HOW-TO BOOKLET #3113

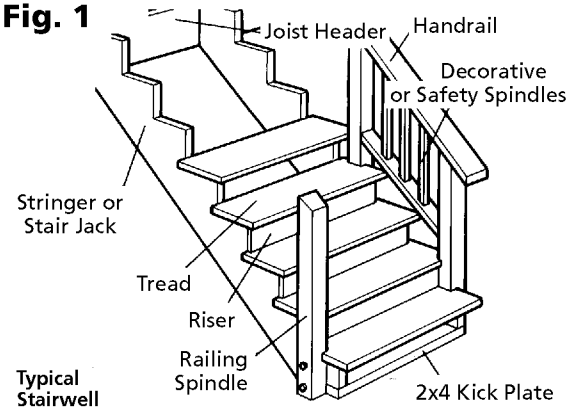
STAIRS & LANDINGS

TOOL & MATERIAL CHECKLIST

- ❑ Hammer
- ❑ Framing & T-Squares
- ❑ Handsaw
- ❑ Level
- ❑ Sawhorses
- ❑ Circular Power Saw
- ❑ Eye, Ear, Mouth Protection
- ❑ Nails
- ❑ Tape Measure
- ❑ Lumber & Plywood

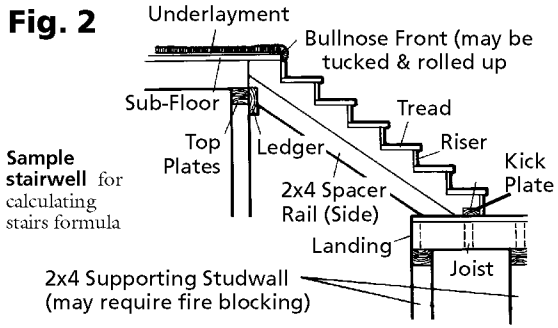
Read This Entire How-To Booklet for Specific Tools and Materials Not Noted in the Basics Listed Above.

Fig. 1



Typical Stairwell

Fig. 2



Sample stairwell for calculating stairs formula

Building stairs is one of the most intimidating projects you may encounter. The reason is the amount of mathematics involved to calculate the angles and cuts.

This booklet deals primarily with interior stairs and landings. Exterior steps are built the same way except that they are stained/painted and otherwise treated for the outdoors.

The overall objective when building stairs is consistency in every tread and riser for a safe and secure stairwell.

It doesn't need to be as complex as it at first seems. This booklet shows how to build stairs using simple mathematics.

The first key to building stairs is being able to visualize on paper. Draw frequently and from different perspectives how the stair is connected above and below, as well as the types of finished floors they will come into contact with **(Fig. 1)**.

The second key is patience. You are building something that a carpenter may take years to learn. You will make mistakes while you learn, but if you are patient and commit the mistakes on paper and scrap materials, the consequences will be minimized.

CODES

Building codes exist for our own safety and well being. You must check with your local building department on the following key items: • Maximum unit rise • Maximum unit tread • Fire blocking requirements • Maximum material spans • Framing requirements • Special considerations • Local Architect's Rule, if different from 18"

MATERIALS AND DEFINITIONS

Materials are 2x12s for stringers, 2x4s for supports, and 2x6 or 2x12 or ¾" CDX plywood for treads.

Total height (rise) is measured from sub-floor to sub-floor. If the finished floors are installed, use finish floor heights.

Keep measures clear on plans, represent feet in large letters and inches in superscript with an underline, such as 7 (for feet) and 6 (for inches): $7^{\underline{6}}$.

A jack (stringer) is the cut-out form of a 2x12 that serves as the main framing member.

STAIRS FORMULA

The following formula is used to calculate stairs. Numbers in parentheses are examples that may be found in table B.

1. Measure the total height between the sub-floors. (108") (**Fig. 2**).
2. Determine the type of framing to be used for stair treads, such as plywood vs. dimensional lumber and place to the side for now. (¾" CDX)
3. Divide the total height by the number 7 to arrive at an **approximate number of stair risers**. (108 divided by 7 = 15.43 risers)
4. Round this number either up or down to the nearest whole number and divide the overall height again by this new number to determine **the average unit rise** (108" divided by 15 risers = 7.2" avg. unit rise)
5. Convert this number back into a fraction using table A, decimal equivalents. **Enter this number onto your worksheet under average unit rise.** (7.2" = 7 3/16")
6. Deduct the average unit rise from the architect's rule of 18" on the worksheet. The result is the **average unit tread.** (18"– 7 3/16" = 10 13/16" avg. unit tread)
7. Now multiply the average unit tread times the rounded number of stair risers; this new number is **the total run of the stairwell.** (convert 10 13/16" to a dec. equiv. = 10.8" x 15 = 162" total run)
8. Take the **square root** of the (total rise)^2 + (total run)^2 to get the length of the stairwell. (sq. root of [108 ^{2} + 162 ^{2}] = 194.7" = 16.2')
9. Add 10% and round up to the next even number to determine the number of feet of material you need for your stair jacks. (16.2' + 1.6'= 17.8', order 18' 2x12s for stair jacks)
10. Multiply the number of treads/risers by the tread width to determine the materials. (15 risers x 36" wide x 7.2" high = 3,888 sq. in.) + 15 treads x 36" x 10.8" = 5,832 sq. in.) = 9,720 sq. in. = 67.5 sq. ft. (3 - 4x8 sheets)

NOTE: There are 32 sq. ft. in a 4'x8' sheet of plywood and 144 sq. inches in one sq. ft. So 32 x 144 = 4,608 sq. inches per 4x8 sheet of plywood. If using dimensional lumber round to the nearest 2 foot increment. If using plywood, plan the tread-cuts across the grain for strength.

2x12s are for stair jacks; 2x4s for space rails, strong backs, kick plates and ledgers; 2x2s may be used for railings.

OTHER CONSIDERATIONS

Since the stairs are usually enclosed on two sides by walls it is necessary to install fire blocking between the wall studs **(see Fig. 2)**.

Fire blocking is a means to retard the spread of fire from one floor to another through the stud-wall cavities. Codes will determine whether your blocking needs to be diagonal, or square and how to be installed. As earlier, the numbers in parentheses indicate sample numbers.

1. Count the number of wall studs to be blocked and note the on center (O.C.) spacing. (24 @ 16" O.C.)
2. Measure cavity between each stud and calculate the total run in inches (24 x 14.5" = 348").
3. Convert the total run in inches to lineal feet, add 20% and round to nearest even number. (348" + 20% = 35 1.ft.; order 5-8' 2x4s)

LAYOUT

A typical stairwell might include: A 3 ft. width enclosed, the bottom finish surface is 1/4" parquet over concrete, the top finish surface 2" carpet and pad, tread surface is same carpet, the tread and riser material is 3/4" CDX plywood.

There are usually 3 jacks in a 3' wide stairwell. The outside jacks are set 1-1/2" away from walls by a 2x4 spacer rail.

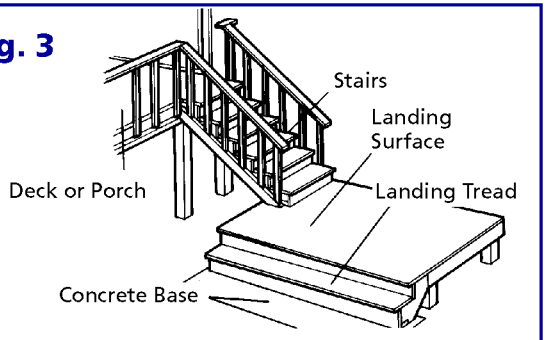
The jacks are equal distance apart, 16" O.C. or as per codes and are supported at top by a ledger and below by a kick-plate (aka "kicker"). Layout is done before cutting the jacks.

LANDINGS

A landing is a structure that connects two stairs between floors. It is used when there is not enough room for a continuous stair run **(see Fig. 2)**.

Most landings form a right angle between the upper and lower staircase. The formula to calculate stairs between landings is exactly the same, except there are two calculations **(Fig. 3)**.

Fig. 3



A Stair and Landing Configuration

The simplest landing is placed half-way. The stairs turn to compress the total run.

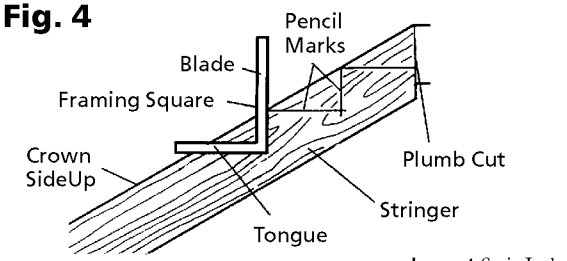
1. Calculate the stairwell without a landing and draw it to scale.
2. Determine the half-way point in the total run and identify obstacles or codes.
3. Set the landing height at the middle tread height which becomes the landing sub-floor.
4. Calculate two stairs:
   A) from the bottom to the landing and
   B) from the landing to the top.
5. Build the landing working to the sub-floor height determined in step 3.
6. Re-calculate the two stairs as in step 4 since the actual sub-floor height/location may vary from the plan.

NOTE: A landing should not be confused with a step. Make it large enough so that you can maneuver furniture around any turns. A 3' square landing is considered minimum by many builders.

PATTERN JACK

1. Set a 2x12 on sawhorses with the crown facing toward you. This is the upward bend on the narrow side of lumber.
2. Grasp the "tongue" of a framing square with your right hand, and the "blade" of the square with your left hand. The tongue is the smaller of the two sides to your square **(Fig. 4)**.
3. Position the inside of the tongue and blade on the crown side of the jack.
4. The unit rise is aligned on the tongue and the unit tread on the blade. Always use the same side of the square while measuring.
5. Draw a pencil line along the inside of the square. The shorter line is the vertical plumb cut and the longer lines are level cuts.

Fig. 4



Layout Stair Jack

6. Slide the square until the inside of the blade/tongue is along the pencil line just drawn and draw more lines. Repeat on the entire jack.

NOTE: The numbers must stay the same to keep the rise and run consistent. Use clamps or tape to make the realignment easy and fast.

7. Cut the top plumb line and the bottom level line. Make the first level/plumb cuts at the very ends of the jack.
8. Position the jack on layout against a stud wall but do not nail. Brace the jack and inspect the plumb and level cuts.

NOTE: The jack should be no longer than needed. The plumb and horizontal cuts are to be trimmed to fit in 3 or more fittings.

9. Measure the overrun and cut **half off each end** and then fit it again.

NOTE: The trick to successful stair building is to gradually decrease the length of the jack until it fits with three or more fittings and cuts. This allows continual slight adjustments.

10. Place the jack in all layout locations to test the trueness of the plumb and level.
11. Now take into account the materials and the finished surfaces of the treads and floors.

For example:

Bottom Riser. Using 3/4" plywood tread and carpet adds 2-3/4" of height to the riser (depending upon thickness of carpet/pad). The bottom finish floor is 1/4" parquet wood flooring. The bottom riser is a net 2-1/2" shorter than the avg. riser.

Top Riser. The same materials as above plus a 1/2" underlayment on the upper finish floor adds 3 1/2" to the upper riser while the tread rises 2 3/4". The top riser is 1/2" shorter than the average riser.

REMEMBER, the overall objective is consistency on every tread/riser for balance/safety.

12. Remove the jack and make the cuts for the bottom kicker, top ledger and strong-back.

NOTE: Never make a cut into a 2x12 jack that leaves less than 6 inches of material from any cut to any other part of the jack, or to local codes.

13. Install the ledger and kick plates and retest the jack's fit in all layout spots.
14. Remove the jack and make the tread and riser cut-outs with *no overcuts.*

NOTE: Use a circular power saw to cut up to the intersection of the lines and finish the cut with a sharp hand saw.

15. Re-test the jack and check that each tread is level or slightly sloped into the cut.
16. When satisfied, mark the bottom of the jack with a crayon "pattern" and return the jack to the sawhorses for the riser and tread cuts.

CUTTING THE OTHER JACKS

1. Lay pattern jack on sawhorses and locate the bottom of the jack.
2. Align the crowns, bottom, top and trace a pencil line along the pattern jack onto each of the remaining jacks.
3. Cut the jacks and install the 2x4 side rails flush to the bottom of the outside jacks.
4. Set jacks in position testing for:

A) alignment of all treads and risers,
B) plumb/level cuts and the fit at ledger/kicker,
C) same tread slopes across all jacks, and
D) uniform riser heights especially to finish floors.

NOTE: You can make a slight adjustment to all of the jacks by cutting or shimming the bottom/top level/plumb cuts. For safety's sake, treads that slope slightly toward the jack, allow a foot to slide into a pocket rather than away from and off the tread.

INSTALLING JACKS, TREADS, RISERS

1. Nail or screw the jack to the support ledger and to the bottom kick plate. Drill a pilot hole to prevent the jack from splitting.
2. Cut and remove a section of the upper sub-floor and reinstall a plywood section that covers the top of the jack.
3. Install underlayment, if any, and add bullnose to top riser before adding finish flooring.

NOTE: Try not to nail jacks to wall studs. This may weaken the jacks and cause sever creaking when the wood shrinks and house settles.

4. Cut and nail in place the temporary treads in order to walk up/down the stairs. Use the material later as the riser material.

NOTE: If ready to install finished treads, do so now. Temporary treads are used to access the upper levels in new construction.

5. Locate the center of the stair run from underneath, and **mark the center jack only** to cut out a notch for the strong-back brace.
6. Install fire blocking between the studs at an angle, or as required by local codes.
7. Install drywall on walls and under the jacks. Finish according to tastes.

TABLE A - DECIMAL EQUIVALENTS

1/16 = .0625	7/16 = .4375	3/4 = .75
1/8 = .125	1/2 = .51	13/14 = .8125
3/16 = .1875	9/16 = .5625	7/8 = .875
1/4 = .25	5/8 = .625	15/16 = .9375
3/8 = .375	11/16 = .6875	16/16 = 1.0

8. Set handrail on one wall at 36" to 44" off front of each tread, or as required by codes (**Fig. 5**).
9. Check consistency of each riser, maximum 8" or to code before finishing.
10. Install kick-board on each side of the stairwell to prevent scuffing the wall surface. Use the pocket from the spacer board to slip in a 1x8 or larger piece of pre-finished lumber.

Your stairwell is complete. Remember that this is a system that must be consistent to be safe. Take your time and use the formula and tables provided to insure your success.

Fig. 5

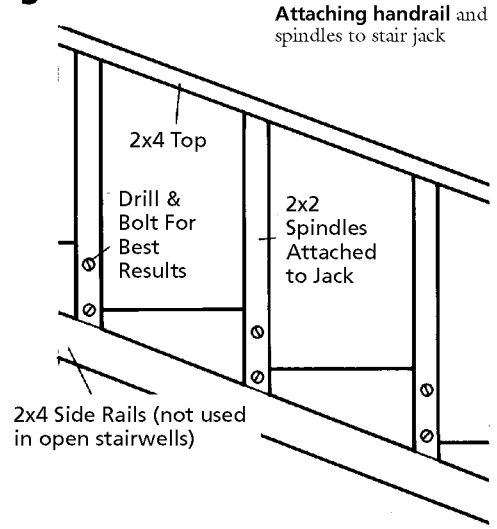


TABLE B - CALCULATIONS

	Our Sample	Your Stairs
Total Height	108"	
Divided by 7		
= Approx. # of Risers	15.43	
(A) rounded to nearest #	15	
Total Height	108"	
Divided by (A)	15	
Average Unit Rise - Decimal	7.2	
Average Unit Rise - Inches	7 3/16	
Architects Rule	18"	18"
Less: Average Unit Rise	7 3/16	
= Average Unit Tread - Inches	10 13/16	
Average Unit Tread - Decimal	10.8	
Multiplied x Stair Risers (A)	15	
= The Total Run - Inches	162"	
Total Run - Feet	13.5'	
$(\text{Total Rise})^2$	$(108")^2$	
Plus $(\text{Total Run})^2$	$(162")^2$	
=	37,908"	
The Square Root = 194.7" or	16.2'	
Add 10%	1.6'	
Round to Nearest Even Number		
= Stair Jack Length	18'	
Width of Stairs	36"	
Multiplied x Tread - Decimal	10.8"	
= Sq. Inches Treads	388.8"	
x 15 Treads =	5832"	
÷ 144" Per Square Foot =	÷ 144	
= Sq. Footage Treads (B)	40.5	
Sq. inches risers (36x72)	259.2"	
X 15 risers =	3888"	
÷ by 144" = sq. footage of risers (C)	27	
(B)	40.5	
plus (C)	27	
= Tread and Riser Sq. Footage	67.5	
÷ 32 Sq. Ft. Per 4x8 Plywood	÷ 32	
= Number of Plywood Sheets	2.11	
Round Up and Order Plywood	3	

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