Wood Joists, Beams and Columns for Farm Structures
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WOOD JOISTS, BEAMS AND COLUMNS FOR FARM STRUCTURES

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PROBLEMS INVOLVING main framing members in farm buildings are of two kinds: (1) the load to be supported is known and the size of framing member is to be determined, or (2) the member size is known and allowable load is to be determined. The first occurs generally with new construction or extensive remodelling; the second with a change in use of an existing structure.

Selecting Joists and Beams

The strength or load-carrying capacity of a wood beam is determined by species and grade of wood, size, span and support system. Table 1 gives the major woods available to Michigan farm builders for which the load-span tables apply.

The load-span table (Table 2) is based on the use of construction grade Douglas fir or an equivalent strength grade if using Group A, or select structural Eastern hemlock or an equivalent strength grade if using Group B listed in Table 1. Beams and joists are assumed to be supported only at the ends and carry a uniformly distributed load. Sizes given are for surfaced lumber. Figures 1 and 2 illustrate terms used in the examples.

If a beam is built of several thinner members spiked together, the total safe load is the sum of the loads for each of the smaller members. For example, four-2″ x 10″'s will carry a load 4 times that for a single 2″ x 10″. Joists and beams should be placed with the largest knots in the upper half of the member. Knots should be sound and held in place firmly after lumber is dried.

Table 1. Species for which the joist, beam and column tables are appropriate.

Group A	
Douglas fir	Sweet and Yellow birch
West Coast hemlock	Rock elm
Western larch	Black and Hard maple
Southern Yellow pine	Red and White oak
White ash	True hickory

Group B	
California red, grand, noble and white fir	Red and Jack pine
Eastern hemlock	Red, White and Sitka spruce
	Tamarack
American and Soft elm	

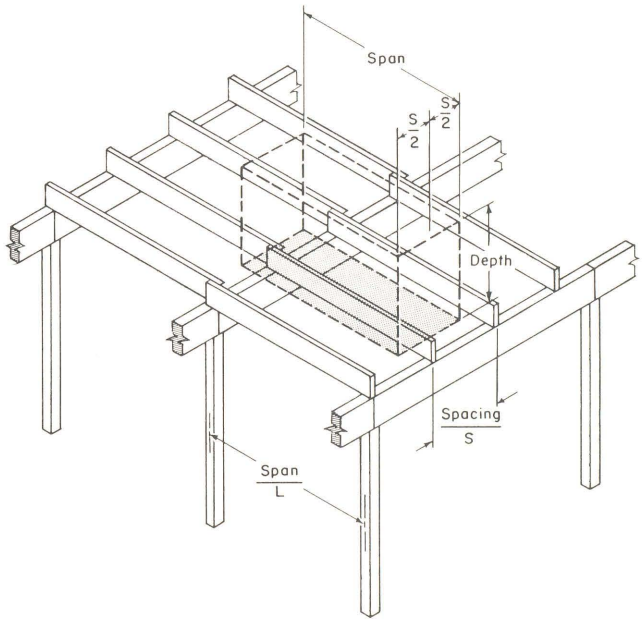

Figure 1. Typical floor joist loading.

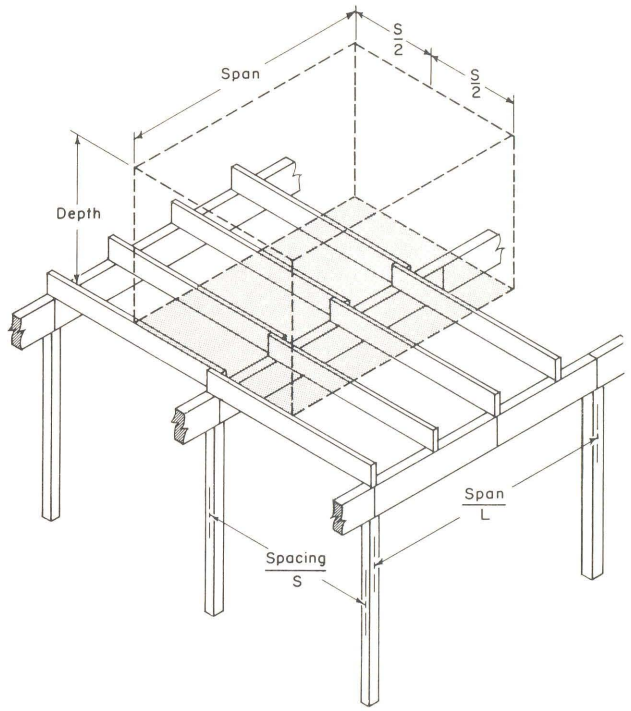

Figure 2. Typical floor beam loading.

EXAMPLE 1: We want to store wheat to a depth of 5 feet in a bin over the 12-foot wide drive of a

TABLE 2. Safe Uniformly Distributed Loads on Joists. (Pounds)

Nominal Joist Size (1) (inches)	SPAN IN FEET											
	6		8		10		12		14		16	
	A(2)	B(3)	A	B	A	B	A	B	A	B	A	B
2 x 4	790	632	593	475	475	380	396	317	339	271	297	238
2 x 6	1900	1520	1428	1140	1140	913	952	762	816	653	715	672
2 x 8	3380	2700	2540	2030	2030	1624	1692	1354	1450	1160	1270	1017
2 x 10	5430	4350	4070	3255	3255	2610	2710	2170	2330	1863	2040	1632
2 x 12	7950	6360	5960	4770	4770	3820	3980	3180	3410	2725	2990	2390

(1) No increase in loads permitted for rough sizes.
(2) Group A woods. See Table 1.
(3) Group B woods. See Table 1.

TABLE 3. Safe Uniformly Distributed Loads on Beams. (thousands of pounds)

Nominal Beam Size (1) (inches)	SPAN IN FEET											
	6		8		10		12		14		16	
	A(2)	B(3)	A	B	A	B	A	B	A	B	A	B
4 x 6	4.25	3.40	3.18	2.55	2.55	2.03	2.12	1.70	1.82	1.46	1.59	1.27
4 x 8	6.86	5.49	5.66	4.53	4.50	3.62	3.78	3.02	3.23	2.60	2.83	2.27
4 x 10	9.35	7.48	8.59	6.87	7.27	5.81	6.06	4.85	5.19	4.15	4.54	3.64
4 x 12	12.20	9.78	10.90	8.73	10.30	8.24	8.88	7.10	7.60	6.09	6.66	5.33
6 x 8	10.40	8.33	8.59	6.88	6.86	5.50	5.73	4.58	4.91	3.93	4.30	3.44
6 x 10	14.20	11.40	13.00	10.40	11.00	8.82	9.19	7.35	7.88	6.30	6.89	5.51
6 x 12	18.60	14.90	16.60	13.30	15.70	12.50	13.50	10.80	11.50	9.24	10.10	8.08
8 x 10	19.30	15.50	17.80	14.20	15.00	12.00	12.50	10.00	10.70	8.59	9.40	7.52
8 x 12	25.30	20.20	22.80	18.20	21.40	17.10	18.40	14.70	15.70	12.60	13.78	11.00
10 x 12	32.10	25.60	28.70	23.00	27.00	21.60	23.30	18.60	19.90	15.90	17.45	14.00

(1) No increase in loads permitted for rough sizes.
(2) Group A woods. See Table 1.
(3) Group B woods. See Table 1.

barn. We have some white oak. What size and spacing of white oak joists is required?

Step 1. Determine the load on each square foot of bin floor:

a. Wheat weighs 48 lbs. per cubic foot (Table 5).

b. A 5-foot depth of wheat would make a column 5 cubic feet in volume over each square foot of bin floor.

c. $5 \times 48 = 240$ lbs. per square foot of bin floor area.

Step 2. Determine the load per joist:

a. Try spacing the joists 12 inches on center. Thus each joist supports 1 x 12 or 12 square feet of floor area.

b. Therefore, the total load on each joist is $12 \times 240 = 2{,}880$ lbs.; the floor area supported by each joist times the load on each square foot of floor.

c. Table 1 shows white oak in species group A. From Table 2, group A, a 2″ x 12″ will carry

TABLE 4. Safe Loads on Solid Wood Columns. (thousands of pounds)

Nominal Column Size (1) (inches)	Cross Sectional Area (sq. inches)	UNSUPPORTED LENGTH IN FEET									
		6		8		10		12		14	
		A(2)	B(3)	A	B	A	B	A	B	A	B
4 x 4	13.14	17.0	12.6	9.6	7.0	6.1	5.5	4.2	3.2	3.1	2.3
4 x 6	20.39	26.4	19.6	14.9	10.9	9.5	7.1	6.6	4.9	4.9	3.6
4 x 8	27.19	35.2	26.1	19.8	14.5	12.7	9.4	8.8	6.6	6.4	4.8
6 x 6	30.25	40.4	29.1	40.4	29.1	35.2	25.5	23.6	17.7	17.4	13.0
6 x 8	41.25	55.1	39.7	55.1	39.7	46.6	34.8	32.2	24.1	23.6	17.7
6 x 10	52.25	69.8	50.3	69.8	50.3	60.7	44.0	40.8	30.5	30.0	22.4
6 x 12	63.25	84.5	60.9	84.5	60.9	73.5	53.4	49.4	37.0	36.3	27.1
8 x 8	56.25	75.1	54.1	75.1	54.1	75.1	54.1	75.1	54.1	62.2	42.7
8 x 10	71.25	95.1	68.5	95.1	68.5	95.1	68.5	95.1	68.5	79.4	54.1
8 x 12	86.25	115.2	83.0	115.2	83.0	115.2	83.0	115.2	83.0	96.2	65.5
10 x 10	90.25	120.5	86.6	120.5	86.6	120.5	86.6	120.5	86.6	120.5	86.6
10 x 12	109.25	146.0	105.0	146.0	105.0	146.0	105.0	146.0	105.0	146.0	105.0
12 x 12	132.25	176.7	127.0	176.7	127.0	176.7	127.0	176.7	127.0	176.7	127.0

(1) No increase in loads permitted for rough sizes.
(2) Group A woods. See Table 1.
(3) Group B woods. See Table 1.

3,980 lbs. Can we space the joists 16″ on center instead of 12″? 16/12 (2,880) = 3,840 lbs., the total load on a strip of floor 16″ wide and 12 feet long. This is less than 3,980 lbs., the safe load on the white oak 2″ x 12″. Therefore, we can use 2″ x 12″'s and space them 16″ on center.

EXAMPLE 2: The beams supporting the joists in Example 1 are American elm and are supported on posts 12 feet on center. What size beam is required to carry the wheat?

Step 1. Determine the floor area supported by each beam. Each beam supports half the floor or a strip 6 feet wide. See Figure 2 for term definition.

Step 2. Each beam supports 240 x 6 x 12 = 17,280 lbs.; load per square foot of floor area x width of floor supported by each beam x length of floor supported by each beam.

Step 3. From table 3, group B, a 10″ x 12″ solid beam will carry 18,600 lbs. on a 12-foot span. Use a 10″ x 12″ beam.

If we want to build up a beam from 2″ x 12″'s, then we divide 17,280, the total load carried by the beam, by 3,180 lbs., the safe load on one 2″ x 12″; (17,280 ÷ 3,180 = 5.4). We can't use half a piece so we must use six-2″ x 12″'s to replace the single 10″ x 12″ in our problem.

Selecting Wood Columns

The load carrying capacity of wood columns is determined by species, grade, size and unsupported length. Figure 3 illustrates terms used with columns. Use of Table 3 assumes the load is directed straight down the column and material of construction grade Douglas fir or an equal strength grade if using group A, or select structural Eastern hemlock or an equal

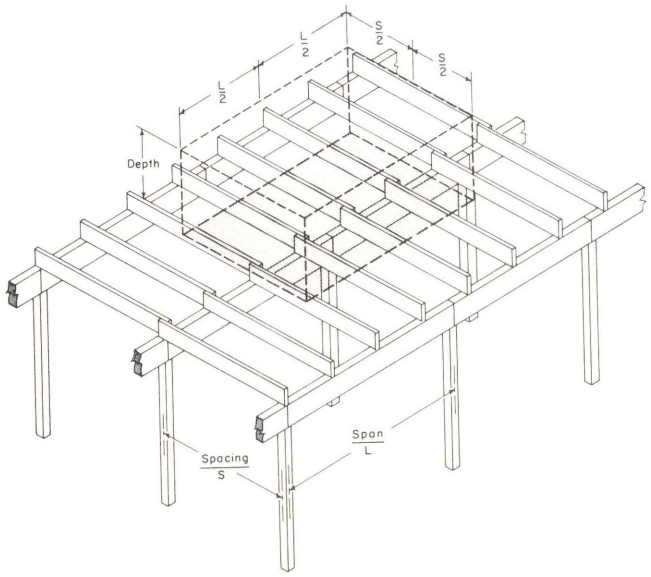

Figure 3. Inside column loading.

strength grade if using group B of the species listed in Table 1. Sizes given are for surfaced lumber.

When columns are built up by spiking two or more smaller pieces together, the safe load is less than can be carried by a single solid column of the same cross sectional area. Reduce safe loads in Table 4 by 30% when using a built-up column.

Round columns or posts are equal in strength as a column to a squared column of the same cross sectional area. For example, a 6″ top diameter pole is approximately equal to a 6″ x 6″ S4S (surfaced 4 sides) post. The area of a 6″ pole is 28.25 square inches, a 6″ x 6″ S4S is 30.25 square inches.

EXAMPLE 3: The columns supporting the beams of example 2 are American Elm and are 10 feet long. What size is required?

Step 1. Determine the floor area supported by one column. Each column supports ½ the span on each side. Therefore, each column supports (6 + 6) × 6 = 72 square feet of floor area.

Step 2. Determine the load supported by each column. 72 × 240 = 17,280 lbs. Floor area supported by each column times the load per square foot of floor area.

Step 3. From table 3, group B, a 6″ x 6″ column 10 feet long will carry 25,500 lbs. Use a 6″ x 6″.

Bearing Areas

To prevent wood from failing by crushing across the grain, adequate bearing surface must be provided. This is generally not a problem with joists if the length of bearing area provided is equal to at least ½ the depth of the joist. Heavily loaded columns generally require a steel cap or plate larger than the column top to keep from crushing into the beam they support. The area of the plate required can be obtained by dividing column loads by 400 if beams are group A wood and by 300 if group B woods.

EXAMPLE 4: In example 2, American elm beams are supported by columns with a load of 17,280 lbs.

Step 1. Since American Elm is a group B wood, divide 17,280 by 300 to get the area of the steel plate in square inches required on the top of the post to prevent crushing of the beam. 17,280/300 = 57.6 square inches of bearing area needed.

Step 2. If we use the 10″ x 12″ beam and have the plate extend across the full width we would need a plate 57.6/9.5 = 6.06 inches long. ¼″ plate is thick enough.

Table 5. Weights of Common Materials Stored on the Farm.

Material	lbs. per cubic foot	Material	lbs. per cubic foot
Barley	39	Apples	38
Corn, ear	28	Potatoes	46
Corn, shelled	45	Ground mixed feed	32
Corn, cob meal	36	Hay, baled	10
Pea beans	48	Hay, chopped	8 to 10
Oats	26	Hay, long	4 to 5
Rye	45	Straw, baled	10
Soy Beans	48	Sawdust	12 to 15
Wheat	48	Shavings, loose	10

Roof loads are computed on area covered by a roof or part of a roof. For computing loads, the total area of a roof is equal to the length times the width of a building. Roof loads—pounds per square foot of area covered; lower Michigan—30 lbs. per square feet, Upper Peninsula of Michigan—35 lbs. per square feet. Driveways—up to 10 ton load limit; 150 lbs. per square foot of floor area.

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