

Applying Mathematics to Construction

Carpentry Mathematics & Estimating

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Part I

Mathematics

Preface

This book was written to assist instructors and contractors in sharpening their understanding of basic construction mathematical calculations as well as how to estimate material quantities so that their students or employees can be prepared for industry. This first section teaches how to think without using a calculator or tape measure. (Thinking is good.) Most carpentry instructors will teach their students to lay out rafters using either the speed square or rafter square called the step-off method, and that's fine; however, mathematical calculations are more accurate.

Introduction

It has been recorded in history that wood-framed structures such as timber-type framing were done by people who were highly skilled. These highly skilled craftsmen would perform complex mortise and tenon, lap or inlay joints that were secured on the ends with trunnels (tree nails). Other fasteners like the metal nails or screws weren't invented yet. After balloon framing was invented by Mr. Snow in Illinois in 1742 and the cut nail was invented, the average farmer could then build his own barn and didn't need to understand a whole lot of the mathematical formulas or need fancy tools. Well even today there are skilled and unskilled contractors. On average, this practice has lowered the quality of workmanship. With a bad economy, many home owners can't afford a skilled craftsman. Some home owners, however, will make sacrifices while others will settle for less encouraging, poor workmanship.

About the tape measure

Symbols = feet (') and inches (")

Tape measures are available in a variety of widths and lengths.

Widths	Lengths
1/2"	8" 10" 12"
3/4"	12" 16" 25"
1" - 1 1/4"	25" - 30" and the new 40'

Wider blades have a deeper cup and are more rigid so that they can extend further without support. When using a tape, extend and retract the blade slowly. Doing it quickly can cause bending and breakage. The standard USA system of measure is feet, inches, and fractions of a foot. The metric system uses meters (feet), centimeters (inches), and millimeters (fractions of a foot).

Note: When reading a tape measure, know that fractions to the right belong to the whole number to the left.

Example: 1 - 1/2 24 - 5/8 65 - 13/16

Numerator = odd numbers

Denominator = even numbers

N odd 1 3 5 7 9 11 13 15

D even 1 2 4 8 16 32 64 128 etc.

Numerators

All numerators are odd numbers, while the denominators are all even numbers except 1 (one), which represents the whole.

Denominators

For denominators, simply add like numbers (1 + 1 = 2 and 2 + 2 = 4 and 4 + 4 = 8 and 8 + 8 = 16 and 16 + 16 = 32 and 32 + 32 = 64).

Four basic math operations

Addition, Subtraction, Multiplication, and Division

Addition and subtraction are opposite operations and multiplication and division are opposite operations.

$$\begin{array}{r} \text{Example: } 23 \\ + 14 \\ \hline 37 \end{array} \quad \begin{array}{r} 37 \\ - 14 \\ \hline 23 \end{array} \quad \text{and} \quad \begin{array}{r} 23 \\ \times 14 \\ \hline 322 \end{array} \quad \begin{array}{r} 322 \\ / 14 \\ \hline 23 \end{array}$$

Whole numbers

A whole number is a complete unit.

Example: (1, 2, 3, 467, 9, 0, 1, 534, 777, etc.)

Taking a closer look at whole numbers

What process would you use to solve this problem?

$$47 + 36$$

In construction, you should learn to solve problems as a whole and not as half and half: (6 + 7) carry 1, then (3 + 4 + 1).

$$\begin{array}{r} 47 \\ +36 \\ \hline \end{array}$$

Note: The number 9 is the largest single-digit number and there are no numbers when adding that will carry more than 1. This means that every number carried over will be 1 (not even the largest single digit plus itself). Example: (9 + 9 = 18)

These are the numbers that when added together equal the largest number before carrying: