	1045.4	11,499	5.5	18,167	15,560	13,605	12,085	10,799	8,911	7,475	6,358	5,471	4,756	4,170	3,685	3,278	2,934
23	415.5	86.6	1194.5	13,737	5.75	19,856	17,007	14,870	13,209	11,879	10,187	8,546	7,269	6,256	5,438	4,769	4,215	3,750	3,357
24	452.4	94.2	1357.2	16,286	6	21,620	18,518	16,192	14,382	12,934	11,578	9,714	8,263	7,112	6,183	5,423	4,793	4,265	3,818

(D)	(A)	(w_t)	(S)	(I)	(r)	Span (feet)													
Dia (in)	Area (sq in)	Weight/ft (lbs/ft)	Section Modulus (in³)	Moment of Inertia (in⁴)	Radius of gyration (in)	20	21	22	23	24	25	26	27	28	29	30	31	32	33
						Allowable uniform load in pounds per feet													
6	28.3	5.9	21.2	64	1.5	16	13	11	9	7	5	4	3	2	1	1	-0	-1	-1
7	38.5	8.0	33.7	118	1.75	33	27	22	19	15	13	10	8	7	5	4	3	2	1
8	50.3	10.5	50.3	201	2	59	49	42	35	30	25	21	18	15	12	10	8	6	5
9	63.6	13.3	71.6	322	2.25	98	83	70	60	51	44	37	32	27	23	20	17	14	11
10	78.5	16.4	98.2	491	2.5	153	130	111	95	81	70	61	52	45	39	34	29	25	21
11	95.0	19.8	130.7	719	2.75	228	194	166	143	123	107	93	81	70	61	54	47	41	35
12	113.1	23.6	169.6	1,018	3	327	279	240	207	179	156	136	119	104	91	80	71	62	54
13	132.7	27.7	215.7	1,402	3.25	455	389	335	290	252	220	192	169	148	131	115	102	90	80
14	153.9	32.1	269.4	1,886	3.5	617	529	456	395	344	300	264	232	205	181	160	142	127	113
15	176.7	36.8	331.3	2,485	3.75	819	703	606	526	459	401	353	311	275	244	217	193	172	154
16	201.1	41.9	402.1	3,217	4	1,004	907	791	687	599	525	462	408	362	322	286	256	229	205
17	227.0	47.3	482.3	4,100	4.25	1,208	1,091	990	881	770	676	595	527	467	416	371	332	297	267
18	254.5	53.0	572.5	5,153	4.5	1,437	1,298	1,178	1,073	974	856	755	668	594	529	473	424	380	342
19	283.5	59.1	673.4	6,397	4.75	1,693	1,530	1,389	1,266	1,158	1,062	944	836	744	664	594	533	479	431
20	314.2	65.4	785.4	7,854	5	1,978	1,788	1,623	1,480	1,354	1,242	1,144	1,034	920	822	736	661	595	537
21	346.4	72.2	909.2	9,546	5.25	2,293	2,073	1,883	1,716	1,570	1,442	1,327	1,226	1,126	1,006	902	811	731	660
22	380.1	79.2	1045.4	11,499	5.5	2,640	2,388	2,168	1,977	1,809	1,661	1,530	1,413	1,308	1,214	1,094	984	888	803
23	415.5	86.6	1194.5	13,737	5.75	3,021	2,732	2,482	2,263	2,072	1,902	1,752	1,619	1,499	1,392	1,295	1,184	1,069	967
24	452.4	94.2	1357.2	16,286	6	3,437	3,108	2,824	2,576	2,358	2,166	1,995	1,843	1,707	1,585	1,475	1,375	1,275	1,155

Key: Dark grey shading = size controlled by shear; Light grey = size controlled by roof deflections (L/240); White = size controlled by flexural strength.

TABLE 5: ALASKA COTTONWOOD ROUND TIMBER BEAMS (ASTM D2899) ALLOWABLE DESIGN LOADS, L240 DEFLECTION

(D) Dia (in)	(A) Area (sq in)	(w_t) Weight/ft (lbs/ft)	(S) Section Modulus (in³)	(I) Moment of Inertia (in⁴)	(r) Radius of gyration (in)	Span (feet): 6	7	8	9	10	11	12	13	14	15	16	17	18	19
						Allowable uniform load in pounds per feet													
6	28.3	3.7	21.2	64	1.5	452	331	253	196	142	106	81	63	49	39	32	26	21	17
7	38.5	5.1	33.7	118	1.75	718	526	402	316	255	198	151	118	93	75	61	50	41	34
8	50.3	6.6	50.3	201	2	1,073	787	601	473	382	315	260	203	161	130	106	87	72	60
9	63.6	8.4	71.6	322	2.25	1,529	1,121	856	675	545	449	376	319	260	210	172	142	118	99
10	78.5	10.4	98.2	491	2.5	2,099	1,539	1,176	927	749	617	517	439	377	323	264	218	182	153
11	95.0	12.5	130.7	719	2.75	2,794	2,050	1,566	1,235	998	823	689	585	503	437	382	322	270	227
12	113.1	14.9	169.6	1,018	3	3,629	2,662	2,035	1,605	1,297	1,069	896	761	654	568	498	439	385	325
13	132.7	17.5	215.7	1,402	3.25	4,616	3,387	2,589	2,042	1,650	1,361	1,141	969	833	724	634	560	497	445
14	153.9	20.3	269.4	1,886	3.5	5,767	4,231	3,235	2,552	2,063	1,701	1,426	1,212	1,043	906	793	701	623	557
15	176.7	23.3	331.3	2,485	3.75	7,094	5,206	3,980	3,140	2,539	2,094	1,756	1,493	1,284	1,115	978	863	768	686
16	201.1	26.5	402.1	3,217	4	8,612	6,320	4,832	3,813	3,083	2,543	2,133	1,814	1,560	1,356	1,188	1,050	933	835
17	227.0	29.9	482.3	4,100	4.25	10,033	7,582	5,798	4,575	3,700	3,053	2,560	2,177	1,873	1,628	1,427	1,261	1,121	1,003
18	254.5	33.6	572.5	5,153	4.5	11,248	9,003	6,885	5,433	4,394	3,626	3,041	2,586	2,225	1,934	1,696	1,499	1,333	1,193
19	283.5	37.4	673.4	6,397	4.75	12,532	10,590	8,099	6,392	5,170	4,266	3,579	3,044	2,619	2,277	1,997	1,764	1,570	1,405
20	314.2	41.5	785.4	7,854	5	13,886	11,896	9,449	7,457	6,032	4,978	4,176	3,552	3,057	2,658	2,331	2,060	1,833	1,641
21	346.4	45.7	909.2	9,546	5.25	15,309	13,116	10,940	8,635	6,985	5,765	4,837	4,115	3,542	3,079	2,701	2,387	2,124	1,902
22	380.1	50.2	1045.4	11,499	5.5	16,802	14,395	12,581	9,930	8,034	6,631	5,564	4,733	4,074	3,543	3,108	2,747	2,445	2,189
23	415.5	54.8	1194.5	13,737	5.75	18,364	15,733	13,760	11,349	9,182	7,579	6,360	5,411	4,658	4,051	3,554	3,141	2,796	2,504
24	452.4	59.7	1357.2	16,286	6	19,996	17,131	14,982	12,898	10,436	8,614	7,229	6,151	5,295	4,605	4,040	3,572	3,180	2,848

(D) Dia (in)	(A) Area (sq in)	(w_t) Weight/ft (lbs/ft)	(S) Section Modulus (in³)	(I) Moment of Inertia (in⁴)	(r) Radius of gyration (in)	Span (feet): 20	21	22	23	24	25	26	27	28	29	30	31	32	33
						Allowable uniform load in pounds per feet													
6	28.3	3.7	21.2	64	1.5	14	12	10	8	7	6	5	4	3	2	2	1	1	0
7	38.5	5.1	33.7	118	1.75	29	24	20	17	14	12	10	9	7	6	5	4	3	2
8	50.3	6.6	50.3	201	2	51	43	37	31	27	23	20	17	14	12	10	9	7	6
9	63.6	8.4	71.6	322	2.25	84	71	61	52	45	39	34	29	25	22	19	16	14	12
10	78.5	10.4	98.2	491	2.5	130	111	95	82	71	62	54	47	41	36	31	27	24	21
11	95.0	12.5	130.7	719	2.75	193	165	142	123	106	93	81	71	62	55	48	43	38	33
12	113.1	14.9	169.6	1,018	3	276	237	204	177	154	134	118	103	91	81	71	63	56	50
13	132.7	17.5	215.7	1,402	3.25	384	329	284	246	215	188	165	146	129	114	101	90	80	72
14	153.9	20.3	269.4	1,886	3.5	501	446	385	334	292	256	225	199	176	157	140	125	111	100
15	176.7	23.3	331.3	2,485	3.75	617	558	506	444	388	341	300	266	236	210	187	168	150	135
16	201.1	26.5	402.1	3,217	4	751	679	616	561	506	445	392	348	309	275	246	221	198	178
17	227.0	29.9	482.3	4,100	4.25	903	816	741	675	618	567	504	447	398	355	318	285	256	231
18	254.5	33.6	572.5	5,153	4.5	1,073	970	881	803	735	675	621	566	504	450	403	362	326	295
19	283.5	37.4	673.4	6,397	4.75	1,264	1,143	1,039	947	867	796	733	677	627	563	505	454	409	370
20	314.2	41.5	785.4	7,854	5	1,477	1,336	1,213	1,107	1,013	930	857	792	733	681	624	562	507	459
21	346.4	45.7	909.2	9,546	5.25	1,712	1,549	1,407	1,283	1,175	1,079	994	919	851	790	736	686	621	562
22	380.1	50.2	1045.4	11,499	5.5	1,971	1,783	1,620	1,478	1,353	1,243	1,146	1,059	981	911	848	791	739	682
23	415.5	54.8	1194.5	13,737	5.75	2,255	2,040	1,854	1,691	1,549	1,423	1,312	1,212	1,123	1,044	972	906	847	793
24	452.4	59.7	1357.2	16,286	6	2,564	2,320	2,109	1,924	1,762	1,620	1,493	1,380	1,279	1,188	1,106	1,032	965	904

Key: Dark grey shading = size controlled by shear; Light grey = size controlled by roof deflections (L/240); White = size controlled by flexural strength.

TABLE 6: ALASKA SPRUCE ROUND TIMBER BEAMS (ASTM D2899) ALLOWABLE DESIGN LOADS, L240 DEFLECTION

(D) Dia (in)	(A) Area (sq in)	(w_t) Weight/ft (lbs/ft)	(S) Section Modulus (in^3)	(I) Moment of Inertia (in^4)	(r) Radius of gyration (in)	Span (feet) 6	7	8	9	10	11	12	13	14	15	16	17	18	19
						Allowable uniform load in pounds per feet													
6	28.3	5.7	21.2	64	1.5	499	365	278	219	161	120	91	70	55	44	35	28	23	19
7	38.5	7.8	33.7	118	1.75	794	581	443	348	281	224	171	133	105	84	68	55	45	37
8	50.3	10.1	50.3	201	2	1,186	869	663	521	420	346	289	230	182	146	119	97	80	67
9	63.6	12.8	71.6	322	2.25	1,690	1,238	945	744	600	494	413	350	295	237	193	159	132	110
10	78.5	15.8	98.2	491	2.5	2,320	1,701	1,298	1,022	825	679	568	482	413	358	298	246	205	172
11	95.0	19.1	130.7	719	2.75	3,090	2,265	1,730	1,363	1,100	906	758	643	552	478	418	364	304	256
12	113.1	22.8	169.6	1,018	3	4,014	2,943	2,248	1,771	1,431	1,178	986	837	719	623	545	480	426	366
13	132.7	26.7	215.7	1,402	3.25	5,106	3,744	2,860	2,254	1,821	1,500	1,256	1,067	916	794	695	613	544	485
14	153.9	31.0	269.4	1,886	3.5	6,379	4,679	3,575	2,818	2,277	1,876	1,572	1,335	1,146	995	870	768	681	608
15	176.7	35.6	331.3	2,485	3.75	7,849	5,757	4,399	3,469	2,803	2,310	1,936	1,644	1,413	1,226	1,073	947	840	751
16	201.1	40.5	402.1	3,217	4	9,528	6,990	5,342	4,212	3,404	2,806	2,352	1,998	1,717	1,491	1,305	1,151	1,023	914
17	227.0	45.7	482.3	4,100	4.25	11,432	8,387	6,410	5,055	4,086	3,369	2,824	2,399	2,062	1,791	1,568	1,384	1,230	1,099
18	254.5	51.2	572.5	5,153	4.5	13,573	9,959	7,613	6,004	4,854	4,002	3,355	2,851	2,451	2,129	1,865	1,646	1,463	1,307
19	283.5	57.1	673.4	6,397	4.75	15,442	11,715	8,956	7,065	5,711	4,710	3,949	3,356	2,886	2,507	2,196	1,939	1,723	1,541
20	314.2	63.3	785.4	7,854	5	17,111	13,668	10,450	8,243	6,665	5,497	4,609	3,918	3,369	2,927	2,565	2,265	2,013	1,800
21	346.4	69.8	909.2	9,546	5.25	18,864	15,826	12,100	9,546	7,719	6,367	5,339	4,539	3,904	3,392	2,973	2,625	2,334	2,088
22	380.1	76.6	1045.4	11,499	5.5	20,704	17,735	13,916	10,979	8,879	7,324	6,142	5,222	4,492	3,904	3,422	3,022	2,687	2,404
23	415.5	83.7	1194.5	13,737	5.75	22,629	19,384	15,905	12,549	10,149	8,373	7,022	5,971	5,137	4,464	3,913	3,457	3,075	2,751
24	452.4	91.1	1357.2	16,286	6	24,639	21,106	18,075	14,262	11,535	9,517	7,983	6,788	5,841	5,076	4,450	3,932	3,497	3,129

(D) Dia (in)	(A) Area (sq in)	(w_t) Weight/ft (lbs/ft)	(S) Section Modulus (in^3)	(I) Moment of Inertia (in^4)	(r) Radius of gyration (in)	Span (feet) 20	21	22	23	24	25	26	27	28	29	30	31	32	33
						Allowable uniform load in pounds per feet													
6	28.3	5.7	21.2	64	1.5	15	12	10	8	6	5	4	3	2	1	0	-0	-1	-1
7	38.5	7.8	33.7	118	1.75	31	26	21	18	15	12	10	8	6	5	4	3	2	1
8	50.3	10.1	50.3	201	2	56	47	39	33	28	24	20	17	14	11	9	8	6	5
9	63.6	12.8	71.6	322	2.25	93	78	66	57	48	41	35	30	26	22	18	16	13	11
10	78.5	15.8	98.2	491	2.5	145	123	105	90	77	67	57	50	43	37	32	27	23	20
11	95.0	19.1	130.7	719	2.75	216	184	158	136	117	101	88	77	67	58	51	44	38	33
12	113.1	22.8	169.6	1,018	3	311	265	228	197	170	148	129	113	99	87	76	67	59	51
13	132.7	26.7	215.7	1,402	3.25	433	370	319	275	239	209	182	160	141	124	109	97	85	76
14	153.9	31.0	269.4	1,886	3.5	546	492	433	375	327	285	250	220	194	172	152	135	120	107
15	176.7	35.6	331.3	2,485	3.75	674	608	551	500	436	381	335	295	261	232	206	183	163	146
16	201.1	40.5	402.1	3,217	4	821	741	671	611	558	499	439	388	344	305	272	243	217	194
17	227.0	45.7	482.3	4,100	4.25	987	891	808	735	672	615	566	500	444	395	352	315	282	253
18	254.5	51.2	572.5	5,153	4.5	1,175	1,061	962	876	800	734	674	622	564	503	449	402	361	325
19	283.5	57.1	673.4	6,397	4.75	1,385	1,251	1,135	1,033	944	866	796	734	679	629	564	506	455	410
20	314.2	63.3	785.4	7,854	5	1,619	1,462	1,327	1,209	1,105	1,013	932	860	795	737	684	628	565	510
21	346.4	69.8	909.2	9,546	5.25	1,877	1,696	1,539	1,403	1,282	1,176	1,082	999	924	856	796	741	691	627
22	380.1	76.6	1045.4	11,499	5.5	2,162	1,954	1,774	1,616	1,478	1,356	1,248	1,152	1,066	988	918	855	798	746
23	415.5	83.7	1194.5	13,737	5.75	2,475	2,237	2,031	1,851	1,693	1,554	1,430	1,320	1,222	1,133	1,053	981	916	856
24	452.4	91.1	1357.2	16,286	6	2,815	2,545	2,311	2,107	1,927	1,769	1,629	1,504	1,392	1,291	1,201	1,119	1,044	977

Key: Dark grey shading = size controlled by shear; Light grey = size controlled by roof deflections (L/240); White = size controlled by flexural strength.

TABLE 7: ALASKA HEMLOCK ROUND TIMBER BEAMS (ASTM D2899) ALLOWABLE DESIGN LOADS, L240 DEFLECTION

(D)	(A)	(w_t)	(S)	(I)	(r)	Span (feet)													
Dia	Area	Weight/ft	Section Modulus	Moment of Inertia	Radius of gyration	6	7	8	9	10	11	12	13	14	15	16	17	18	19
(in)	(sq in)	(lbs/ft)	(in³)	(in⁴)	(in)	Allowable uniform load in pounds per feet													
6	28.3	5.7	21.2	64	1.5	618	453	306	213	154	114	87	67	53	42	33	27	22	18
7	38.5	7.8	33.7	118	1.75	983	720	550	398	288	215	164	127	100	80	65	52	43	35
8	50.3	10.1	50.3	201	2	1,469	1,077	822	647	495	369	282	220	174	139	113	93	76	63
9	63.6	12.8	71.6	322	2.25	2,093	1,534	1,172	923	745	595	455	355	282	227	185	152	126	105
10	78.5	15.8	98.2	491	2.5	2,873	2,107	1,609	1,268	1,024	844	698	545	433	349	285	235	196	164
11	95.0	19.1	130.7	719	2.75	3,826	2,806	2,144	1,690	1,365	1,125	942	800	639	516	421	348	290	244
12	113.1	22.8	169.6	1,018	3	4,969	3,645	2,785	2,196	1,774	1,462	1,225	1,041	894	735	601	497	415	350
13	132.7	26.7	215.7	1,402	3.25	6,320	4,636	3,543	2,794	2,258	1,862	1,560	1,325	1,139	989	833	690	577	487
14	153.9	31.0	269.4	1,886	3.5	7,409	5,793	4,428	3,492	2,823	2,327	1,951	1,658	1,425	1,237	1,084	933	781	659
15	176.7	35.6	331.3	2,485	3.75	8,506	7,128	5,449	4,298	3,474	2,865	2,402	2,041	1,755	1,524	1,335	1,179	1,034	874
16	201.1	40.5	402.1	3,217	4	9,677	8,289	6,615	5,219	4,219	3,480	2,918	2,480	2,133	1,853	1,623	1,433	1,274	1,137
17	227.0	45.7	482.3	4,100	4.25	10,925	9,358	7,938	6,262	5,064	4,177	3,503	2,978	2,561	2,225	1,950	1,722	1,531	1,370
18	254.5	51.2	572.5	5,153	4.5	12,248	10,491	9,173	7,437	6,014	4,961	4,161	3,538	3,043	2,644	2,318	2,047	1,821	1,629
19	283.5	57.1	673.4	6,397	4.75	13,647	11,689	10,221	8,749	7,076	5,838	4,897	4,164	3,582	3,113	2,729	2,411	2,145	1,919
20	314.2	63.3	785.4	7,854	5	15,121	12,952	11,325	10,060	8,257	6,813	5,714	4,860	4,182	3,634	3,187	2,816	2,505	2,241
21	346.4	69.8	909.2	9,546	5.25	16,671	14,279	12,486	11,091	9,562	7,890	6,619	5,629	4,844	4,211	3,692	3,263	2,903	2,598
22	380.1	76.6	1045.4	11,499	5.5	18,296	15,672	13,703	12,172	10,947	9,075	7,614	6,476	5,573	4,845	4,249	3,755	3,341	2,991
23	415.5	83.7	1194.5	13,737	5.75	19,997	17,129	14,977	13,304	11,965	10,374	8,703	7,404	6,372	5,540	4,859	4,295	3,822	3,421
24	452.4	91.1	1357.2	16,286	6	21,774	18,651	16,308	14,486	13,028	11,791	9,893	8,416	7,244	6,299	5,525	4,884	4,346	3,891

(D)	(A)	(w_t)	(S)	(I)	(r)	Span (feet)													
Dia	Area	Weight/ft	Section Modulus	Moment of Inertia	Radius of gyration	20	21	22	23	24	25	26	27	28	29	30	31	32	33
(in)	(sq in)	(lbs/ft)	(in³)	(in⁴)	(in)	Allowable uniform load in pounds per feet													
6	28.3	5.7	21.2	64	1.5	14	12	9	7	6	5	3	2	2	1	0	-0	-1	-1
7	38.5	7.8	33.7	118	1.75	29	24	20	17	14	11	9	7	6	4	3	2	1	0
8	50.3	10.1	50.3	201	2	53	44	37	31	26	22	19	16	13	11	9	7	5	4
9	63.6	12.8	71.6	322	2.25	88	75	63	54	46	39	33	28	24	20	17	14	12	10
10	78.5	15.8	98.2	491	2.5	138	117	100	85	73	63	54	47	40	35	30	26	22	18
11	95.0	19.1	130.7	719	2.75	206	176	150	129	111	96	84	73	63	55	48	41	36	31
12	113.1	22.8	169.6	1,018	3	297	253	217	187	162	141	123	107	94	82	72	63	55	48
13	132.7	26.7	215.7	1,402	3.25	413	353	304	263	228	199	174	152	134	118	104	91	81	71
14	153.9	31.0	269.4	1,886	3.5	561	480	414	358	312	272	238	210	185	163	144	128	114	101
15	176.7	35.6	331.3	2,485	3.75	744	638	550	477	416	364	319	281	249	220	196	174	155	138
16	201.1	40.5	402.1	3,217	4	969	832	718	623	544	477	419	370	327	291	259	231	206	184
17	227.0	45.7	482.3	4,100	4.25	1,232	1,066	921	800	699	613	540	477	423	376	336	300	268	241
18	254.5	51.2	572.5	5,153	4.5	1,465	1,324	1,164	1,012	885	777	685	606	538	479	428	383	344	309
19	283.5	57.1	673.4	6,397	4.75	1,726	1,560	1,417	1,263	1,105	971	857	759	675	602	538	482	433	390
20	314.2	63.3	785.4	7,854	5	2,017	1,823	1,656	1,509	1,363	1,199	1,059	939	835	745	667	599	539	486
21	346.4	69.8	909.2	9,546	5.25	2,338	2,114	1,920	1,751	1,602	1,464	1,294	1,148	1,022	913	818	735	662	597
22	380.1	76.6	1045.4	11,499	5.5	2,692	2,435	2,211	2,017	1,846	1,695	1,562	1,390	1,239	1,107	993	893	805	727
23	415.5	83.7	1194.5	13,737	5.75	3,080	2,786	2,531	2,308	2,113	1,941	1,788	1,652	1,488	1,331	1,194	1,074	969	876
24	452.4	91.1	1357.2	16,286	6	3,503	3,169	2,879	2,627	2,405	2,209	2,036	1,881	1,743	1,586	1,424	1,282	1,157	1,047

Key: Dark grey shading = size controlled by shear; Light grey = size controlled by roof deflections (L/240); White = size controlled by flexural strength.

Table 8. Maximum deflections for a 200 plf uniform load acting on Cotton wood logs

Span (ft)	Pole Diameter (inches)																		
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Maximum mid-span deflection (inches)																		
6	0.09	0.05	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.28	0.15	0.09	0.06	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.69	0.37	0.22	0.14	0.09	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
12	1.43	0.77	0.45	0.28	0.18	0.13	0.09	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
14	2.64	1.43	0.84	0.52	0.34	0.28	0.17	0.12	0.09	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01
16	4.51	2.43	1.43	0.89	0.58	0.40	0.28	0.20	0.15	0.12	0.09	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.02
18	7.22	3.90	2.29	1.43	0.94	0.64	0.45	0.33	0.24	0.18	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03
20	11.01	5.94	3.48	2.17	1.43	0.97	0.69	0.50	0.37	0.28	0.22	0.17	0.14	0.11	0.09	0.07	0.06	0.05	0.04
24	22.83	12.32	7.22	4.51	2.96	2.02	1.43	1.04	0.77	0.58	0.45	0.35	0.28	0.23	0.18	0.15	0.13	0.11	0.09
26	31.44	16.97	9.95	6.21	4.08	2.78	1.97	1.43	1.06	0.80	0.62	0.49	0.39	0.31	0.25	0.21	0.17	0.15	0.12
28	42.29	22.83	13.38	8.35	5.48	3.74	2.64	1.92	1.43	1.08	0.84	0.66	0.52	0.42	0.34	0.28	0.23	0.20	0.17
30	55.74	30.09	17.64	11.01	7.22	4.93	3.48	2.53	1.88	1.43	1.10	0.86	0.69	0.55	0.45	0.37	0.31	0.26	0.22
32	72.15	38.95	22.83	14.25	9.35	6.39	4.51	3.27	2.43	1.85	1.43	1.12	0.89	0.72	0.58	0.48	0.40	0.33	0.28
34	91.95	49.63	29.09	18.16	11.92	8.14	5.75	4.17	3.10	2.35	1.82	1.43	1.14	0.91	0.74	0.61	0.51	0.43	0.36

The tables in this publication are calculated specifically for Alaska wood species. Wood properties can exhibit significant variation. It is suggested that when using these tables, the user engage the services of a professional engineer.

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