Using These Tables

The purpose of this publication is to provide easy-to-use joist and rafter span tables for specific grades of Southern Pine lumber under common loading conditions. Users of these span tables have the final responsibility for determining if the load and design assumptions represent actual conditions for their specific applications.

Table Categories	
Application	**Tables**
Floor Joists	
Conventional loads	1 - 7
Heavy live loads	8 - 11
Wet-service conditions	12 - 14
Ceiling Joists	15 - 16
Rafters	
Snow loads	17 - 40
Construction loads	41 - 46

A total of 46 span tables are provided for three types of framing members: floor joists, ceiling joists, and rafters. Spans in the tables are listed in feet and inches and are the maximum allowable horizontal span of the member from inside to inside face of supports.

Loading Conditions

The Index to Tables summarizes the loading conditions included in this publication. The design loads and deflection criteria used to generate the listed spans are also stated in each table heading. Live and dead loads are given in psf (pounds per square foot). Live loads in the tables range from 10 to 100 psf. Dead loads range from 5 to 20 psf and include the weight of the framing members. Deflection is limited to the span in inches divided by 360, 240, or 180 and is based on live load only. The load duration factor, C_D, is 1.0 unless shown as 1.15 for snow loads or 1.25 for construction loads.

Roof Live Loads		
Table Numbers	**Roof Live Load***	
	12 psf	**16 psf**
17 and 29	1.17	1.07
21 and 33	1.14	1.06
25 and 37	1.12	1.05
*Use straight line interpolation for intermediate roof live loads.		

The loading conditions included in this document cover typical building applications for wood structural framing members. Rafter spans are tabulated for the most common roof loads. Snow loads are based on adjusted roof snow loads from the governing building code. For roof live loads less than 20 psf, tabulated span lengths may be multiplied by the factors shown in the table above.

While directed principally to residential construction, the tables in this publication may also be suitable for other occupancies with similar loading conditions. Note, however, that listed spans do not include checks for concentrated or partition loads that may be required for specific occupancy or use categories. Check governing building code requirements for other applicable occupancies. Also see *Span Tables for Joists and Rafters*, published by the American Forest & Paper Association (AF&PA), for more details on material and occupancy assumptions.

Lumber Grades

There are three grading methods for sorting Southern Pine dimension lumber and assigning design values:

- Visually graded lumber
- Machine Stress Rated (MSR) lumber
- Machine Evaluated Lumber (MEL)

Visually graded lumber is the oldest and most common of the three methods. Visual grading is performed by qualified graders in the mill. These graders sort each piece of lumber into various grades based on visual characteristics known to affect lumber strength and stiffness, such as knot size and slope-of-grain. Consistent visual grading is achieved through proper training, education and supervision of the lumber graders. Visually graded lumber will adequately meet the structural requirements for most traditional applications.

Machine grading, which categorizes both MSR and MEL, reduces the variability associated with assigning stress grades to lumber. MSR and MEL can be advantageous, therefore, in more demanding engineered applications, such as trusses or long-span joists and rafters.

Machine Stress Rated (MSR) lumber is evaluated by mechanical stress rating equipment. MSR lumber is distinguished from visually graded lumber in that each piece is nondestructively tested and then sorted into bending strength and stiffness classes. In addition, each piece must meet certain visual requirements before it can be assigned design values. MSR also requires daily quality control tests for bending strength and stiffness.

Machine Evaluated Lumber (MEL) is similar to MSR in that each piece is evaluated by nondestructive grading equipment, checked for visual requirements and then sorted into various strength classifications. MEL requires daily quality control tests for tension strength in addition to the daily bending strength and stiffness tests required for MSR.

Visually Graded Lumber
Select Structural No.1 No.2 No.3
Machine Stress Rated (MSR)
2400f-2.0E 2250f-1.9E 1950f-1.7E
Machine Evaluated Lumber (MEL)
M-23 M-14 M-12

Selected Grades

The most common lumber grades for the three different grading methods are included in these span tables. Contact the Wood Products Help Desk for span assistance on grades, on-center spacings, or loads not included in these tables.

Lumber Sizes

Computations for these span tables are based on net lumber dimensions (actual sizes) from the *American Softwood Lumber Standard PS 20* published by the U.S. Department of Commerce.

Nominal Size	Actual Dry Size
(inches)	(inches)
2 x 4	1-1/2 x 3-1/2
2 x 6	1-1/2 x 5-1/2
2 x 8	1-1/2 x 7-1/4
2 x 10	1-1/2 x 9-1/4
2 x 12	1-1/2 x 11-1/4

Most Commonly Produced Sizes, by Grade

Although the most common grades were selected for these tables, no single manufacturer produces all grades and not all sizes are produced for all grades. This chart indicates the most commonly produced sizes, by grade. Sizes that are blank are NOT currently produced by any manufacturer, but this is subject to change at any time based on market conditions. Check sources of supply at the time of your project.

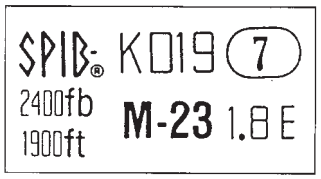
Grade	Size				
	2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
Visually Graded					
SS	●	●	●	●	●
No. 1	●	●	●	●	●
No. 2	●	●	●	●	●
No. 3	●	●	●	●	●
Machine Stress Rated (MSR)					
2400f-2.0E	●	●	●	●	●
2250f-1.9E				●	●
1950f-1.7E		●			
Machine Evaluated Lumber (MEL)					
M-23		●	●	●	●
M-14		●			
M-12	●	●	●	●	●

Lumber Identification

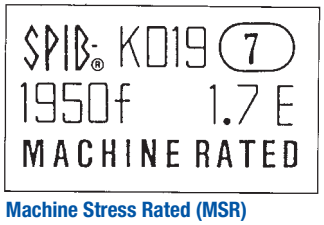
Maximum spans in these tables apply to properly identified material. Lumber must be identified by the grade mark of an agency certified by the Board of Review of the American Lumber Standard Committee (ALSC) and manufactured in accordance with the *American Softwood Lumber Standard (Voluntary Product Standard PS 20)*. A certified grade mark on Southern Pine dimension lumber indicates the lumber has been properly seasoned by the manufacturer and meets the structural and appearance requirements established for the grade.

Typical Lumber Grade Marks

Visually Graded



Machine Evaluated Lumber (MEL)



Machine Stress Rated (MSR)

Note: The Southern Pine Inspection Bureau (SPIB) publishes the *Standard Grading Rules for Southern Pine Lumber*. Other agencies are accredited by ALSC to inspect and grade all or selected Southern Pine products according to those rules, including: California Lumber Inspection Service (CLIS); Northeastern Lumber Manufacturers Association (NELMA); Renewable Resource Associates (RRA); Stafford Inspection and Consulting (SIWP); Timber Products Inspection (TP); West Coast Lumber Inspection Bureau (WCLIB); and Western Wood Products Association (WWPA). Numerous other inspection agencies are also approved for the heat treatment portion only of the SPIB rules.

Design Assumptions

General Requirements

This publication assumes the quality of wood products and fasteners, and the design of load-supporting wood members and connections, conforms to the *National Design Specification (NDS) for Wood Construction* published by AF&PA. All members must be framed, anchored, tied, and braced to achieve the required strength and rigidity. Adequate bracing and bridging to resist wind and other lateral forces must be provided.

Support Requirements

Joists and rafters must also have adequate support. Ridge beams must be installed at roof peaks with rafters bearing directly on the ridge beam or supported by hangers or framing anchors. Ceiling joists are not required when properly designed ridge beams are used.

A ridge board may be substituted for a ridge beam when the roof slope equals or exceeds 3 in 12, except that ridge beams are required for cathedral ceilings. Ridge boards must be at least one-inch nominal in thickness and not less than the depth of the cut end of the rafter. Rafters must be placed directly opposite each other, and ceiling joists must be installed parallel with rafters to provide a continuous tie between exterior walls.

Spans

The spans provided in these tables were determined on the same basis as those given in the code-recognized *Span Tables for Joists and Rafters* and *Wood Structural Design Data*, both published by AF&PA. Maximum spans were computed using Allowable Stress Design (ASD) and standard engineering design formulas for simple span beams with uniformly distributed gravity loads. The calculated spans assume fully supported members, properly sheathed and nailed on the top edge of the joist or rafter. They do not, however, include composite action of adhesive and sheathing. Listed spans also do not include checks for concentrated or partition loads that may be required by building codes for specific occupancy or use categories. Uplift loads caused by wind also have not been considered.

Spans in the tables are given in feet and inches and are the maximum allowable horizontal span of the member from inside to inside of bearings. For sloping rafters, the span is also measured along the horizontal projection. The diagram on page 32 provides a convenient tool for calculating the corresponding sloping distance of a rafter.

Reference Design Values

The Southern Pine Inspection Bureau publishes Southern Pine reference design values in the *Standard Grading Rules for Southern Pine Lumber*. The table on page 6 lists the reference design values used for this publication. Refer to the *SPIB Grading Rules* or *Southern Pine Use Guide* published by the Southern Pine Council to obtain reference design values for other Southern Pine products, grades and sizes.

Reference design values are based on normal load duration and dry service conditions. Because the strength of wood varies with conditions under which it is used, reference design values should only be applied in conjunction with appropriate design and service recommendations from the *NDS*.

Adjustment Factors

Reference design values must be multiplied by all applicable adjustment factors to determine adjusted design values. Adjusted design values are then used to calculate the maximum allowable span for a specified load condition. The adjustment factors used to develop the span tables in this document are described below. For more complete information on reference design values and adjustment factors, refer to the *NDS* or the *Southern Pine Use Guide*.

Repetitive Member Factor, C_r – Bending design values, F_b, for dimension lumber 2" to 4" thick are multiplied by the repetitive member factor, $C_r = 1.15$, when such members are used as joists, truss chords, rafters, studs, planks, decking or similar members that are in contact or spaced not more than 24" on center, are not less than three in number and are joined by floor, roof or other load distributing elements adequate to support the design load.

Load Duration Factor, C_D – Wood has the ability to carry substantially greater maximum loads for short durations than for long durations. Reference design values apply to the normal 10-year load duration. With the exception of modulus of elasticity, E and E_{min}, and compression perpendicular-to grain, $F_{c\perp}$, reference design values must be multiplied by the appropriate load duration factor, C_D.

Floor joist and ceiling joist tables are based on the normal load duration which implies a load duration factor, C_D, of 1.0. For rafters, the load duration factor, C_D, is typically either 1.15 for two-month snow loads or 1.25 for seven-day construction loads. Snow loads are presented in rafter tables 17-40, while construction loads are presented in rafter tables 41-46. All rafter tables are labeled to indicate the load duration factor used.

Wet Service Factor, C_M – When dimension lumber is used where moisture content will exceed 19% for an extended time period, design values must be multiplied by the appropriate wet service factors.

Almost all of these tables are intended for use in covered structures or where the moisture content in use does not exceed 19% for an extended time. Three wet-service floor joist tables (tables 12-14) are included for structures (such as outdoor decks) where the moisture content exceeds 19%.

Calculations

The spans provided in these tables are limited to the minimum value calculated for the following design parameters using Allowable Stress Design (ASD):

- **Bending (flexure)**
- **Deflection (based on live load only)**
- **Compression Perpendicular-to-Grain**
- **Shear Parallel-to-Grain (horizontal shear)**

Spans have been limited to 26'–0" based on material availability. Southern Pine is commonly available in lengths up to 20'. Check sources of supply for longer lengths.

Bending

Bending design values assume a fully supported member, properly sheathed and nailed on the top edge of the joist or rafter. The repetitive member factor, C_r, of 1.15 was included due to the assumption of the installation of at least three joists or rafters spaced not more than 24" on center. The load duration factor, C_D, has also been applied as appropriate.

Deflection

Deflection may be the controlling factor in determining the member size required when appearance or rigidity is important. Control of floor vibration is another important reason to limit deflection. Deflection limits are expressed as a fraction of the span length in inches (ℓ), and consider only live load in accordance with established engineering practice for the design of joists and rafters. The most commonly used deflection limits are summarized above.

Application	Deflection Limit
Floor Joists	ℓ/360
Ceiling Joists	ℓ/240
Rafters: *Drywall Ceiling*	ℓ/240
Rafters: *No Finished Ceiling*	ℓ/180

The live load deflection limit for the floor joist span charts used in this document is ℓ/360. A stricter deflection limit may be obtained by multiplying the tabulated span by the appropriate factor shown in the table to the right.

Deflection Limit	Adjustment Factor
ℓ/480	0.91
ℓ/600	0.84

Compression Perpendicular-to-Grain

The compression perpendicular-to-grain check used to develop these span tables assumes a 2.0" bearing length. An additional check is required for shorter bearing lengths, such as for 1.5" ledgers.

Shear Parallel-to-Grain (horizontal shear)

All loads within a distance from the inside face of each support equal to the depth of the member have been ignored for determining the maximum allowable span based on horizontal shear.