

CONSTRUCTION FORMULAS

These are formulas that I refer to almost daily. Some are extremely complicated, most are not. I explain in the CB (Carpenters Book) extensively about formulas and calculations. They are essential for proper construction. If you are in construction you need to print these out and carry them in your billfold for reference. I do.

When I show a formula such as $\pi r^2 = \text{area}$ (area of a circle) and you see the pi symbol, π , (3.14) [pi is calculated by dividing the circumference of a circle by its diameter] next to the r, this means you multiply 3.14x the radius. Squared ² means to multiply the factor (radius) times itself. If you have a 6" radius you would multiply 3.14x36=113.04, the 12" diameter circle has 113.04 square inches in its area.

You may need to study these formulas for they are probably simple for some of you and not so simple for some of us carpenters.

First, some abbreviations:

$\pi=3.14$, a=area, d=diameter,
c=circumference, w=width,
h=height, l=length, Rs=rise,
Rk=rake (hypotenuse), Rn=run.

To learn these formulas you will need to do them a few times with your own measurements.

The formulas are:

Circle:

$\pi r^2 = \text{area of a circle}$

$\pi d = \text{circumference of a circle}$

Let me explain this next one to you again until you get use to these formulas. The surface area of a ball is calculated by multiplying 4 times pi times the radius of ball squared equals the area. Example an 8" diameter ball: 4 times 3.14 times 16 (4x4) equals 201 square inches of surface area on an 8" ball. Painters would use this to figure how much surface area a ball shaped water storage tank has.

Ball:

$4\pi r^2 = a$

$4\pi r^3 \div 3 = \text{volume}$ (r^3 is the radius to the third power. If you have a radius of 4, r^3 would calculate 4x4x4, third power is 64. 4x4=16, 16x4=64.

Cone:

$Lc \div 2 = a$

$\pi r^2 L \div 3 = \text{volume}$

Cylinder:

$cL = a$

$\pi r^2 L = \text{volume}$

Ellipse: (Egg)

$h \div 2$ times the $w \div 2$ times $\pi = \text{area}$

$h \div 2$ plus $w \div 2$ times $\pi = \text{circumference}$

These are the most common shapes in construction, probably the ones you will be dealing with. Now, with this information let's go onto some

more common formulas that you will actually use on the job.

I have had some engineers and architects tell me that there is no way to calculate the angle of a triangle by only knowing two factors of the triangle. Read on.

We are going to use the most commonly known triangle in carpentry, the 3-4-5, 3"rise-4"run-5"rake. These two formulas are from the Magic Circles in the Carpenters Book. Using the Magic Circles you can calculate distances using a transit level, calculate heights of buildings and structures without ever leaving the ground and find any factor in a triangle. It would take me 3 pages to explain the Magic Circles, so I am going to give you the two main formulas only. There are 16 of these in the CB, but these are the most common.

You need a "scientific calculator" to do these formulas with. Most of those fancy Construction Calculators that cost \$50 don't have near the formulas that I am giving you. These Casio fx-260 calculators that I use cost \$9.

We have this 345 triangle and we want to know what the angle is at the top, the one where the rise and the rake meet. The formula is: $rn \div rs \times Stan$ is the rs-rk angle. Now, enter 4, push the division symbol, enter 3, push the x symbol,

push the Shift symbol on the top left, then push the tan symbol, and it will show 53.13 (do not push the =). Now for the bottom angle, the formula is: $rs \div rn = Stan = rn, rk$ angle. Enter 3 ÷ 4, hit the =, then push the Shift then the tan, this will give you 36.86.

53.13 plus 36.86 equals 89.99 which is about as close to 90° as any carpenter I ever knew could get.

Now I know most of you know that the pitch of a roof is the inches of rise at the center of the roof per foot of run. For instance, a 5/12 is 5" of rise for every foot of run (half of the span). Here are three formulas I use when I am building a common roof. Pay close attention to the feet and inches symbols on the rs-rn-rk's.

$Rn'' \div 12 \times pitch' = rise \text{ in inches}$

$Rs' \times 12 \div pitch' = run \text{ in feet}$

$Rs'' \div rn' = pitch \text{ in feet}$

Let's do the last one. We have a rise of 4', a run of 16'. $48'' \div 16 = 3$, we have a 3/12 pitch.

One thing here, if you have a rise of 91" and you want to know how many feet this is, simply divide 91 by 12 and you will get 7.58 feet, now read below and learn how to turn this .58 into inches and sixteenths.

Now something that I preached about in the CB again and again. If you take a regular calculator and

you are calculating the diagonal (rake length of the footprint) [footprint is the overhead view of a building laid out on the ground] of a building such as a building 30'x50' and you enter $30 \times 30 = 900$ and then $50 \times 50 = 2500$, add these two sums, and then you get the square root of 3400 you will get 58.3. This is not 58' and 3". The .3 is three tenths of a foot. To change tenths of a foot to inches you multiply the tenths **.3 times 12** and you get 3.6". Three inches and six tenths of an inch. To change the .6 tenths of an inch to sixteenths you multiply the **.6 times 16** and you get 9.6, the answer is 58' 3" and $9\frac{1}{2}$ sixteenths. This is one of the most common mistakes in laying out buildings. Something you don't want to forget. Some say this is trivial and doesn't have that big of an effect on a slab or footing. It does to me, and should to you. If my calculator says the diagonal is 34.5', I am going to mark 34' 6". I am a carpenter not an estimator of heights and lengths.

This ends this segment of carpentry. The projects I am about to show you on this site will require that you know these or have reference to them, as I am not going to go into detail about every calculation that we do when we lay out a foundation.

You need to study your speed square and learn about it. If you have a pitch of a roof and you want the degrees simply lay a straight edge on the square and it will give you degrees, same thing if you have degrees and you want the rise per foot. Be careful, there are two rows of measurements, one is common and one is hip/val. Hip/val is for hip and valley plumb cuts only. Common is for common rafters. I have about 75 pages about framing in the CB. The procedures I am going to give you on this site only touch the surface, but I know that most of you already know how to frame and I am going to give you procedures I have learned that have helped me. I am going to start with a foundation layout and take you through a building process. Bob