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. The maximum spans provided in these tables were determined on the same basis as those given in *Span Tables for Joists and Rafters* published by the American Forest & Paper Association (AF&PA).

There are three general categories of span tables.

Table Categories	Tables	Page(s)
Floor Joists		
Conventional loads	1 - 7	8 - 11
Heavy live loads	8 - 13	11 - 14
Wet-service conditions	14 - 16	14 - 15
Ceiling Joists		
Conventional loads	17 - 18	16
Rafters		
Snow loads (C_D = 1.15)	19 - 42	17 - 28
Construction loads (C_D = 1.25)	43 - 48	29 - 31

General Requirements

The quality of wood products and fasteners and the design of load-supporting wood members and connections shall conform to the *National Design Specification® (NDS®) for Wood Construction* published by AF&PA. All members shall be so framed, anchored, tied, and braced to have the necessary strength and rigidity. Adequate bracing and bridging to resist wind and other lateral forces shall be provided.

Design Loads

Assumed loading conditions are stated in the heading for each table. Live and dead loads are shown in psf (pounds per square foot). The provided range of loads accommodates the most common design loads used. Structures in heavy snow load areas should be analyzed thoroughly using accepted engineering practice. For rafters with roof live loads less than 20 psf, see AF&PA's *Span Tables for Joists and Rafters* for adjustments.

Roof Coverings
Light Roofing *(10 psf dead load)* Up to 2 courses of asphalt shingles, or wood shakes/shingles
Medium Roofing *(15 psf dead load)* 2″ clay book tile
Heavy Roofing *(20 psf dead load)* 3″ clay book tile

The estimated dead loads for rafters are based on the type or amount of roof covering material. Tables are included for three common coverings.

Listed dead loads include the weight of the framing members.

Lumber Grades

There are currently three different grading methods for sorting Southern Pine dimension lumber and assigning appropriate 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 also 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 and then sorted into various strength classifications, plus each piece must meet certain visual requirements. 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-29

Selected Grades

The most common lumber grades for the three different grading methods were selected for inclusion in these span tables. Contact the Southern Pine Council for span assistance on grades, on-center spacings or loading conditions not covered in these tables.

Most Commonly Produced Sizes, by Grade

Although the most common grades were selected for these tables, no single manufacturer produces all grades. In addition, 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 in your area 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-29			●	●	●

Lumber Sizes

Computations for these span tables are based on net lumber dimensions (actual sizes), provided by the *American Softwood Lumber Standard PS 20.*

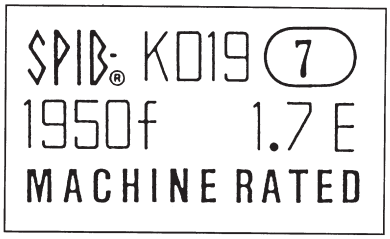
Nominal Size	Actual Dry Size
(inches)	(inches)
2 x 4	1-1/2 x 3-1/2
2 x 6	1-1/2 x 5-1/2
2 x 8	1-1/2 x 7-1/4
2 x 10	1-1/2 x 9-1/4
2 x 12	1-1/2 x 11-1/4

Lumber Identification

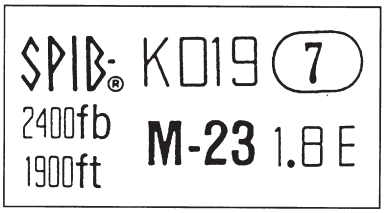
The maximum spans in these tables apply to properly identified material. Lumber must be identified by the grade mark of an agency certified by the Board of Review of the American Lumber Standard Committee (ALSC), and manufactured in accordance with *Product Standard PS 20* published by the U.S. Department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

Typical Lumber Grade Marks

Visually Graded



Machine Stress Rated (MSR)



Machine Evaluated Lumber (MEL)

Note: Other agencies are accredited by ALSC to inspect and grade all or selected Southern Pine products according to SPIB Grading Rules, including: California Lumber Inspection Service (CLIS); Northeastern Lumber Manufacturers Association (NELMA); Renewable Resource Associates (RRA); West Coast Lumber Inspection Bureau (WCLIB); and Western Wood Products Association (WWPA).

Spans

The maximum spans in these tables were computed using standard engineering design formulas for simple span beams with uniform loads. They assume installation of at least three joists or rafters spaced not more than 24″ on center. 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.

Tabulated maximum spans are the distance from face to face of supports, and are given in feet and inches of horizontal projection of the member. This represents the actual length of horizontal members such as floor and ceiling joists. For sloping rafters, the span is also measured along the horizontal projection, with the chart on page 32 providing a convenient tool for calculating the corresponding sloping rafter length.

These span tables were calculated considering four design conditions:

- **Bending (flexure)**
- **Deflection**
- **Compression Perpendicular-to-Grain**
- **Shear Parallel-to-Grain (horizontal shear)**

Only the controlling length rounded to the nearest inch is shown in the tables. Listed spans in this publication 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.

Load Duration

Wood has the ability to carry substantially greater maximum loads for short durations than for long durations. Tabulated design values apply to normal loading conditions, and may be multiplied by a load duration factor, C_D, permitted by established engineering design criteria and building code regulations.

Floor and ceiling joists are based on the normal ten-year 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 7-day construction loads. Snow loads are presented in rafter tables 19 – 42, while construction loads are presented in rafter tables 43 – 48. All rafter tables are labeled to indicate the load duration factor used.

Moisture Content

Almost all of the spans in these tables are intended for use in covered structures or where the moisture content in use does not exceed 19% for an extended period of time. Three wet-service floor joist tables, tables 14 – 16, are included for structures where the moisture content exceeds 19%.

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.

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

Deflection limits are expressed as a fraction of the span length in inches, and consider only the live load in accordance with established engineering practice for the design of joists and rafters. The most generally used deflection limits are summarized above.

In cases where a stricter deflection limit is desired, and the length is controlled by the ℓ/360 deflection limit, the tabulated span lengths may be multiplied by the factors shown to the right.

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

Bending

Bending design values used assume a fully supported member, properly sheathed and nailed on one edge of the joist or rafter. The repetitive member use factor, C_r, of 1.15 was included, as allowed in the *NDS*. The load duration factor, C_D, was also applied as appropriate.

Compression Perpendicular-to-Grain

The compression perpendicular-to-grain check assumed a 2.0″ bearing length and rarely controlled the maximum spans. An additional check should be made for shorter bearing lengths, such as for 1.5″ ledgers.

Shear Parallel-to-Grain (Horizontal Shear)

Shear parallel-to-grain was checked using revised shear design criteria in the *2001 National Design Specification®* (*NDS®*) and higher shear design values published in the *2001 NDS® Supplement: Design Values for Wood Construction.* All loads within a distance from supports equal to the depth of the members were neglected when calculating the shear force.

Design Values

Spans in this publication are based on Southern Pine design values published in the *2002 SPIB Standard Grading Rules for Southern Pine Lumber* and listed in the table on page 7. The stress values and modulus of elasticity values assigned to dimension lumber in those rules are based on tests of full-size lumber conducted by SPIB in cooperation with the U.S. Forest Products Laboratory.

Adjustment Factors

The tabulated SPIB design values on page 7 were multiplied by appropriate adjustment factors to determine allowable design values. Adjustment factors used for these tables are described below. For greater detail on design values and adjustment factors, refer to the *2001 NDS®* published by AF&PA or the SPC publication *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 which are in contact or spaced not more than 24″ on centers, 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 – Tabulated design values (except modulus of elasticity, E, and compression perpendicular-to-grain, $F_{c\perp}$, based on a deformation limit) are multiplied by the appropriate load duration factor.

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