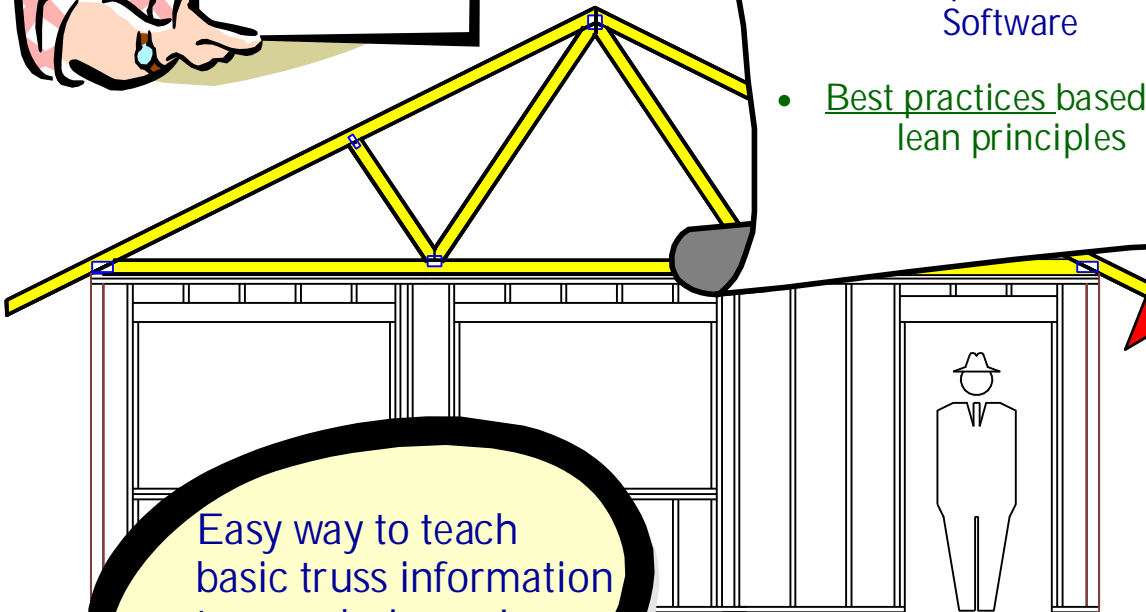# Truss Basics

Written by:

Todd Drummond

Lean Manufacturing Consulting Services

- Time Standards for truss labor estimation (Houlihan type system)

- Truss Shop Labor Tracking Software

- Best practices based on lean principles

Easy way to teach basic truss information to new designers!

Truss Geek

Todd Drummond Consulting, LLC

Lean Manufacturing Principles for the Component Industry

Website: **www.todd-drummond.com**
Email: todd@todd-Drummond.com
Phone: 603-763-8857

Preface

The design of trusses is much more complicated than just knowing spans and shapes. The plate manufactures have spent millions of dollars creating some of the most sophisticated engineering software in the construction industry. The programs have become easier to use and can do a great deal more now for the truss designer, but they can not do it all for the designer.

A truss designer must know two distinct aspects of designing roof trusses.

1. What kind of information to input into the programs.

2. How to use the design software.

The information needed to input into the computer to design roof trusses is what this book is all about. The skills needed to correctly design roof truss systems can be overwhelming. Too many individuals, who have no practical experience, underestimate the needed skills that are required and the learning curve (time line) that normally is required to acquire them. This book was created to teach new designers and help develop better skills for knowledgeable designers. With the knowledge gained from this book it will in itself shorten the learning curve and develop new designers at a more cost effective pace.

Each chapter covers individual subject matter that a truss designer encounters everyday. The Subject matter is first explained in detail for better understanding. Then an explanation of how to approach and solve the problem is explained. Some chapters will have a form to be copied for assisting in problem solving for everyday truss designing.

As a study guide it is best to have an experienced truss design guide the new designer through each chapter. It provides a structure for the training of all the essential skills needed to create the proper roof systems. By assisting the new designer you will also know on what skill level he is at. This book can be read as its own, but having an guidance from an experienced designer will help give added dimension to the learning experience.

As a reference guide each designer can refer to deferring chapters for deferent conditions as they occur while designing.

This book does not contain any information on how to use or input information into any truss program. The manufacture of the plating programs provides training and technical support for operating their programs.

Contents

Preface

Chapter 3   **Truss Math**

Chapter 4   **Loading**

Chapter 1

Truss Basics

Roof trusses are an intricate part of the framing of a building structure. The make it possible to create a roof that spans large distances without internal support. The first metal plated wooden truss began in Florida in 1952 by A Carroll Sanford. Since then the metal plated wooden truss has gained in market share, over 80% in residential. Trusses have grown in versatility and become more complicated in design. This book will talk about wood trusses only, but all roof trusses whether made of metal or other material, use the same type of information contained in this book. A wood truss has members that is wood with each piece being tied together by metal plates. The metal plates have teeth that are pressed into the wood that then will hold the members together.
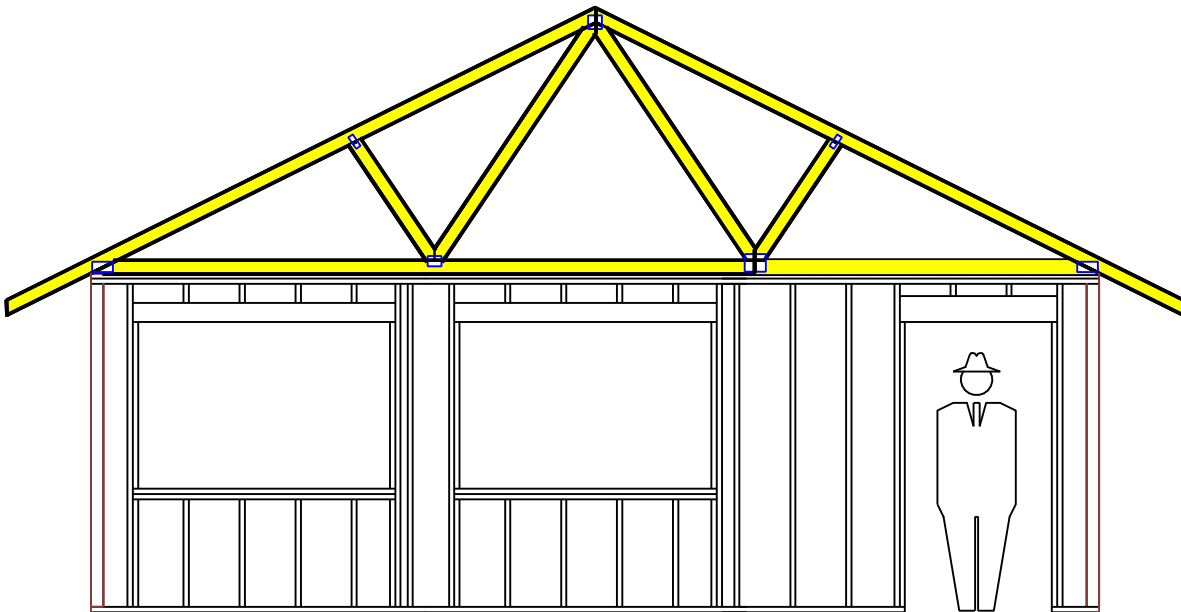
Since the creation of the computer, the manufactures of the metal plates have created the software programs to design the trusses. The first programs were developed to handle all the necessary calculations for the forces of individual trusses. Then they progressed to providing the needed paperwork for the cutting of each member in the truss. As the computers and software got more powerful the evolution of the programs included truss layouts and management software. Each year brings better and better truss designing software from the nation's plate suppliers.

The homes over years have grown in complexity and square footage. As the homes get bigger the spans for the roofs have grown with them. The costs of framing the building have to be kept to within reasonable limits for the contractors to make a reasonable profit. In every part of the country trusses have made huge gains in market share (verses stick framing and other methods) for framing the roofs. Roof trusses are an extremely versatile product.

They allow the building designers to create buildings with complex rooflines and greater open areas, but at a reasonable cost. It is not uncommon to find roof truss systems with greater than 50 different design types of trusses in a single roof system.

The versatility of wood is three folds. First the strength that wood provide compared its own weight is remarkable. Second is its ability to cut and shape it to specific needs makes it flexible. Third would be its availability around the country is extensive. Because of the versatility of wood trusses gives them a long product life cycle. In other words there are no other products out there that are going to knock roof trusses off the roof support system "king of the hill".

Definitions

Every truss has individual parts that make up the whole. The members that form the top parameter are referred to as the Top Chords. The members that form the bottom of the truss are called the Bottom Chords. Webs are the members that tie the outside chords together. Each member is held together by Gussets. All trusses must bear (sit) on a wall or in a hanger, which would be referred to as a Bearing.
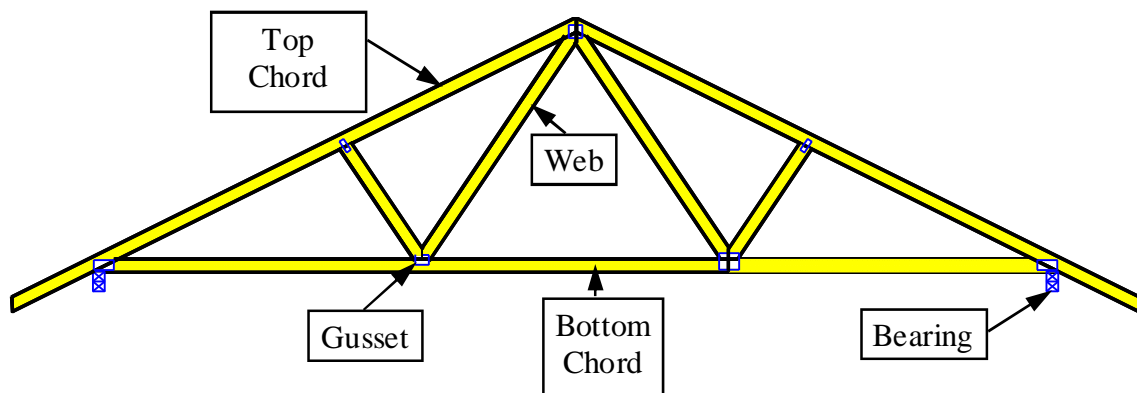
The slope or angles of the cords are measured by what is known as a Pitch. The pitch would be called out as the number of inches the chord rises for every twelve inches in horizontal measurement. An example is 6/12, which is the chord rises 6" for every 12" of horizontal measurement.

Top Chord Pitch

12

6

or as **6/12**

12

3

or as **3/12**

Bottom Chord Pitch

Peak

Panel

Heel

Joints

Splice

Overhang

Cantileve
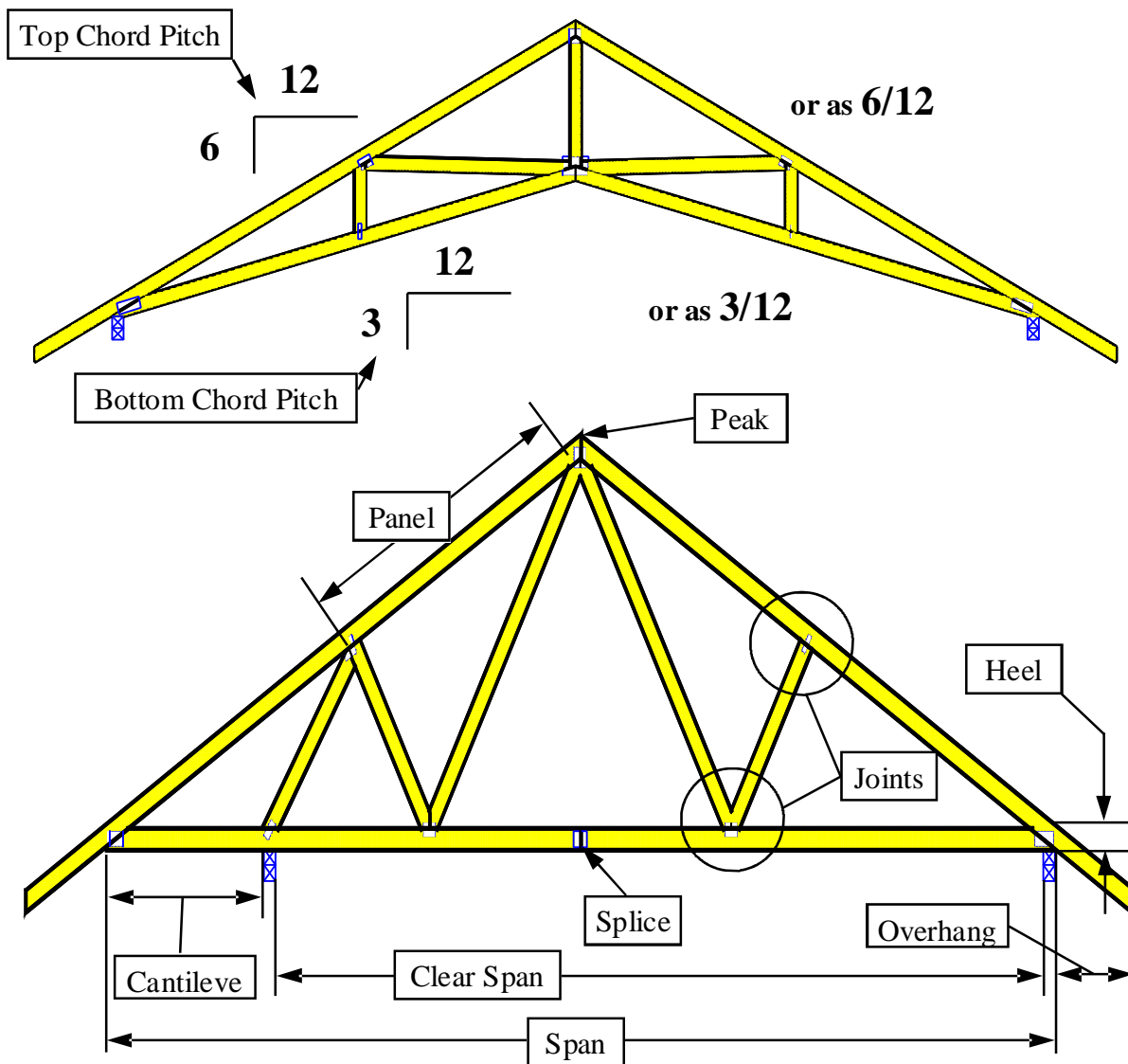
Clear Span

Span

Cantilever is when the bottom chord extends beyond the bearing. (Does not include overhang)
Clear Span the distance between supports.
Heel of a truss is the end where the top chord and the bottom chords meet. See chapter 3 for more definitions of heel heights.
Joint is a point where webs and chords are attached to each other. Also known as Panel point
Overhang is the top chord extended beyond the heel of the truss.
Panel is the segment of chord between two joints.
Peak is the top ridge or the highest point.
Span is the over all length of the bottom chord.
Splice is when two chords are attached together because the over all length was too long for a single 2x member.

Wedge · Plumb Cut · Slider · Square Cut · Level Cut
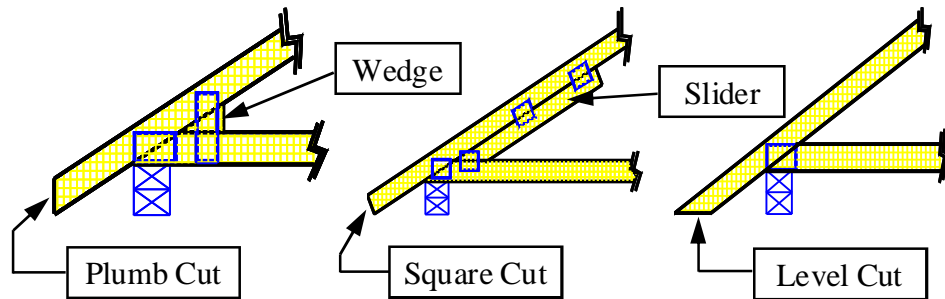
Butt Cut is a vertical cut on the end of the bottom chord to insure uniform spans. (1/4" is common)

Level Cut is a cut parallel to the ground.

Plumb Cut is a cut perpendicular to the ground.

Square Cut is a 90-degree cut to the member.

Slider is an added member to reinforce the top and bottom chords.

Wedge is a block cut too reinforces the top and bottom chords.

Butt Cut

Stubbed · Stubbed End with Top Chord Bearing · FILLER
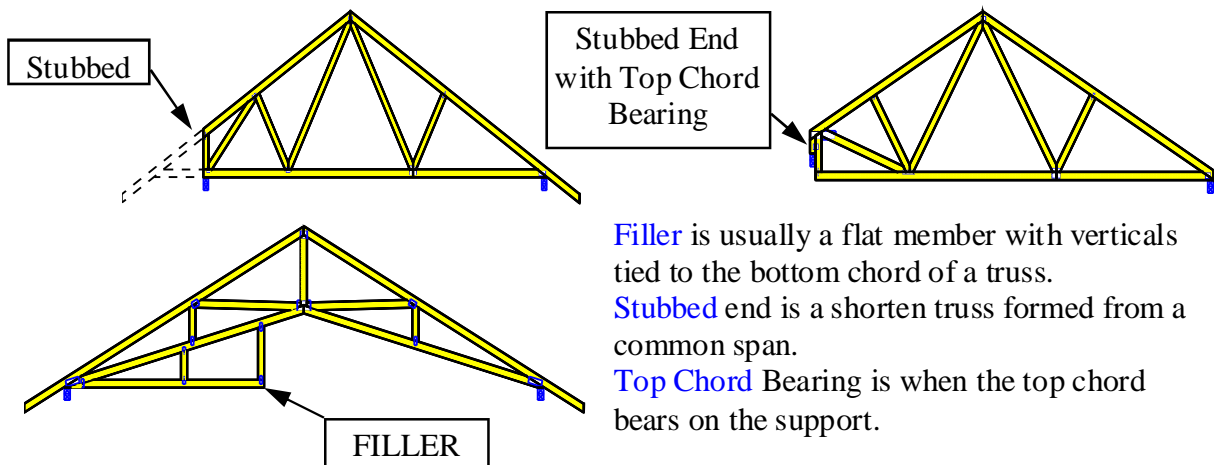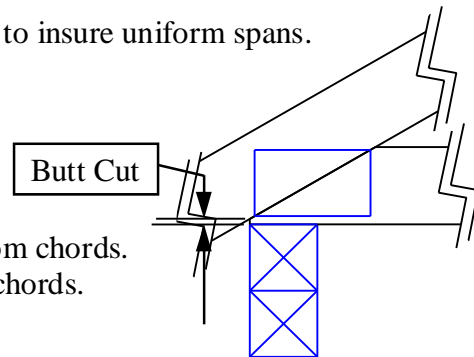
Filler is usually a flat member with verticals tied to the bottom chord of a truss.

Stubbed end is a shorten truss formed from a common span.

Top Chord Bearing is when the top chord bears on the support.

Truss Types

Illustrated below are common truss types. The name of the truss is based on its shape and function. Look at the difference between a common truss and an attic. Each look very similar, but an attic is designed for a floor and ceiling loads within the truss itself. You need to know what each truss looks like and what they are used for.
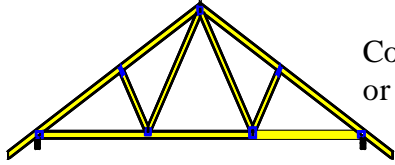
Common or Typical

Attic

Room
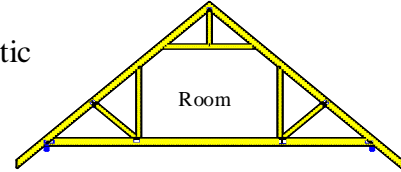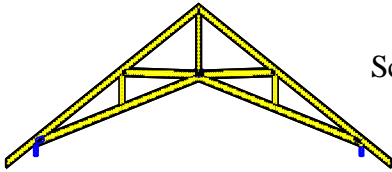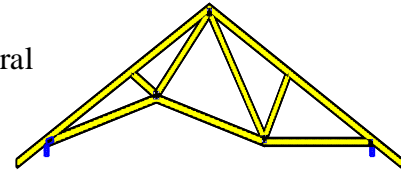
Scissor

Cathedral
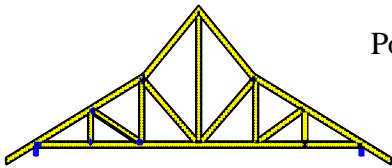
Polynesian
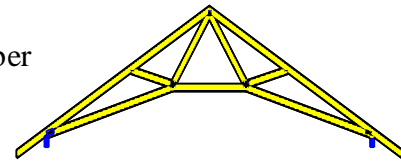
Camber
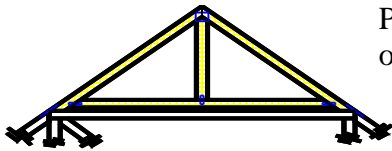
Piggyback or Capped
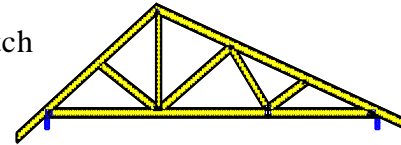
Dual Pitch
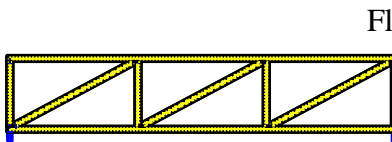
Flat or Box
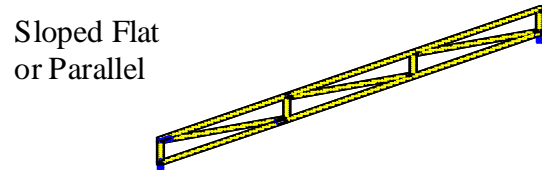
Sloped Flat or Parallel
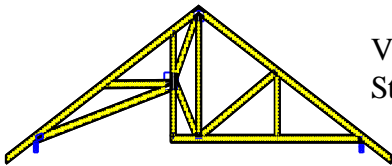
Vault or Studio
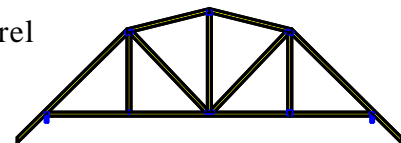
Gambrel
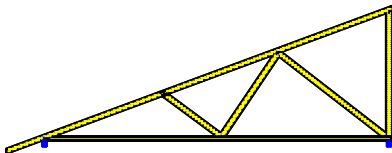
Mono
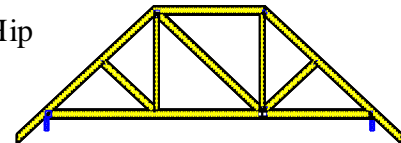
Hip
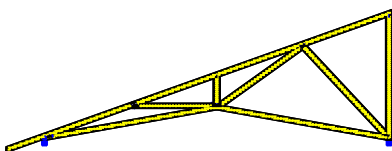
Mono Scissor

Hip Mono
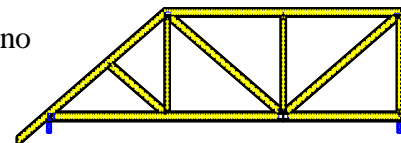
Web Patterns

The name for each truss below is used for describing the web patterns. They are also can be described by how many panels each one has.

I love naming web types!

Truss Geek

2   **3**

1   **4**

1   **2**   **3**
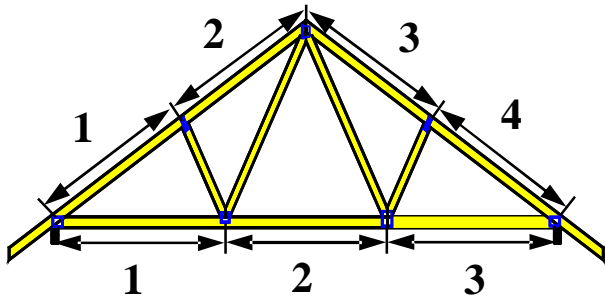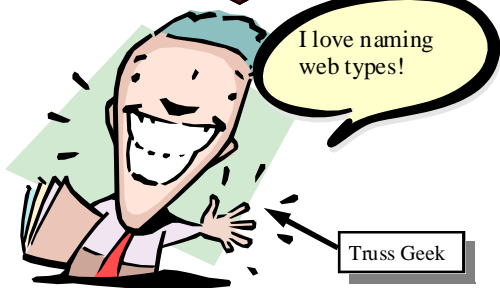
Fink *or*
4 over 3 Panel Truss
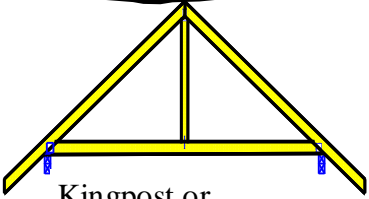
Kingpost or
2 over 2 Panel
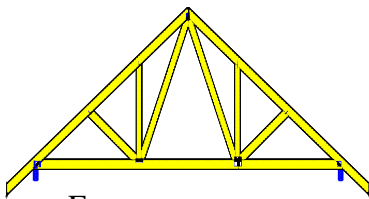
Fan or
6 over 3 Panel
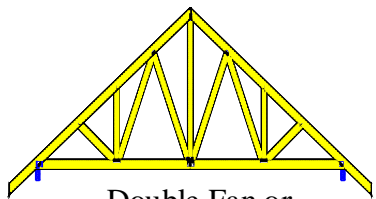
Double Fan or
8 over 4 Panel
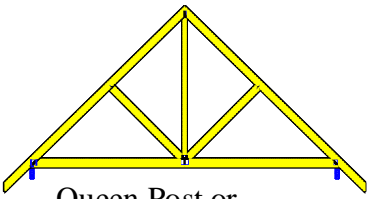
Queen Post or
4 over 2 Panel
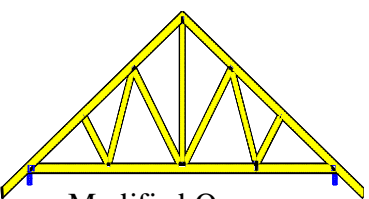
Modified Queen
or 6 over 4 Panel
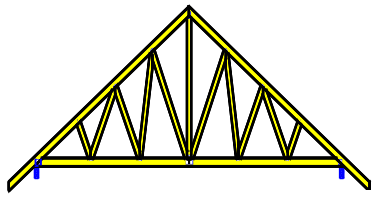
Double Modified Queen
or 8 over 6 Panel
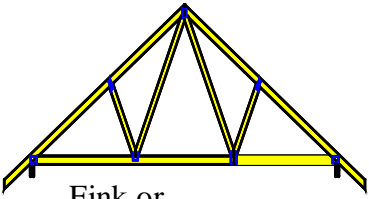
Fink or
4 over 3 Panel
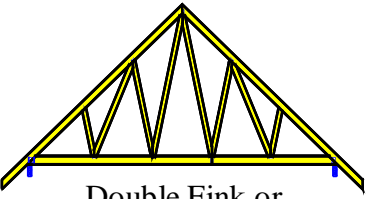
Double Fink or
6 over 5 Panel
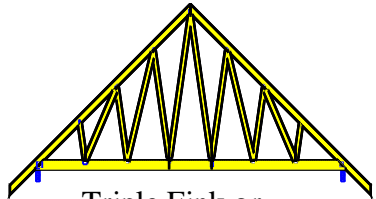
Triple Fink or
8 over 7 Panel
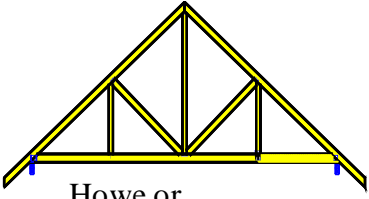
Howe or
4 over 4 Panel
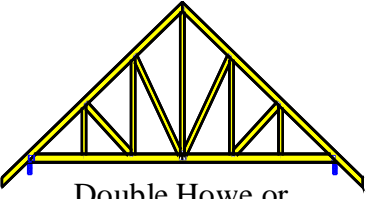
Double Howe or
6 over 6 Panel
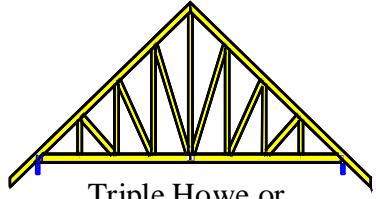
Triple Howe or
8 over 8 Panel

Roof Styles

The style or type of roof comes mostly in four basic forms. The four basic types are Gable, Hip, French and Tudor. (See Figure 1-2) A house might have a combination of a few or all the styles.

Gable	Hip
French or Dutch	**Tudor or Clipped**

Fig. 1-2
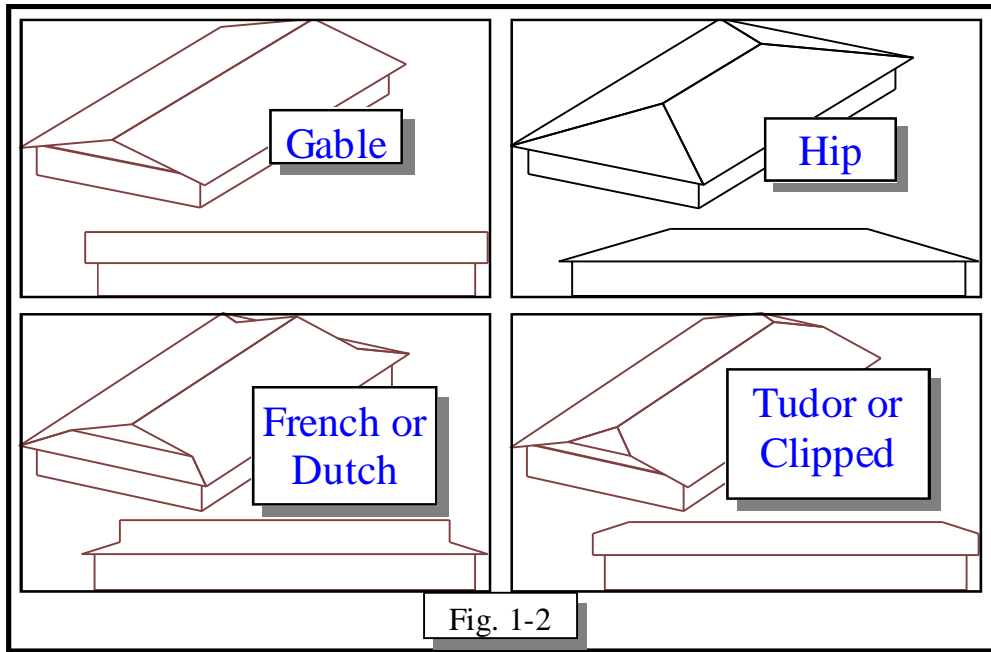
Some other styles are Flat, Gambrel, Polynesian and SaltBox. These styles are not as common as the ones displayed in figure 1-2, but you need to know each of them.

Flat	Gambrel
Polynesian	**Saltbox**

Fig. 1-3
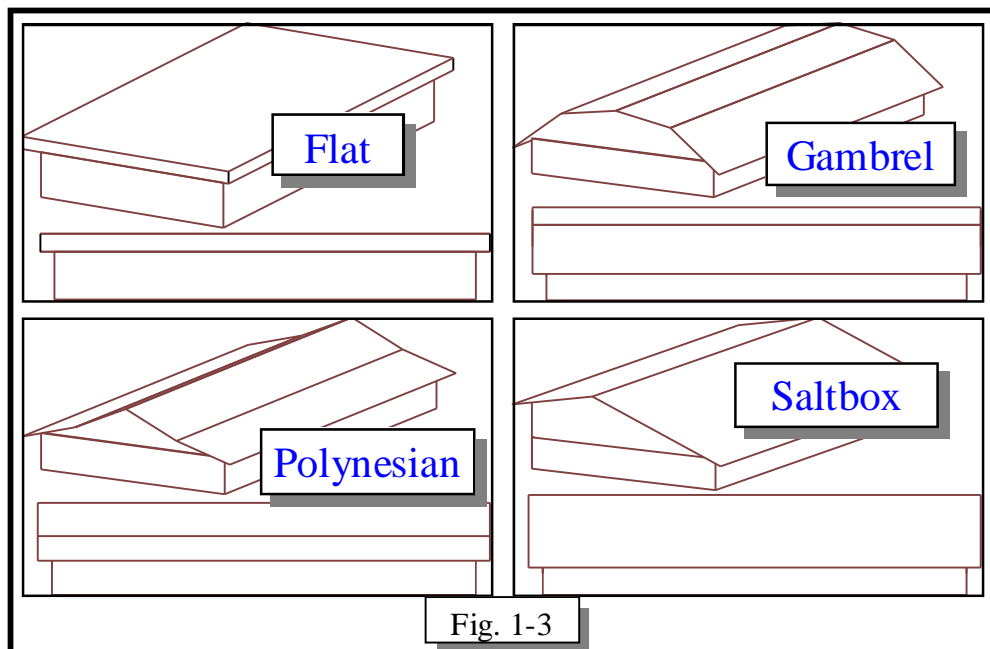
Truss Layout

Figure 1-1 below is called a Layout Print. A layout shows the truss positions on the framing. A layout print is always displayed from a top down view. Each layout, from different designers, may differ in how each truss is called out or displayed, but they all show essentially the same things. Each one shows the truss labels and positioning of each truss on the framing. As buildings have become more complicated, layout prints have become a necessity for the framer and the truss designer. The sole function is to illustrate the position
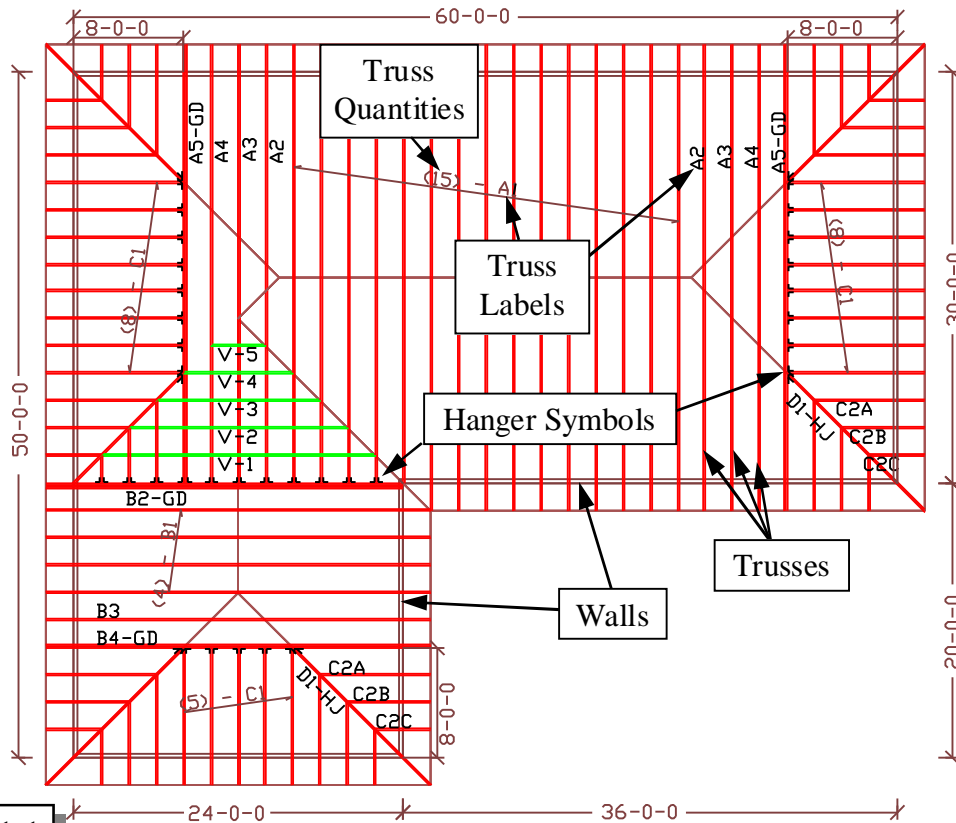
Fig 1-1
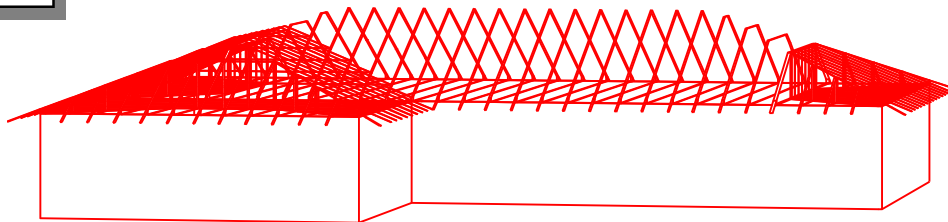
Fig 1-2

of each truss in the roof system. As the roofs become more complicated (having multiple rooflines) the quantity of differing trusses increases. With increasing truss designs quantities on a single framing, the more it becomes a complex puzzle. The framer then has to figure a way to put this puzzle together, which only a layout print can best show where each part of the puzzle goes.

Figure 1-2 is a 3-dimensional display of the same building as figure 1-1. The 3-D

drawing is displayed for greater visual understanding of figure 1-1 only. Some truss designers add these 3-D drawings to their layouts for the same reason.

Truss Type by Function

Fig 1-3

End-Jacks or Monos

Corner-Jacks

Hip-Jack

Valley Set

Girder

Hip Set
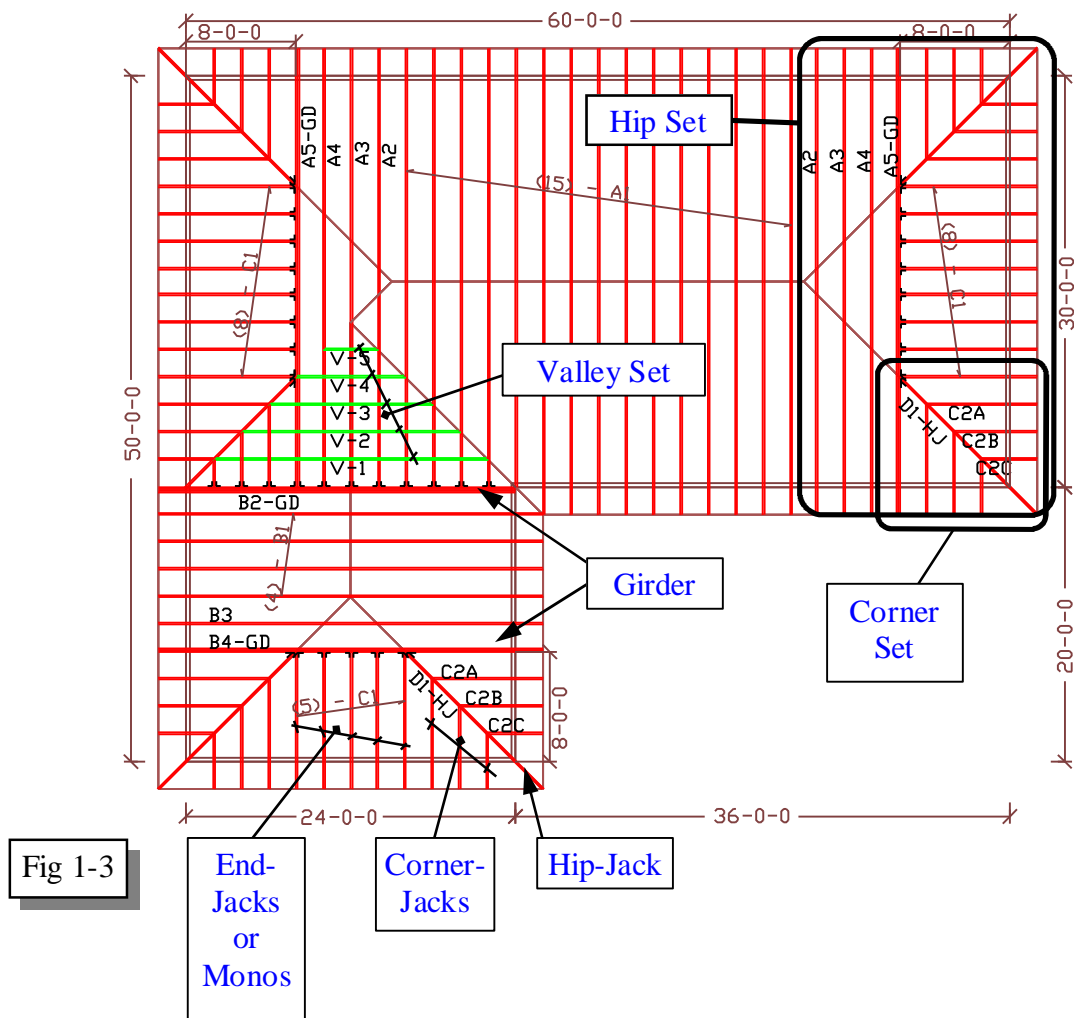
Corner Set

The placement and function can describe trusses in the roof system. The following is a list of examples; look at figure 1-3 for a reference.

- **Corner-Jack** is a small mono truss that ties into a Hip-Jack. It helps to create the corner of a hip.
- **Corner Set** is the entire corner truss set that forms a corner of a hip roof.
- **End-Jack** or **Mono** is a truss that ties into the hip girder to form the end roof of a hip roof.
- **Girder** truss is any truss that carries other trusses or other special loading, such as

upper wall or floor.
- **Hip-Jack** is the mono girder that is angled to the hip girder truss and carries the corner-jack trusses.
- **Hip-Set** is the entire truss system that forms the end wall sloped roof. There are many different types of hip-sets.
- **Valley –Set** are the small trusses forming the valley roof. They sit on top of trusses (and plywood) perpendicular to them.

Roof Line Description

Hip Ridge Line

Ridge Line

Valley Lines

Eave or Overhang

Soffit Line

Ridge Line

Hip Ridge Line

Valley Lines

Eave or Overhang

Soffit Line
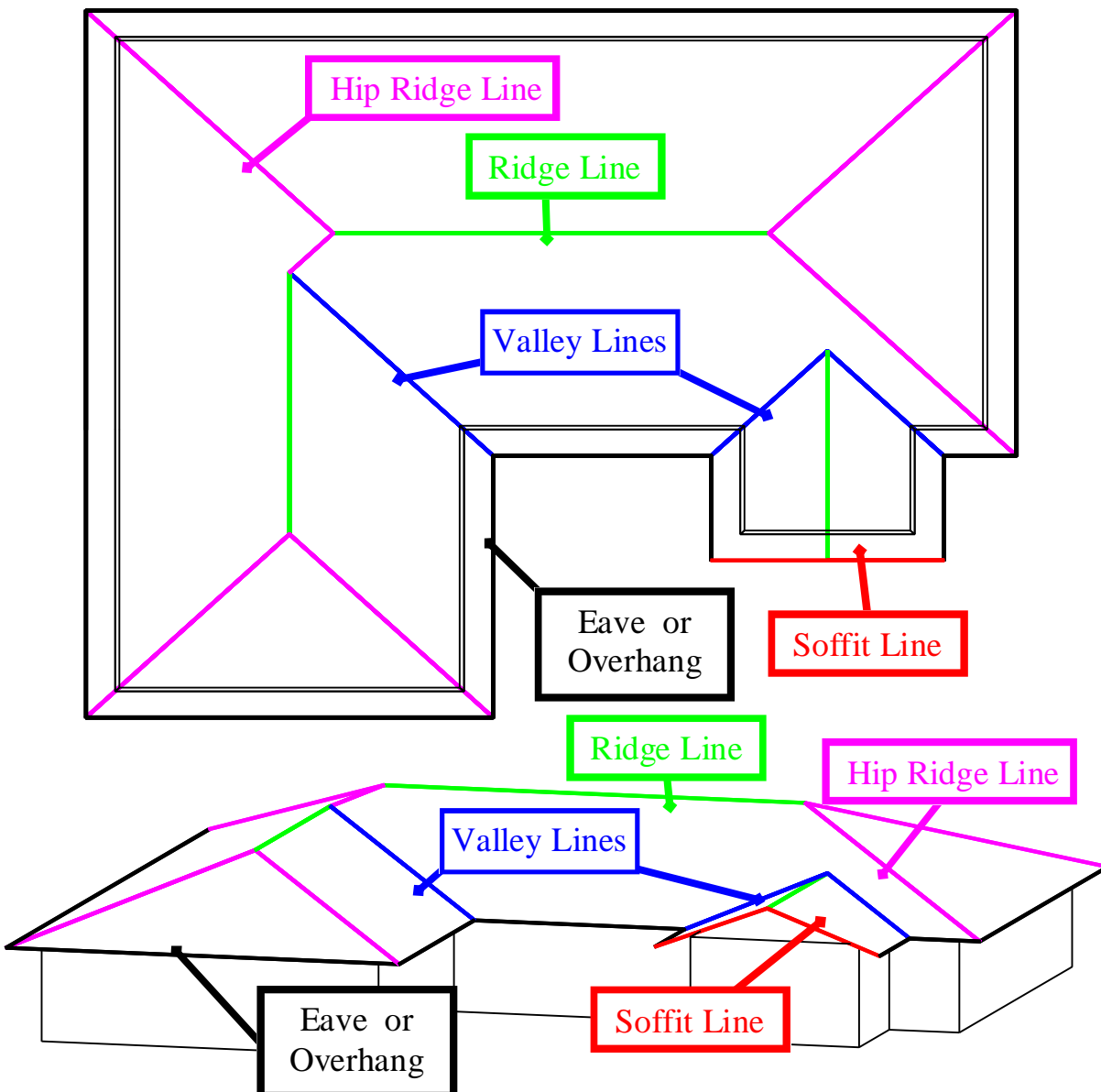
Origin of a Specification

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The U.S. Standard railroad gauge (distance between rails) is 4 feet, 8.5 inches. That's a very unusual number. Why is that gauge used? Because that's the way they built them in England, and English expatriates built the U.S. railroads. Why did the English people build them like that? Because the first rail lines were built by the same people who built the pre-railroad tramways, and that's the gauge they used.

Code for United States Railroad Guage

The required gauge for all standard railroad in the United States shall be 4 feet, 8 ½ inches..

Why did "they" use that gauge then? Because the people who built the tramways used the same jigs and tools that they used for building wagons, which used that wheel spacing. Okay! Why did the wagons use odd wheel spacing? Well, if they tried to use any other spacing the wagon would break on some of the old, long distance roads, because that's the spacing of the old wheel ruts.

So who built these old rutted roads? Imperial Rome, for the benefit of their legions, built the first long distance roads in Europe. The roads have been used ever since. And the ruts? The Roman chariots first made the initial ruts, which everyone else had to match for fear of destroying their wagons. Since the chariots were made for or by Imperial Rome they were all alike in the mater of the wheel spacing.

Thus we have the answer to the original question. The United States standard railroad gauge of 4 feet, 8.5 inches derives from the original specifications for an Imperial Roman war chariot.

Specifications and Bureaucracies live forever. So, the next time you are handed a specification and wonder what horse's___ came up with it, you may be exactly right. Because the Imperial Roman chariots were made to be just wide enough to accommodate the back-ends of two war horses.

(Visit Woodwords web site at www.woodwords.com)
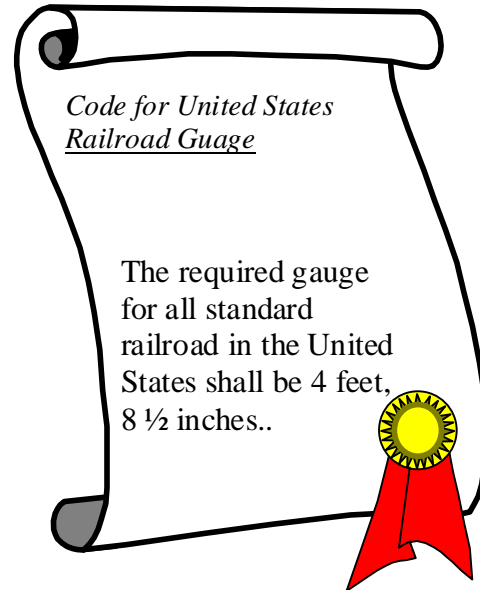
Chapter 2
Math for Truss Designing

Level :
Basic to Intermediate
Group:
Everyone

This chapter will explain the math needed to solve most basic design problems. After completing this chapter, you should be able to solve for the rise, run, diagonal and the pitch of a triangle. The math I will describe in this chapter is only for finding the proper truss design, not the loading. Loads and forces will be covered in chapter 4. Whether a roof is made of one type of truss or multiple different trusses, you will always have to make sure the profile of the truss is what the customer wants and needs.

The math used in creating the proper profile of a truss is used through out the designing of a truss job. An example would be finding the elevation difference between two wall heights and than convert that to a pitch is the same as finding the pitch for a top or bottom chord of a truss. The most important shape to understand and solve for is a triangle. But, lets go over some basic rules first.

You need to be able to use a calculator, which is essential for truss designing. I will explain how to use 3 different types of calculators.

1) Construction Master by Calculated Industries Incorporated

   Website is www.caculated.com
   E-mail is techsup@calculated.com

2) Jobber by Jobber Instruments

   Website is www.jobbercalculator.com
   E-mail is jobber@jobbercalculator.com

3) Scientific Calculator in Microsoft Windows Accessories Group

Note: Each of these calculators is a register trademark of the respective companies.

Want to save a great deal of time and money?

Buy a Construction Master or a Jobber!

You will save time by not having to key in as many keystrokes. You will also make fewer mistakes, which are *very costly* after the trusses have been made and shipped.

The units of measurements used in this book are called imperial numbers. The lengths will be called out in Feet, Inches, and Fractions of an inch.

1 Foot = 12 Inches

1 Inch = 16 Sixteenths

The following symbols are commonly used to describe units of measurements.

_' Describes Feet, so 6' = 6 Feet

_" Describes Inches, so 6" = 6 Inches

_/_ Describes Fraction, so 1/16" = 1 of 16th of an Inch

12' 4 3/8" = 12 Feet, 4 Inches, 3 of 8th an Inch

Lumber is described by thickness than height than length. An example would be 2"x

> ### Rules of Thumb
> Truss engineering programs describe distance with 3 numbers spaced with a dash for feet – inches – sixteenths.
> (Example is 16 – 4 – 9 would be 16 feet, 4 inches, 9 sixteenths)

4"x16', which is a 2 inch by 4 inch by 16 foot nominal lumber piece. All dimensional lumber is rounded up to the nearest inch for thickness and height. The true dimensional sizes are as follows…

2"x 4" = 1 ½" by 3 ½"

2" x 6" = 1 ½" by 5 ½"

2" x 8" = 1 ½" by 7 ¼"

2" x 10" = 1 ½" by 9 ¼"

2" x 12" = 1 ½" by 11 ¼"

Of course the exception is for rough sawn lumber, which would be the size called out. That kind of lumber is not used in convention wood trusses. A truss using rough sawn lumber is normally called a "Timber Truss."

Board Foot Measurement

Lumber is bought and sold in what are called board feet. As you know a stick of lumber comes in many sizes. A board foot is the (Width * Height) ÷ 12. So, each size of lumber has different board footage for a given 12" of length. The width and the height are the nominal measurements that are called out. An example would be a 2x4 uses 2 times 4 instead of 1 ½" times 3 ½" which is the actual measurements.

Size	Board Foot
2" x 4"	(2*4) ÷ 12 = **.667 Board Foot**
2" x 6"	(2*6) ÷ 12 = **1 Board Foot**
2" x 8"	(2*8) ÷ 12 = **1.333 Board Foot**
2" x 10"	(2*10) ÷ 12 = **1.667 Board Foot**
2" x 12"	(2*12) ÷ 12 = **2 Board Foot**

A unit of 2"x 6"x 12' that has 196 pieces would have 2,352 board feet. To figure the board feet ….

Board Foot x Length x Quantity of Pieces = Total Board Footage of Unit
(2 * 6) ÷ 12 = 1 Board Foot for a 2"x 6"
1 * 12 "Length" * 196 "Qty" = 2,352 Board Feet

A unit of lumber would be priced in per thousand board feet. Lets say that the price of a certain species of 2"x 6"x 12' is $500 per thousand board feet and it had 2,352 board feet in the unit. What would the unit cost you to purchase?
500 ÷ 1000 = $0.50 per 1 board foot
.5 * 2,352 = $1,176 for the unit

There is a big difference between the inputting lengths in the scientific calculator verses the other types.

- Ø The scientific calculator must always be converted to a common number unit. This means the feet with a decimal for inches and fraction or the feet converted to inches with a decimal for the fractions.

- Ø The Construction Master and the Jobber have dimensional input keys. You do not have to convert dimensions to a common number unit. The calculator does the needed unit adjustments internally so the operator does not have to concern himself with this.

Scientific Calculator Dimension Inputting

When a dimension is inputted in a scientific calculator it must be keyed in as a common number. In other words, the unit of measurement must stay constant through the whole process of a calculation.

An example would be if you needed to add a 16 foot dimension to 6 inches. You will get 22 for an answer when you add 16 to 6 (16 + 6 = 22). Would it be 22 feet or 22 inches, or is either correct? What you need do, is to convert the 16 feet to 192 inches than add 6 inches, this would equal 198 inches (192" + 6" = 198"). The 6 inches could also have been converted to .5 feet, than add 16, than this would equal 16.5 feet (.5' + 16' = 16.5'). When you convert 198 inches to feet, you find that it equals 16 feet 6 inches (16.5' = 198").

A fraction is a unit of an inch. The smallest fraction of an inch you will need to use will be a sixtieth. It is most common to change a fraction into a decimal number of an inch. To convert a fraction to a decimal of an inch, divide the numerator by the denominator. An example would be 5/8" = 5 ÷ 8 = .625 of an inch. If you wanted to convert the 5/8" into a decimal of feet, you would divide the numerator by the denominator than divide the answer by 12. An example would be 5/8" = (5 ÷ 8) ÷ 12 = .052083 of a foot.

There are 12 inches in every foot. To convert feet to inches, multiply the number of feet by 12. An example would be 12' = 12 x 12 = 144". To convert inches to feet you would divide the inches by 12. An example would be 144" = 12 ÷ 12 = 12'

Now lets take everything I just explained and put it into an example.
Add 12' 6 ½" to 15' 9 ¾"…

$$12' \ 6 ½" = (12 \ x \ 12 = 144) + (6 + ((1 ÷ 2 = .5)) = 150.5"$$
$$15' \ 9 ¾" = (15 \ x \ 12 = 180) + (6 + ((3 ÷ 4 = .75)) = 189.75"$$
$$150.5" + 189.75" = 340.25"$$

Than convert your answer to Feet – Inches - Fraction
Break down the answer of 340.25" into three parts.
- a) First convert 340" to feet

$$340" \div 12 = 28.3333'$$

   b) Convert .3333' to inches

       .3333' x 12 = <u>4</u>" (rounding of 3.9996 to 4)

   c) Convert .25", of the 340.<u>25</u>" to inches

       .25" x 16 = 4 sixtieths or <u>¼</u>"

<u>So the answer is 28' 4 ¼"</u>

At this point you are thinking, "What a pain in neck this conversion stuff is!" Well take hart, because there are short cuts you can use.

  Ø Conversion charts

  Ø Knowing the decimal equivalent without figuring the answer by hand

After doing this for a while you will know .25" is equal to ¼". But no matter if you are using conversion charts or figuring the conversion in your head, you are performing steps that are required to calculate the proper answer.
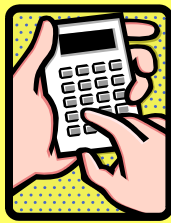
> ### *<u>Scientific Calculator</u>*
> ### *<u>Standardization of units will be converted to inches</u>*
> *All measurements, for the scientific calculator, will be converted to inches with a decimal for the fractions. The following charts can be used to create shortcuts. This will only apply to the scientific calculator columns.*

Conversion Chart for <u>Fractions</u> to <u>Decimal</u>			
1" = 1	3/4" = .75	1/2" = .5	1/4" = .25
15/16" = .9375	11/16" = .6875	7/16" = .4375	3/16" = .1875
7/8" = .875	5/8" = .625	3/8" = .375	1/8" = .125
13/16" = .8125	9/16" = .5625	5/16" = .3125	1/16" = .0625

Conversion Chart for <u>Feet</u> to <u>Inches</u>			
1' = 12"	5' = 60"	9' = 108"	13' = 156"
2' = 24"	6' = 72"	10' = 120"	14' = 168"
3' = 36"	7' = 84"	11' = 132"	15' = 180"
4' = 48"	8' = 96"	12' = 144"	16' = 192"

All dimensions can be inputted as they are described. In other words, there is not a need to convert to common numbers. You can input feet, inches and fractions using the feet, inches and fraction input keys. All keys that perform a function will be displayed in parentheses. An example would be the "Feet" key would be displayed as (feet). To input a dimension such as 9' 6 ½", you would key in..

> 9 (feet), 6 (inches), 1 (/) 2 or you could key in..

> 9 (feet), 6.5 (inches)

Note that the fraction key is a (/) key and does not denote a dividing function.

All the key functions are described wonderfully in the booklet that comes with the Construction Master calculator. You should review it so you will better understand all the functions that can be performed. Reviewing the booklet on your own will give you understanding of the model which you are using. Each model has differing functions added to the latest calculators. The individual functions do remain constant among the varying models, so I will be able to explain how to use the needed inputs in the following pages.

Finding the Triangle in Every Truss

Let me begin by reminding you that, "there is more than one way to skin a cat". Just like skinning cats, you can solve mathematical problems in different ways and still get the same result. People tend to solve problems the way they were taught. So to make my point as clear as possible, do not get upset if I tackle a problem differently than what someone else has done. We both can be "right". I will try to show different ways to solve the same problem, but you must decide what is right for you.

If you do not know how to add, subtract, multiple or divide you are in the wrong profession. If you have mastered those basic math skills then you are not far from be able to solve most truss problems.

To solve for the profile (shape or perimeter) of a truss, requires the understanding of solving the equation for a triangle. There are a few steps that should be followed.

1) Look for the triangle in the problem

2) Recognize and look for the multiple triangles that may be present

3) Define the known segments of the triangle equation

4) Solve for the missing segment of the triangle

Were are they?
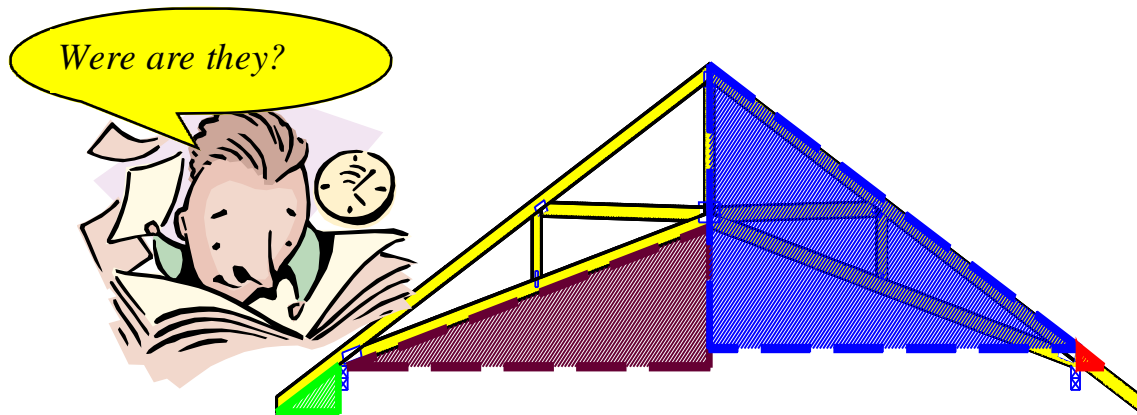
Please do not get a panic attack right now. This is a lot easier than you may think. At first you may need to draw out the cross section of the truss or roof to get an understanding of what to look for. After a few times of solving the same type of problem it will become second nature to you. The trusses all very in shapes and sizes, but the math is still the same. All it takes is a little common sense to think the problem through.

The Construction Master and the Jobber have input keys that that form the trigonometry calculations for you. You do not have to think in terms such as sine, cosine, and tangent for the angles. The perimeter of a right triangle is described as run, rise, and diagonal. Think of a right triangle as displayed in figure 2-1.

Fig. 2-1
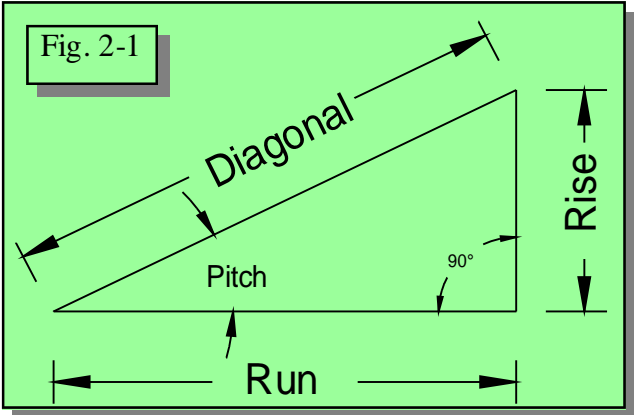
The scientific calculator views the right triangle in trigonometry terms only. This should be a blast to your past, in high school, when your teacher took a couple of weeks to cover this terminology. Figure 2-2 shows the angles in upper case letters and the chord segments in lower case letters. The charts below figure 2-2 are a listing of the trigonometry solutions to find each part of the right triangle given known angle or segment lengths.

Fig. 2-2
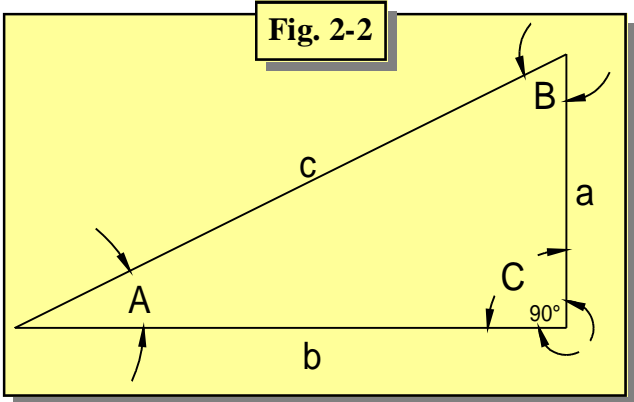
Find	Given	Solution
A	a,b	$\tan A = a \div b$
	a,c	$\sin A = a \div c$
	b,c	$\cos A = b \div c$
B	a,b	$\tan B = b \div a$
	a,c	$\cos B = a \div c$
	b,c	$\sin B = b \div c$

Find	Given	Solution
a	A,b	$b \tan A$
	A,c	$c \sin A$
b	A,a	$a \div \tan A$
	A,c	$c \cos A$
c	A,a	$a \div \sin A$
	A,b	$b \div \cos A$
c^2	a,b	$a^2 + b^2$
b^2	c,a	$c^2 - a^2$
a^2	c,b	$c^2 - b^2$

We will only be dealing with right triangles. This means that two of the segments of the triangle are at a 90-degree angle from each other. (See figure 2-3) This makes life a whole lot easier by creating the same known segments at a 90-degree you have known equations to solve for missing information.

If you are given any 2 parts of a right triangle, excluding the right angle, you can solve for the other 2 missing parts. When describing the individual parts of a triangle the most common terminology a truss designer will use is shown in figure 2-3.

1) Diagonal

2) Rise

3) Run

4) Pitch

5) Right angle or 90-degree (Always a given)

Fig. 2-3

Diagonal

Pitch

Run

Rise

90°
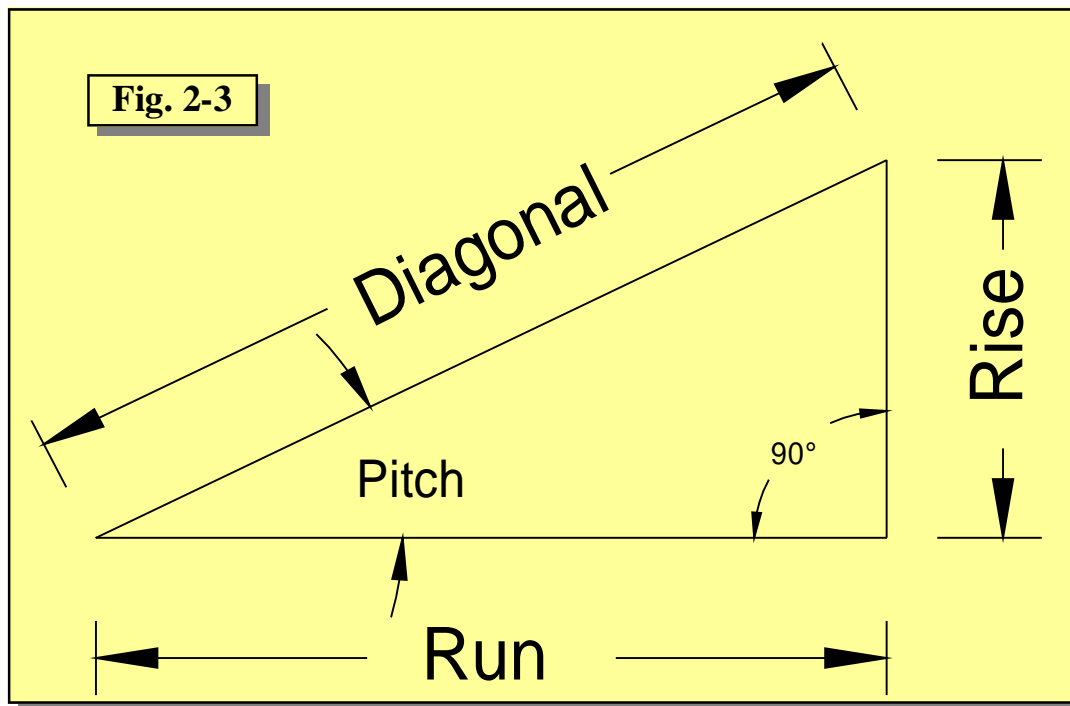
If you input the known segments of the right triangle, the Construction Master or the Jobber will solve for the missing segments for you. You will not have to remember any particular formula to solve for the missing segment. It is as easy as keying in the know segments than hitting the key for the unknown piece. So, save yourself a lot of headache and purchase a Construction Master or a Jobber calculator.

Covert Pitch or Angle

The pitch of a roof is the distance of rise (vertical measurement) for every 12" of run (horizontal measurement). The pitch can be converted to an angle (A) or an angle can be converted to a pitch.
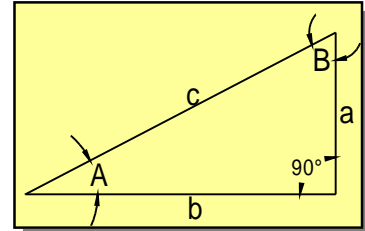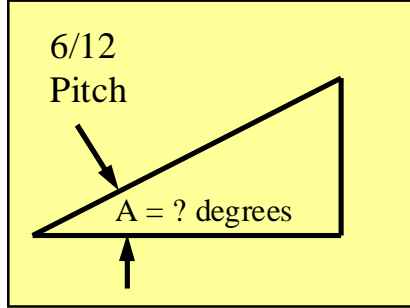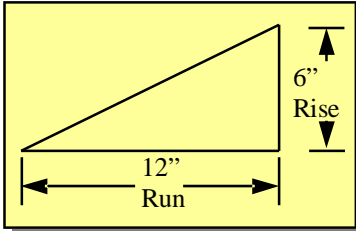
6/12 Pitch

A = ? degrees

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
6 (Inch) (Pitch) *(Input Run)*	Pitch 6 Inch	(FIS) Mode 6, 0 (Pitch)	6" 0/16	6 ÷ 12 = *(pitch to decimal)*	.5
(Pitch) *(Press Pitch key again)*	Pitch 26.57 degree	(Deg)	26.56505	.5 Inv Tan = *(Inverse Tangent of decimal = A)*	26.56505
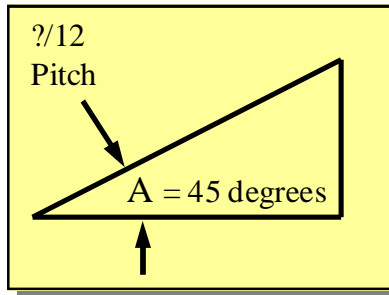
?/12 Pitch

A = 45 degrees

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
45 (Pitch) *(Input Pitch w/o Inch key)*	Pitch 45 degree	(DEC) Mode .45 (DEC)	45	45 Tan = *(Tangent of A)*	1
(Pitch) *(Press Pitch key again)*	Pitch 12 Inch	(Pitch)	1	1 * 12 = *(Tan A * 12 = Pitch)*	12

The pitch of a roof is the distance of rise (vertical measurement) for every 12" of run (horizontal measurement). In the example below the run (b) and the rise (a) are given to solve for the pitch (A).
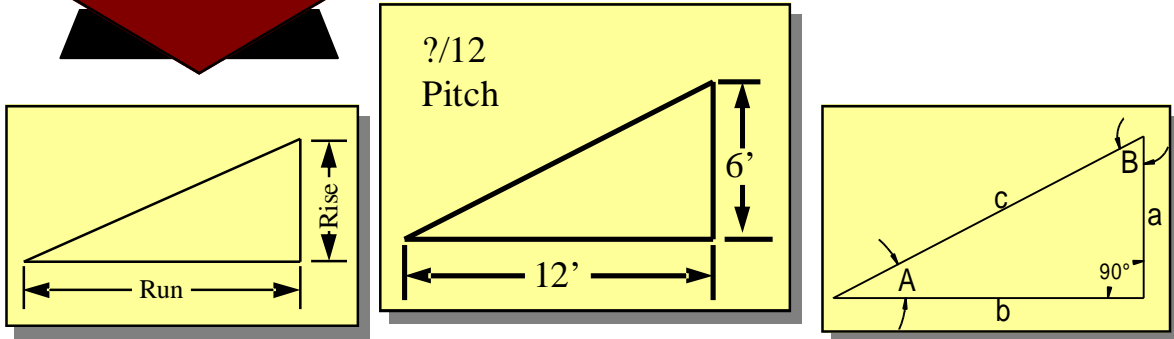
?/12 Pitch

6'

12'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
12 (Feet) (Run) *(Input Run)*	Run 12 Feet	(FIS) Mode 1,2,0,0 (Run)	1:0 0/16	12 * 12 = *(b to inches)*	144
6 (Feet) (Rise) *(Input Rise)*	Rise 6 Feet	6,0,0 (RIS)	6: 0 0/16	6 * 12 = *(a to inches)*	72
(Pitch) *(Find Pitch)*	Pitch 6 Inch	(Pitch)	6 0/16	72 ÷ 144 = *(a ÷ b = A)*	.5
				.5 * 12 = (A to Feet)	6
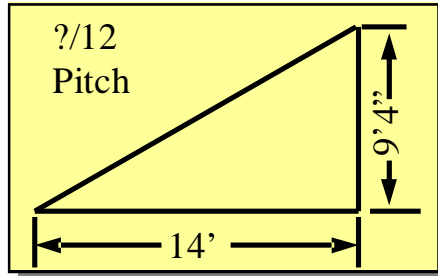
?/12 Pitch

9' 4"

14'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
14' Run	Run 14'	1,4,0,0 (Run)	14: 0 :0	14 * 12 =	168
9'4" Rise	Rise 9'4"	9,4,0 (RIS)	9: 0 0/16	9 * 12 = 108 108 + 4 =	112
Pitch	Pitch 8"	(Pitch)	8 0/16	112 ÷ 168 =	.666667
				.666667 * 12 =	8

Pitch
(Diagonal + Run)

The pitch of a roof is the distance of rise (vertical measurement) for every 12" of run (horizontal measurement). In the example below the run (b) and the diagonal (c) are given to solve for the pitch (A).
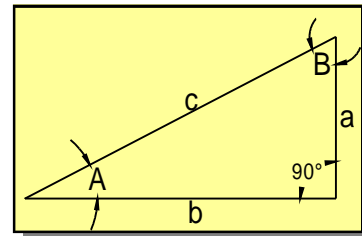
Diagonal / Run

?/12 Pitch
14' 1 11/16"
10'

?/12 Pitch

c, B, a, 90°, A, b

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10 (Feet) (Run) *(Input Run)*	Run 10 Feet	(FIS) Mode 1,0,0,0 (Run)	10: 0 0/16	10 * 12 = *(b to inches)*	120
14 (Feet) 1 (Inch) 11 (/) 16 (Diag) *(Input Diagonal)*	Diag 14 Feet 1 Inch 11/16	1,4,1,11 (SLP)	14: 1 11/16	((14 * 12) + 1)) + (11 ÷ 16)= *(c to inches)*	169.6875
(Pitch) *(Find Pitch)*	Pitch 12" Inch	(Pitch)	1: 0 0/16	(120 ÷ 169.6875) Inv Cos= *(b ÷ c) than Inverse cosine = A in degrees*	44.99387
				(44.99387 Tan) * 12 = *(A Tan)* 12= pitch*	12
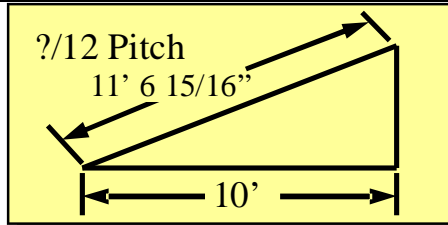
?/12 Pitch
11' 6 15/16"
10'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10' Run	Run 10'	1,0,0,0 (Run)	10: 0 0/16	10 * 12 =	120
11'6 15/16" Diag	Diag 11'6 5/16"	1,1,6,15 (SLP)	11: 6 15/16	((11 * 12) + 6)) + (15 ÷ 16)=	138.9375
Pitch	Pitch 7	(Pitch)	7 0/16	120 ÷ 138.9375 Inv Cos =	30.26566
				30.26566 Tan * 12 =	7

The pitch of a roof is the distance of rise (vertical measurement) for every 12" of run (horizontal measurement). In the example below the rise (a) and the diagonal (c) are given to solve for the pitch (A).
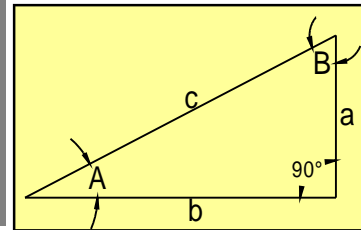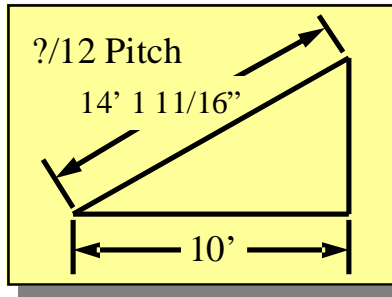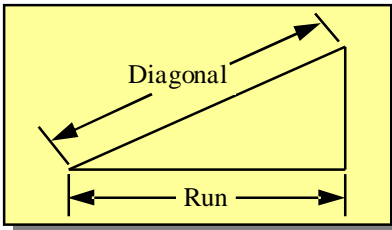
?/12 Pitch
18' 0 5/16"
10'

?/12 Pitch
15' 2 4/16"
10'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10 (Feet) (Rise) *(Input Rise)*	Rise 10 Feet	(FIS) Mode 1,0,0,0 (RIS)	10: 0 0/16	10 * 12 = *(a to inches)*	120
18 (Feet) 5 (/) 16 (Diag) *(Input Diagonal)*	Diag 18 Feet 11/16	1,8,0,5 (SLP)	18: 0 5/16	(18 * 12) + (5 ÷ 16)= *(c to inches)*	216.3125
(Pitch) *(Find Pitch)*	Pitch 8" Inch	(Pitch)	8 0/16	(120 ÷ 216.3125) Inv Sin= *(a ÷ c) than Inverse Sine = A in degrees*	33.6937
				(33.6937 Tan) * 12 = *(A Tan)* 12= pitch*	8
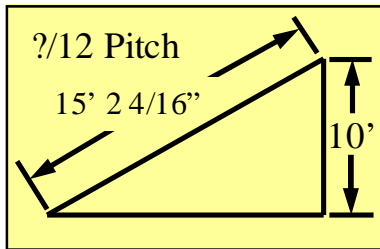
Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10' Run	Run 10'	1,0,0,0 (RIS)	10: 0 0/16	10 * 12 =	120
15' 2 4/16" Diag	Diag 15' 2 4/16"	1,5,2,4	15: 2 4/16	((15 * 12) + 2)) + (4 ÷ 16)=	182.2311
Pitch	Pitch 10.5"	(Pitch)	10 1/2	120 ÷ 182.2311 Inv Sin =	41.18592
				41.18592 Tan * 12 =	10.5

Rise
(Pitch & Run)

The height of a triangle can be solved using the angle and the horizontal distance. The angle is referred to as the pitch (A) and the horizontal distance is the run (b) which are a given in the examples.

6/12 Pitch — Run

6/12 Pitch — 12' — ?'

B, a, 90°, A, b, c

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
12 (Feet) (Run) *(Input Run)*	Run 12 Feet	(FIS) Mode 1,2,0,0 (Run)	12: 0 0/16	12 * 12 = *(b to inches)*	144
6 (Inch) (Pitch) *(Input Pitch)*	Pitch 6 Inch	6, 0 (Pitch)	6 0/16	6 ÷ 12 = *(Pitch ÷ 12) = A as a decimal of a foot*	.5
(Rise) *(Find Rise)*	Rise 6 Feet	(RIS)	6: 0 0/16	144 * .5 = *(b * A) = Rise in inches*	72
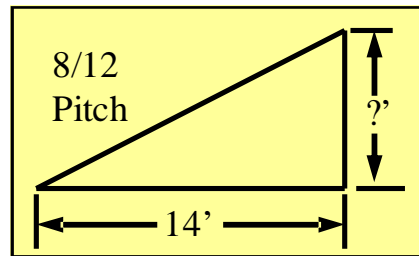
8/12 Pitch — ?' — 14'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
14' Run	Run 14'	1,4,0,0 (Run)	14: 0 0/16	14 * 12 =	168
8" Pitch	Pitch 8"	8, 0 (Pitch)	8 0/16	8 ÷ 12 =	.66667
Rise	Rise 9' 4"	(RIS)	9: 4 0/16	168 * .66667 =	112

Rise
(Diagonal & Run)

The height of a triangle can be solved using the diagonal and the horizontal distance. The diagonal (c) is the length of the slope and the horizontal distance is the run (b) which are a given in the examples.

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
12 (Feet) (Run) *(Input Run)*	Run 12 Feet	(FIS) Mode 1,2,0,0 (Run)	12: 0 0/16	12 * 12 = *(b to inches)*	144
16 (Feet) 11 (Inch) 10 (/) 16 (Diag) *(Input Diagonal)*	Diag 16 Feet 11 Inch 10/16	1,6,11,10 (SLP)	16: 11 10/16	((16 * 12) + 11) + (10 ÷ 16) = *(c to inches)*	203.625
(Rise) *(Find Rise)*	Rise 12 Feet	(RIS)	12: 0 0/16	(203.625^2) - (144^2) = *(c^2 - b^2 = square root of a)*	143.9692 = 144
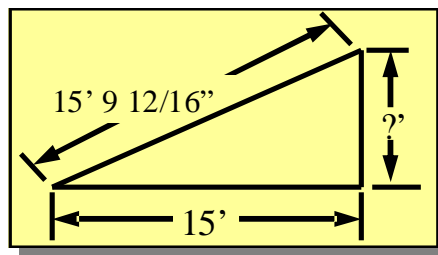
Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
15' Run	Run 15'	1,5,0,0 (Run)	15: 0 0/16	15 * 12 =	180
15' 9 3/4" Diagonal	Diag 15' 9 3/4"	1,5,9,12 (SLP)	15 9 12/16	((15 * 12) + 9) + (12 ÷ 16) =	189.75
Rise	Rise 5' 0" 1/16	(RIS)	5: 0 1/16	(189.75^2) - (180^2) = sqrt	60.0421 = 60

Rise
(Pitch & Diagonal)

The height of a triangle can be solved using the diagonal and the pitch. The diagonal (c) is the length of the slope and the pitch (A) is the angle given in inches for each 12 inches of run are a given in the examples.

3/12 Pitch
12' 4 7/16"
?'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
12 (Feet) 4 (Inch) 7 (/) 16 (Diag) *(Input Diagonal)*	Diag 12 Feet 4 Inch 7/16	(FIS) Mode 1,2,4,7 (SLP)	12: 4 7/16	((12 * 12) + 4) + (7 ÷ 16) = *(c to inches)*	148.4375
3 (Inch) (Pitch) *(Input Pitch)*	Pitch 3 Inch	3,0 (Pitch)	3 0/16	(3 ÷ 12) Inv Tan, Sin = *(Pitch ÷ 12) Inverse Tangent, Sin =*	.242536
(Rise) *(Find Rise)*	Rise 3 Feet	(RIS)	3: 0 0/16	148.4375 * .242536 = *(c * sin A = a in inches)*	36.00138 = 36
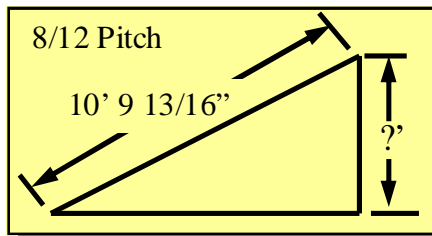
8/12 Pitch
10' 9 13/16"
?'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10' 9 13/16" Diag	Diag 10' 9 13/16"	1,0,9,13 (SLP)	10: 9 13/16	((10 * 12) + 9) + (13 ÷ 16) =	129.8125
8" Pitch *(Input Pitch)*	Pitch 8"	8,0 (Pitch)	8 0/16	(8 ÷ 12) Inv Tan, Sin =	.5547
Rise *(Find Rise)*	Rise 6'	(RIS)	6: 0 0/16	129.8125 * .5547 =	72.00702 = 72

Run
(Pitch & Rise)

The length of a triangle can be solved using the rise and the pitch. The rise (a) is the height and the pitch (A) is the angle given in inches for each 12 inches of run are a given in the examples.

5/12
Pitch

5/12
Pitch

6'

?

B
c
a
A
90°
b
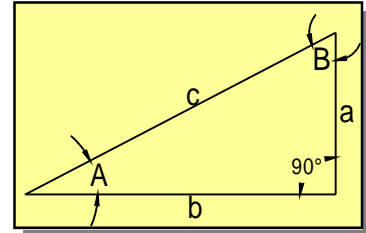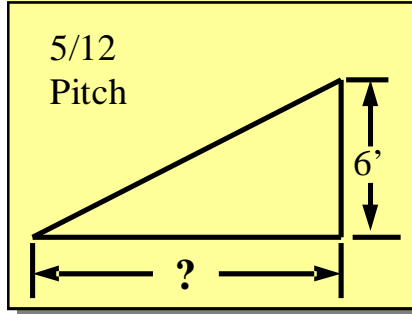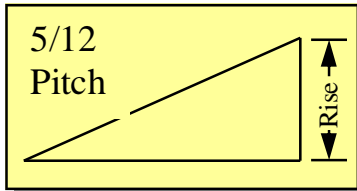
Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
16 (Feet) (Rise) *(Input Rise)*	Rise 6 Feet	(FIS) Mode 6,0,0 (RIS)	6: 0 0/16	6 * 12 = *(a to inches)*	72
5 (Inch) (Pitch) *(Input Pitch)*	Pitch 5 inch	5,0 (Pitch)	5 0/16	5 ÷ 12 = *(Pitch ÷ 12) = Tangent*	.416667
(Run) *(Find Run)*	Run 14 Feet 4 Inch 13/16	(Run)	14: 4 13/16	72 ÷ .416667 = *(a ÷ tan A = b)*	172.7999
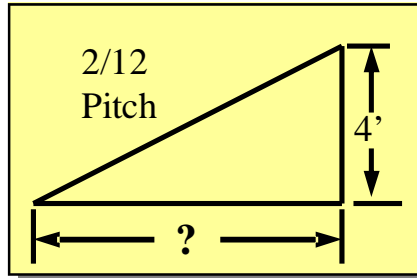
2/12
Pitch

4'

?

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
4' Rise	Rise 4'	4,0,0	4: 0 0/16	4 * 12 =	48
2" Pitch	Pitch 2"	2,0 (Pitch)	2 0/16	2 ÷ 12 =	.166667
Run	Run 24'	(Run)	24: 0 0/16	48 ÷ .166667 =	287.9994 = 288

Run
(Diagonal & Rise)

The length of a triangle can be solved using the rise and the diagonal. The rise (a) is the height and the diagonal (c) is the length of the slope are a given in the examples.

14' 1 11/16"   **10'**   **?**

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10 (Feet) (Rise) *(Input Rise)*	Rise 10 Feet	(FIS) Mode 1,0,0,0 (RIS)	10: 0 0/16	10 * 12 = *(a to inches)*	120
14 (Feet) 1 (Inch) 11 (/) 16 (Diag) *(Input Diagonal)*	Diag 14 Feet 1 Inch 11/16	1,4,1,11 (SLP)	14: 1 11/16	$((14 * 12) + 1) + (11 \div 16)=$ *(c to inches)*	169.6875
(Run) *(Find Run)*	Run 10 Feet	(Run)	10: 0 0/16	$(169.6875^2) - (120^2) =$ *($c^2 - a^2$ = square root of b)*	119.9744 = 120
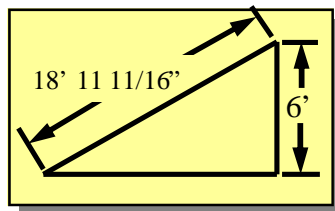
18' 11 11/16"   **6'**

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
6' Rise	Rise 6'	6,0,0 (RIS)	6: 0 0/16	6 * 12 =	72
18' 11 11/16" Diag	Diag 18' 11 11/16"	1,8,11,11 (SLP)	18: 11 11/16	$((18 * 12) + 11)) + (11 \div 16)=$	227.6875
Run	Run 18'	(Run)	18: 0 0/16	$(227.6875^2) - (72^2) =$ sqrt	216.0037 = 216

Run
(Pitch & Diagonal)

The length of a triangle can be solved using the pitch and the diagonal. The pitch (A) is the angle given in inches for each 12 inches of run and the diagonal (c) is the length of the slope are a given in the examples.
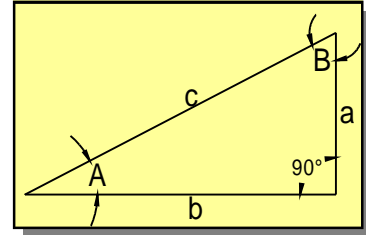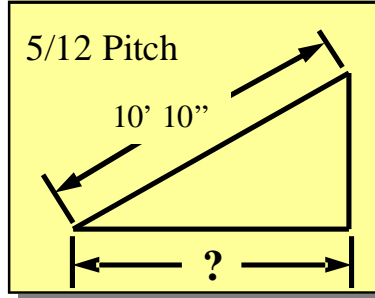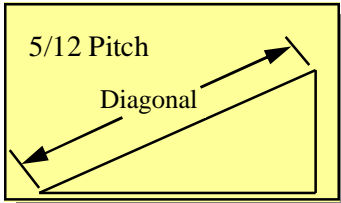
5/12 Pitch
Diagonal

5/12 Pitch
10' 10"
?

B
c
a
A
90°
b

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10 (Feet) 10 (Inch) (Diag) *(Input Diagonal)*	Diag 10 Feet 10 Inch	(FIS) Mode 1,0,10,0 (SLP)	10: 10 0/16	(10 * 12) + 10 = *(c to inches)*	130
5 (Inch) (Pitch) *(Input Pitch)*	Pitch 5 Inch	5,0 (Pitch)	5 0/16	(5 ÷12) Inv Tan = *(pitch ÷12) than Inverse Tangent = degree*	22.61986
(Run) *(Find Run)*	Run 10 Feet	(Run)	10: 0 0/16	(22.61986 cos) * 130 = *(cosine of A * c) = b*	120
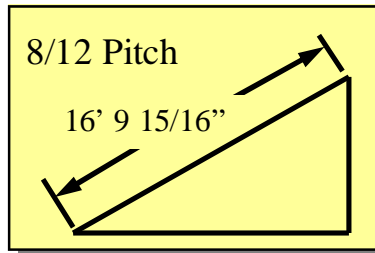
8/12 Pitch
16' 9 15/16"

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
16' 9 15/16" Diag	Diag 16' 9 15/16"	1,6,9,15 (SLP)	16: 9 15/16	((16 * 12) + 9) + (15 ÷ 16) =	201.9109
8" Pitch	Pitch 8"	8,0 (Pitch)	8 0/16	(8 ÷12) Inv Tan =	33.69007
Run	Run 14'	(Run)	14: 0 0/16	(33.69007 cos) * 201.9109 =	168

Diagonal
(Run & Rise)

The diagonal (c) of a triangle can be solved using the rise and the run. The rise (a) is the height and the horizontal length which is the run (b) are a given in the examples.

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10 (Feet) (Rise) *(Input Rise)*	Rise 10 Feet	(FIS) Mode 1,0,0,0 (RIS)	10: 0 0/16	10 * 12 = *(a to inches)*	120
15 (Feet) (Run) *(Input Run)*	Run 15 Feet	1,5,0,0 (Run)	15: 0 0/16	(15 * 12) = *(b to inches)*	180
(Diagonal) *(Find Diagonal)*	Run 18 Feet 0 Inch 5/16	(SLP)	18: 0 5/16	$(120^2) + (180^2) =$ *($a^2 + b^2 = $ square root of c)*	216.3330
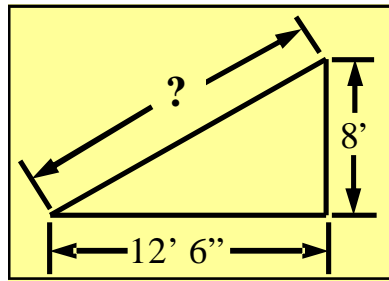
Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
8' Rise	Rise 8'	8,0,0 (RIS)	8: 0 0/16	8 * 12 =	96
12' 6" Run	Run 12' 6"	1,2,6,0 (Run)	12: 6 0/16	(12 * 12) + 6 =	150
Diag	Diag 14' 10 1/16"	(SLP)	14: 10 1/16	$(96^2) - (150^2) =$ sqrt	178.0898

Diagonal
(Pitch & Rise)

The diagonal (c) of a triangle can be solved using the rise and the pitch. The rise (a) is the height and the pitch (A) is the angle given in inches for each 12 inches of run are a given in the examples.
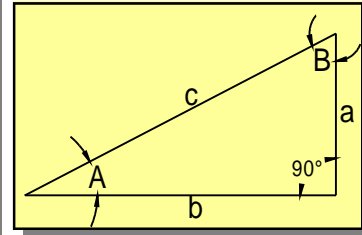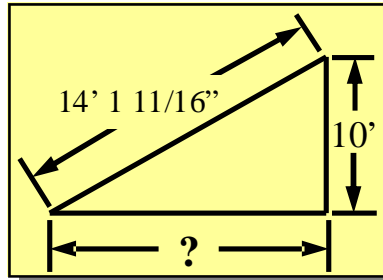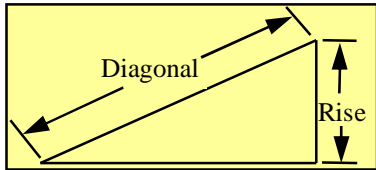

6/12 Pitch

Diagonal

Rise

6/12 Pitch

?

10'

B

c

a

A

90°

b

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
10 (Feet) (Rise) *(Input Rise)*	Rise 10 Feet	(FIS) Mode 1,0,0,0 (RIS)	10: 0 0/16	10 * 12 = *(a to inches)*	120
6 (Inch) (Pitch) *(Input Pitch)*	Pitch 6 Inch	6,0 (Pitch)	6 0/16	(6 ÷ 12) Inv Tan, Sin = *(Pitch ÷ 12) Inverse Tangent, Sine)*	.447217
Diag *(Find Diagonal)*	Diag 22 Feet 4 Inch 5/16	(SLP)	22: 4 5/16	(120 ÷ .447217) = *(a ÷ sin A)*	268.3261
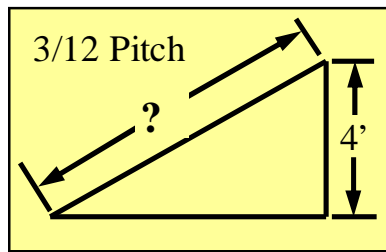
3/12 Pitch

?

4'

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
4' (Rise)	Rise 4 Feet	4,0,0 (RIS)	4: 0 0/16	4 * 12 =	48
3" (Pitch)	Pitch 3 Inch	3,0 (Pitch)	3 0/16	(3 ÷ 12) Inv Tan, Sin =	.242536
Diag	Diag 16 Feet 5 Inch 15/16	(SLP)	16: 5 15/16	(48 ÷ .242536) =	197.9088

Diagonal
(Pitch & Run)

The diagonal (c) of a triangle can be solved using the run and the pitch. The horizontal length which is the run (b) and the pitch (A) is the angle given in inches for each 12 inches of run are a given in the examples.

Diagonal / Run

7/12 Pitch
?
15'

Triangle with angles B, A, 90°; sides c, a, b
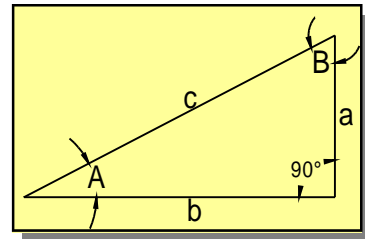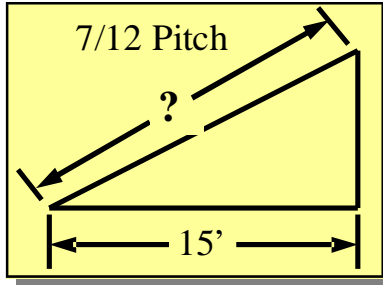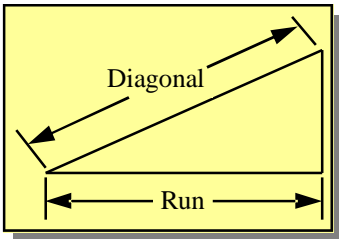
Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
15 (Feet) (Run) *(Input Run)*	Run 15 Feet	(FIS) Mode 1,5,0,0 (Run)	15: 0 0/16	15 * 12 = *(b to inches)*	180
7 (Inch) (Pitch) *(Input Pitch)*	Pitch 7 Inch	7,0 (Pitch)	7 0/16	(7 ÷ 12) Inv Tan, Cos = *(Pitch ÷ 12) Inverse Tangent, Cosine)*	.86377
Diag *(Find Diagonal)*	Diag 17 Feet 4 Inch 3/8	(SLP)	17: 4 3/8	(180 ÷ .447217) = *(b ÷ cos A)*	208.38665
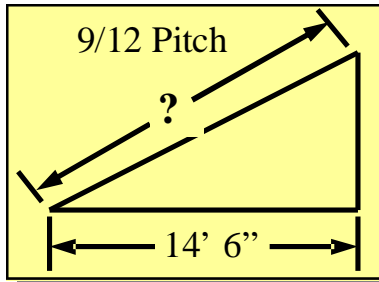
9/12 Pitch
?
14' 6"

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
14' 6" (Feet) (Run)	Run 14 Feet 6 Inch	1,4,6,0 (Run)	14: 6 0/16	(14 * 12) + 6 =	174
9 (Inch) (Pitch)	Pitch 9 Inch	9,0 (Pitch)	9 0/16	(9 ÷ 12) Inv Tan, Cos =	.8
Diag	Diag 18 Feet 1 Inch 1/2	(SLP)	18: 1 1/2	(174 ÷ .8) =	217.5

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Plumb Distance

When a member is sloping at a pitch (angle), the plumb distance is greater than the width of the lumber. The math for figuring the plumb distance is the same for finding the diagonal length of a triangle. You need to find the triangle within the member as it is drawn in the example.

The "Run" is the member size and the "Pitch" is the pitch of the truss member (it may be a bottom chord or top chord).
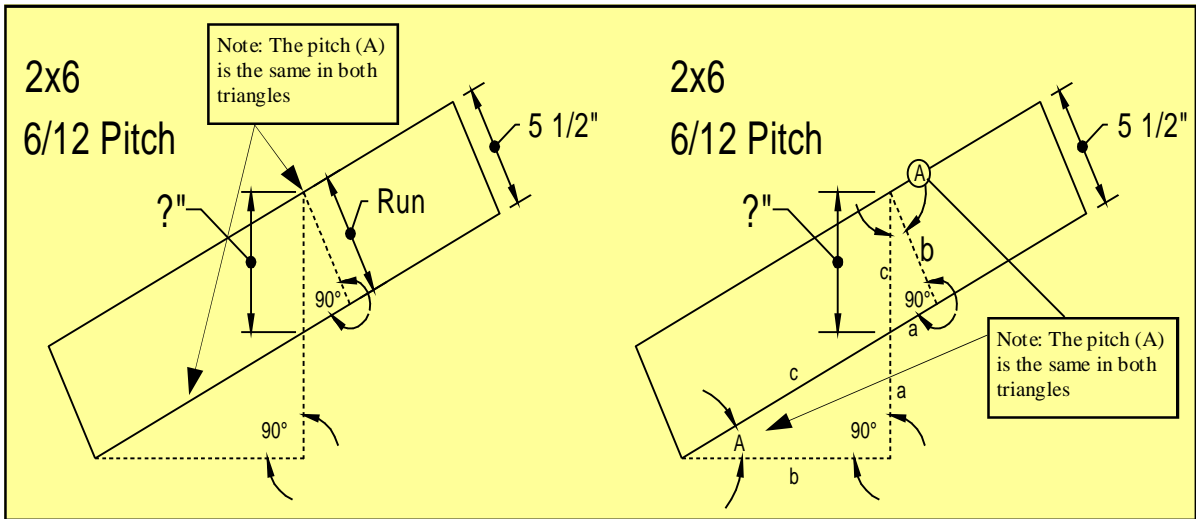
2x6
6/12 Pitch

Note: The pitch (A) is the same in both triangles

5 1/2"

?"

Run

90°

90°

2x6
6/12 Pitch

5 1/2"

?"

Note: The pitch (A) is the same in both triangles

90°

90°

Construction Master		Jobber		Science	
Keystrokes	**Display**	**Keystrokes**	**Display**	**Keystrokes**	**Display**
5 (Inch) 1 (/) 2 (Run) *(Input Run)*	Run 5 Inch 1/2	(FIS) Mode 5,8 (Run)	5 1/2	5 + (1 ÷ 2) = *(b to inches)*	5.5
6 (Inch) (Pitch) *(Input Pitch)*	Pitch 6 Inch	6,0 (Pitch)	6 0/16	(6 ÷ 12) Inv Tan, Cos = *(Pitch ÷ 12) Inverse Tangent, Cosine)*	.894427
Diag *(Find Diagonal)*	Diag 6 Inch 1/8	(SLP)	6 1/8	(5.5 ÷ .894427) = *(b ÷ cos A)*	6.149188

By finding the plumb cut distance you can find the _**STANDARD HEEL HEIGHT**_ for any given truss. The standard heel height is…

   Plumb Cut Height + Butt Cut = Standard Heel
   6 1/8" + 1/4" = 6 3/8" for a 2x6 at a 6/12 pitch

A standard butt cut is 1/4".

Run

Butt Cut
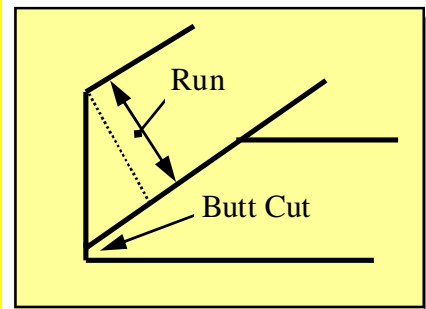
Chapter 3
Overhangs and Heels

In this section I will cover the truss's overhang and heel. Changing a truss heel or overhang will change the elevation (look) of the house. These two elevations (Fig. 3-1 & 3-2) demonstrate what the difference in a truss heel height or overhang length will do to the soffit height (Note that the blue arrows are spaced further apart on the left elevation).

Fascia

Trim

4' Windows

8' Walls

Fig. 3-1

Fig. 3-2
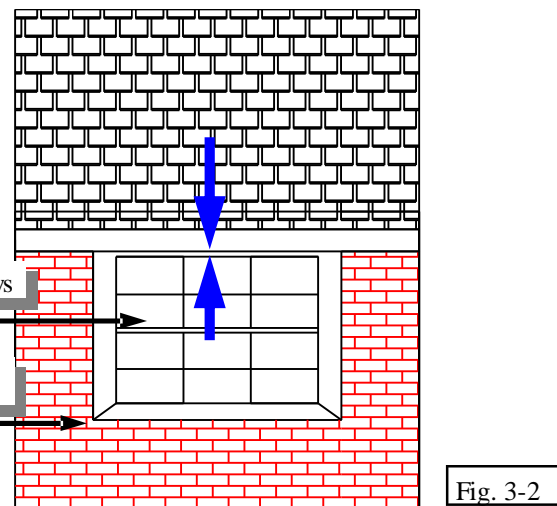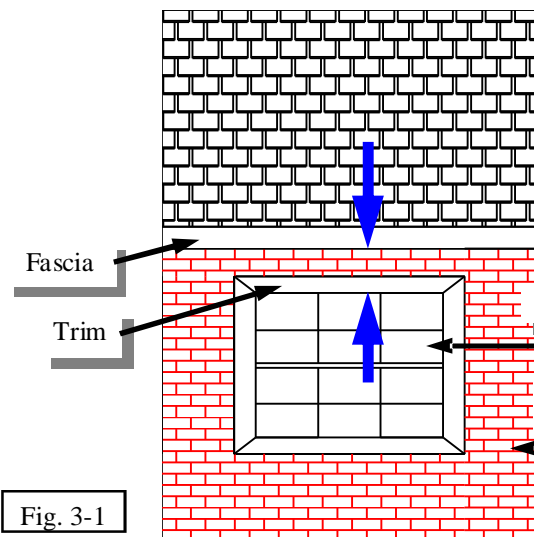
The fascia and window trim is what truss designers usually use to determine a heel height on residential prints. I will talk about the differences between residential and commercial as we cover different aspects on these topics.

Lets start by looking at two "typical" soffit details figures 3-3 & 3-4. Note the soffit returns are at two different heights in relation to the top wall plate. The top of standard windows is normally at a 7' height. A standard wall height is at 8' (8' 1 1/8") and the fascia appears to be just above the window in figure 3-2. Figure 3-3 may be the type of soffit used for Figure 3-2.

Top wall plate

Fascia

Soffit return

Fig. 3-3

Top wall plate

Fascia

Bottom chord used as Soffit return

Fig. 3-4
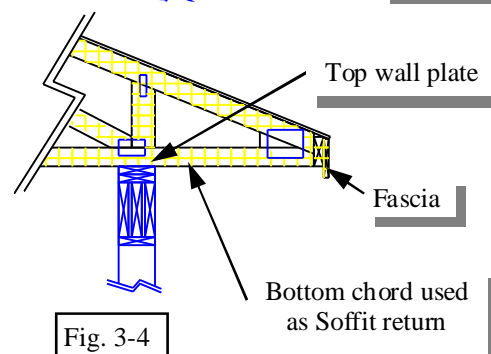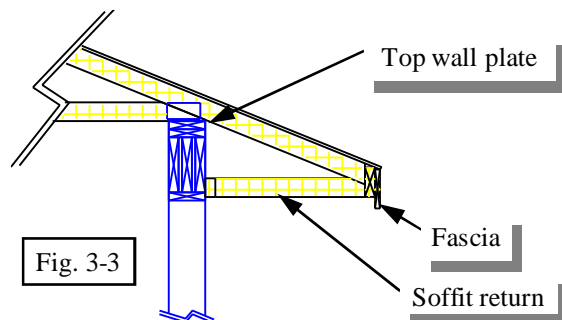
Definition page

Heel Height is the measurement where the top and bottom chords intersect or end. The heel height is critical for the overall truss profile and soffit elevation. Heel height is always determined from the very top of the top chord to the very bottom of the bottom chord on the outside of bearing end. (See figures 3-5, 6 & 7)

Sub-

Fascia

Soffit Return

Fig. 3-

Heel Hgt

Fig. 3-

Heel

Fig. 3-7
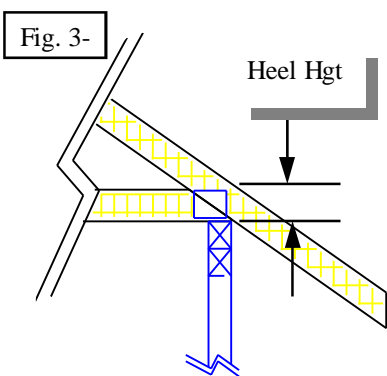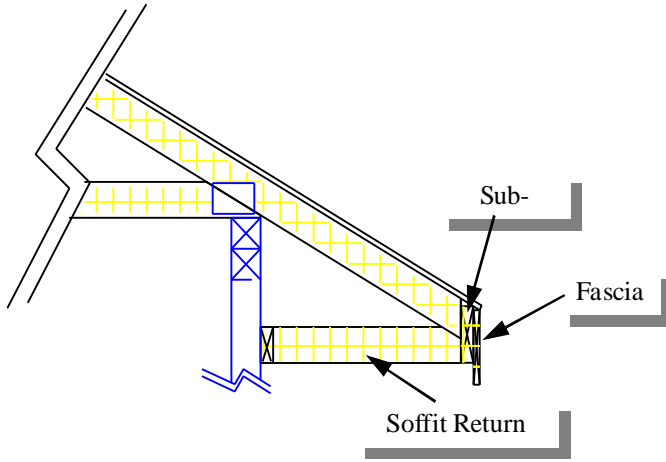
Heel Hgt

Standard heel
(Plumb hgt + butt cut)
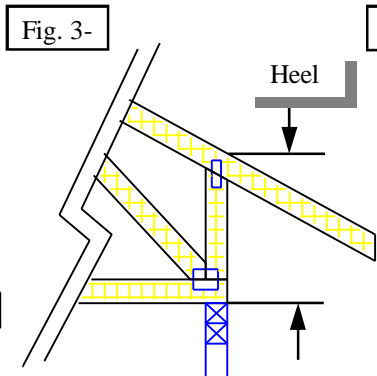
Energy heel or Raised heel
(Heel hgt over wall is raised usually for proper insulation depth)
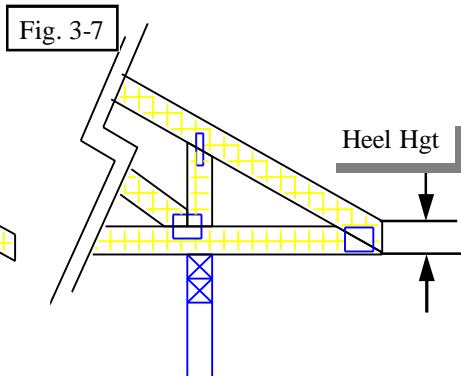
Cantilever End
(Hgt of top chord over wall is raised usually for proper insulation depth)

Overhang is the extended top chord beyond the end vertical or bottom chord. An overhang length is the measurement of the soffit minus the fascia and sub-fascia. You can have an overhang with a cantilever bottom chord. The length would then be the soffit length minus cantilever, fascia and sub-fascia. (See figures 3-8, 9 & 10) Some areas of the country ignore fascia thickness for overhang length.

Overhang length

Overhang

Overhang length

Fig. 3-8

Fig. 3-

Fig. 3-
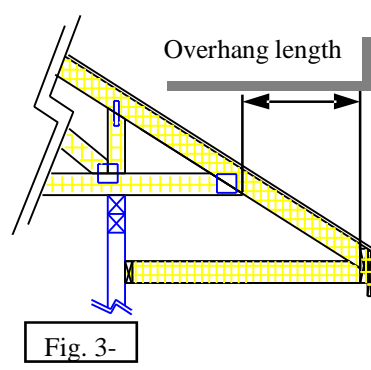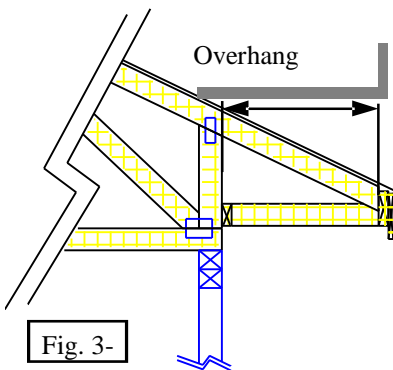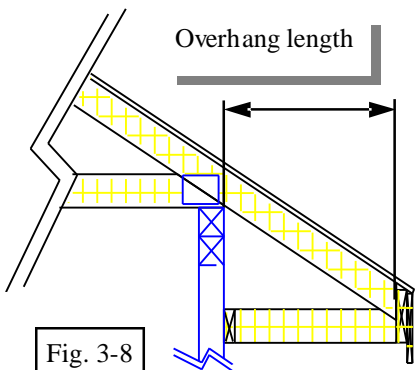
OK, by now your wondering if you can find some easy short cut, like looking at a cross section. You're thinking that the heel and overhang should be diagramed for you with all the correct measurements. **Don't rely on cross section totally!** They are correct maybe 25% of the time on residential. Commercial prints are correct about 98%, but you must cross-reference them with other sections of the prints.

Fascia

Trim

4' Windows

8' Walls

Fig. 3-1

Fig. 3-2
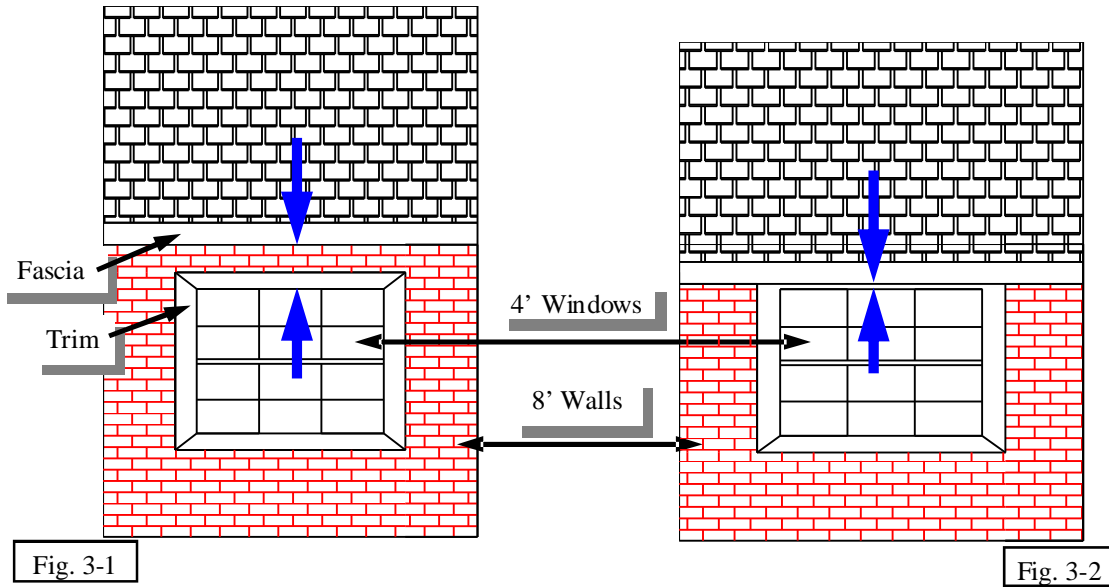
Residential

On residential prints the wall cross section on the left (Fig. 3-11) would be used for either elevations illustrated above (Fig. 3-1 & 2). This is known as a "canned" drawing. Canned drawings are useful to save time while drawing a house. Notice that the truss heel height is not called out or dimensioned. You **must** check the heel height and overhang length to accomplish the look that the architect wants.

1x8 Fascia
2x Sub Fascia

1/2 GYP Board
2x6 Studs 24" OC
Blown Insulation

3/8" Plywood w/
2" Perforated vent

3/4" Sub floor
2x10 Floor Joist

4' Brick
1/2" Air Space

Fig. 3-11

Typical cross
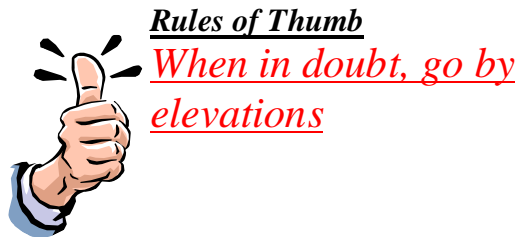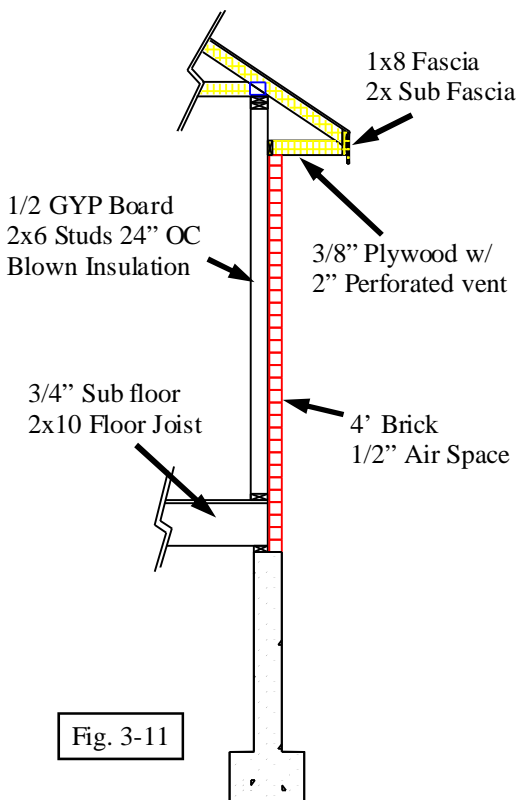
Rules of Thumb
When in doubt, go by elevations

Commercial

Commercial prints *usually* call out the heel heights. The prints go through a detailed scrutiny by all parties involved in getting the prints approved for building permits, which residential does not. It is wise to cross-reference each section to make sure they are consistent.

Heel Hgt for Different Markets

At this point I would like to take a moment and talk about region differences. What may be common in Florida market may not be true in Montana. Differing practices may be as small a region as by county. These differing practices, as far as heel heights are concern deals with what is "most" common. In southern Wisconsin you must check soffit height on every drawing. But in southern Idaho you may need only be concerned with 10% of the prints concerning soffit height, which the standard practice would be to use a standard heel height. Other areas require some type of energy heel to meet local codes. No matter what your market has as the most common, the rest of this chapter will give you the skills needed to solve and deal with each soffit height.

Heel Hgt for Single Pitch

This section explains how to figure the proper heel height for any *single pitch* roof and overhang. Before we continue, lets cover some.

Rules of Thumb
Walls heights
- **8'1 1/8"** is a Standard wall (Double top plate (3") + 92 5/8" studs + single Bottom plate (1 1/2"))
- **9'1 1/8"** "9' Standard"
- **10'1 1/18" etc..**

Top of Window
Standard height for top of window & door **6' 10 1/2"**
This is done by taking a standard 8' 1 1/8" wall height and subtracting 2 top plates (3") - standard header (10 1/4") - trim plate (1 1/2") = 6' 10 3/8" (round up from 3/8" to 1/2" for hgt). All other heights of none standard windows and doors must be calculated from rough openings (example windows with circular windows above).

Follow these steps to find your proper heel height:
(numbers in red are inputted in example (Fig. 3-12) displayed below)

1) Start with "Top of Window" : **6'10 1/2"**
2) Scale distance between "Top of Window" and "Hgt of fascia bottom" : <u>8"</u>
   - This is one of the few areas you will have to rely on using a scale
   - Use the window trim size to "scale" more accurately. (5 1/2" trim + 2" or 3" space)
3) Add (6'10 1/2" + 8") to get "Hgt of Fascia bottom": 7'6 1/2"
4) Add the size of the fascia (<u>7 1/4"</u>) to "Hgt of Fascia bottom" to get "Hgt of Fascia top": <u>8'1 3/4"</u>
5) Using the Soffit length of (24") and a pitch of (8/12) = 16" Rise
6) Add the rise of 16" to "Hgt of Fascia top" to get "Hgt of Top chord" = <u>9'5 3/4"</u>
7) Heel = "Hgt of Top chord"-"Top of Wall Plt"; 9'5 3/4" - 8'1 1/8" = <u>16 5/8"</u>
8) Overhang = (Soffit - (Fascia + Sub-Fascia)); 24" - <u>2 1/4"</u> = <u>21 3/4"</u>

PAY ATTENTION!!!
This section explains the why and the how to. In other words, the *MATH*!!

8/12 Pitch

16" Rise

Hgt of Top chord: **9'5 3/4"**

Hgt of Fascia top: **8'1 3/4"**

Hgt of Fascia bottom:**7'6 1/2"**

Top of Wall Plt: **8'1 1/8"**

21 3/4" Overhang

Top of Window: **6'10 1/2"**

16 5/8"
Heel Hgt

24" Soffit

Window trim for reminder
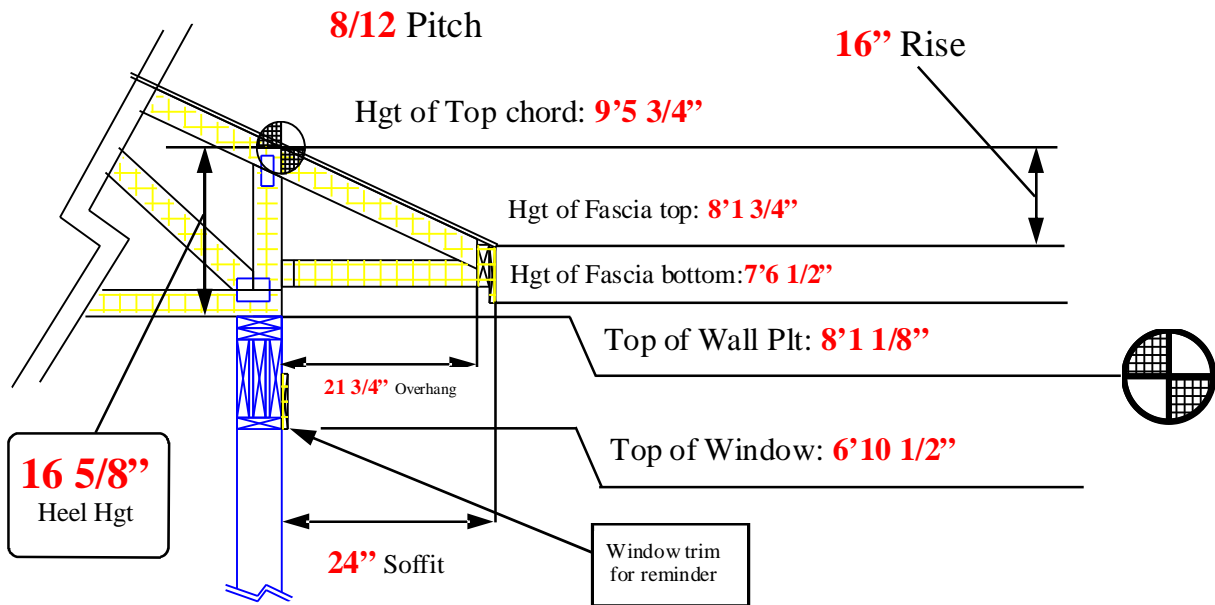
Fig. 3-12

Note: Some regions use the size of sub-fascia instead of fascia To determine heel hgt.

Dual Pitch Soffit

Why is a dual pitch any different?

On the previous page you learned how to figure the heel height of a *single pitch* and what it does to the soffit height. What would you do if there were *dual pitch* roof? Well in this next brief section I will attempt to explain the math.

Example: Fig. 3-13 shows the following
   8/12 pitch, 24" overhang, *standard heel*
   4/12 pitch, 24" overhang, *standard heel*

Results:
   8/12 soffit line is at 7'1 9/16" "Hgt of Fascia top" (8'1 1/8" plt hgt + 4 7/16" heel - 16" rise = 7'1 9/16)
   4/12 soffit line is at 7'9 1/16" "Hgt of Fascia top" (8'1 1/8" plt hgt + 3 15/16" heel - 8" rise = 7'9 1/16")
This creates a 7 1/2" difference between the soffit heights.

8/12

4/12

7'9 1/16"

7'1 9/16"

Fig. 3-13

8'1 1/8" plt
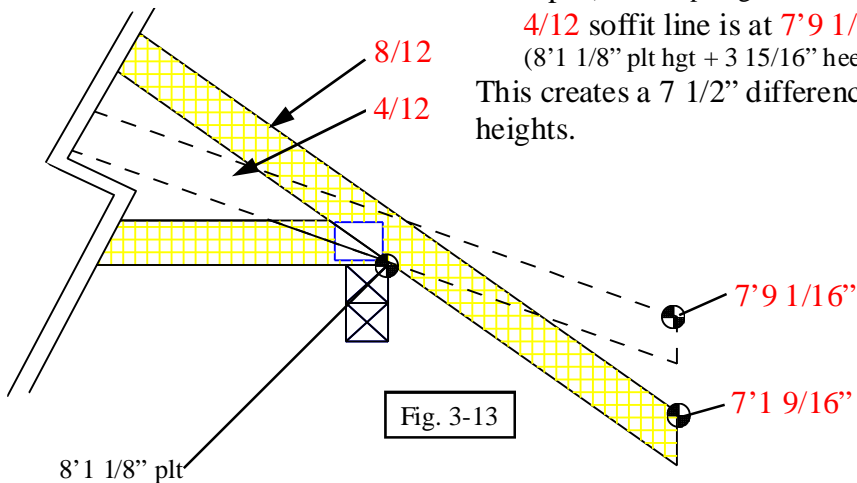
These two different soffit heights would not look like most elevations that have come across my desk. Most have a soffit line that is level all away around the house. Otherwise you have a soffit dropping in height where there is an 8/12 pitch verses the 4/12 pitch soffit. There are two ways to resolve this dilemma.

Adjust the Heel Height
or
Adjust the Overhang Length

First you must determine which to adjust, the heel or overhang. This is done by looking at the print's elevations, then verifying that the soffit either shortens on the steeper slopes or stays the same length. Let us look at how it would be dealt with in either case.

Adjust Heel for Dual Pitch

> Dual pitch roofs create my favorite kind of soffit!!

Truss Geek

Now on this first example, I will explain the steps you need to follow in order for the soffit to..

    a) Remain the <u>same lengths</u>

    b) Soffit hgt would be proper elevated above windows and doors

    c) The soffit line would be continuous (same hgt) around the house

Example:

        6/12 front to rear of house; 8/12 left to right of house

        Standard wall hgts of 8'

        Approx. 2" space below Fascia (no trim board above window)

        5 1/2" Fascia

        24" soffit for 6/12 pitch

8/12   16" Rise

Hgt of Top chord: 8' 10"

Fig. 3-15

Hgt of Fascia top: 7' 6"

Top of Wall Plt: 8' 1 1/8"

21 3/4"

8 7/8"
Heel Hgt

24" Soffit

Note:

⇒ To adjust **HEEL HGT**, start with "Hgt of fascia top"

⇒ To adjust **OVERHANG**, start with "Top of Wall Plt"
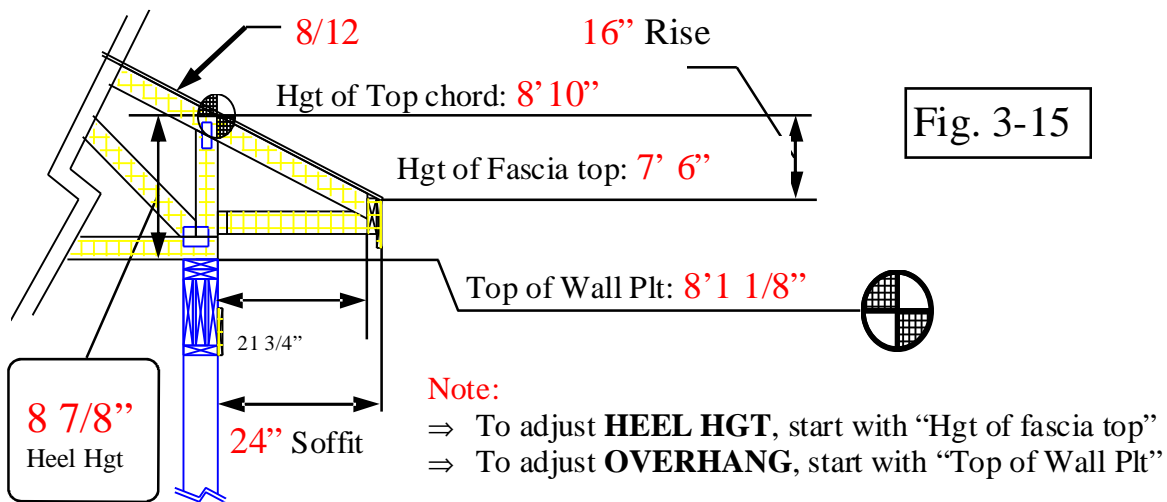
(All numbers in RED are displayed in Fig. 3-15)

1) Start by solving the heel height for the *lowest* pitch first. Use the worksheet for "Heel Height for Single Pitch". (Heel height worksheet at end of chapter)

    ♦ Heel Hgt = 4 7/8"

    ♦ Hgt of Fascia top = 7' 6"

2) Using the Hgt of Fascia top from the 6/12 and inserting it into the worksheet "See Fig. 3-15, Match Soffit hgt of differing pitch worksheet"
   This will create a reference point so the 8/12 pitch soffit is at the same elevation.
3) Finish the worksheet:
   - Add 16" to 7' 6" (24" run, 8/12 pitch)
   - Hgt of Top chord = 8' 10"
   - Subtract "Top of Wall Plt" from "Hgt of Top chord" to give you your Heel hgt = 8' 10" - 8'1 1/8" = 8 7/8" Heel Hgt for the 8/12

If you find that in order to match the print's elevations the heel height is less than a standard heel, for any of the pitches, the prints are *usually* drawn wrong. The heel height should be assumed to be, at a minimum, to have a standard heel height. Which leads me back to tell you why you should solve for the lowest pitch. If you solve for the higher pitch first, you may end up with a negative heel height for the lower pitch (less than standard).

Rules of Thumb
Minimum heel height, for any pitch, is a standard heel unless specifically asked for by the architect. (Plumb Height + Butt Cut = Standard Heel)

Adjust Overhang Length of Dual Pitch

The next example I will explain the steps you need to follow in order for the soffit to..

   a) Very in length
   b) Soffit hgt would be proper elevated above windows and doors
   c) The soffit line would be continuous (same hgt) around the house

Example: 6/12 front to rear of house; 8/12 left to right of house
   Standard wall hgts of 8'
   Approx. 2" space below Fascia (no trim board above window)
   5 1/2" Fascia
    24" soffit for 6/12 pitch

1) Start by solving the heel height for the ***lowest pitch.*** Your answers should be similar to what was drawn for each pitch's soffit length on the blue print elevations.
   Use the worksheet for finding heel height.
   - Heel Hgt = 4 7/8" for the 6/12
   - Hgt of Fascia top = 7' 6"

2) Your starting point for the 8/12 will be "Top of Wall Plt". See Fig. 3-16 for, "Match Soffit hgt of differing pitch worksheet"
   - 8'1 1/8"

3) Then fill in the rest of work sheet by

- Adding 8/12 heel (standard heel hgt) to Top of Wall Plt
  8' 1 1/8 + 4 7/16" = 8' 5 9/16" Hgt of Top chord
- Subtract "Hgt of Fascia top" from "Hgt of Top chord"
  8' 5 9/16" - 7' 6" = 11 9/16" Rise
- Soffit length = 8/12 pitch with 11 9/16" rise = 17 3/8" run
- Overhang length is 15 7/8"

(All numbers in RED are displayed in Fig. 3-16)

8/12 Pitch   11 9/16" Rise

Hgt of Top chord: 8' 5 9/16"

Hgt of Fascia top: 7' 6"

Top of Wall Plt: 8' 1 1/8"

15 1/8" Overhang

4 7/16"
Heel Hgt

17 3/8" Soffit
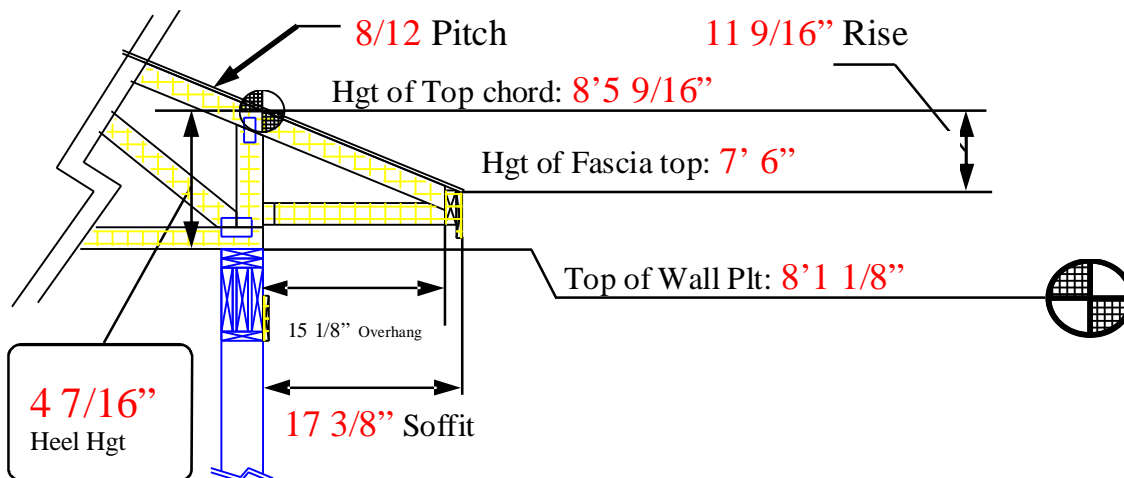
Fig. 3-16

Note:
⇒ To adjust **HEEL HGT**, start with "Hgt of fascia top"
⇒ To adjust **OVERHANG**, start with "Top of Wall Plt"

Heel Hgt of Single Pitch Cantilever

To get the proper heel height for a cantilever soffit is very easy. You get it by adding the sub-fascia height to the rise of the sub-fascia thickness for the lowest pitch.

Example: 6/12 pitch, 1 1/2" x 5 1/2" sub-fascia

The rise of a 1 1/2" run at a 6/12 is 3/4" (1st Run in figure 3-17) So the heel height is 5 1/2" + 3/4" = 6 1/4"

For a duel pitch roof your starting

1st Run

2nd Run
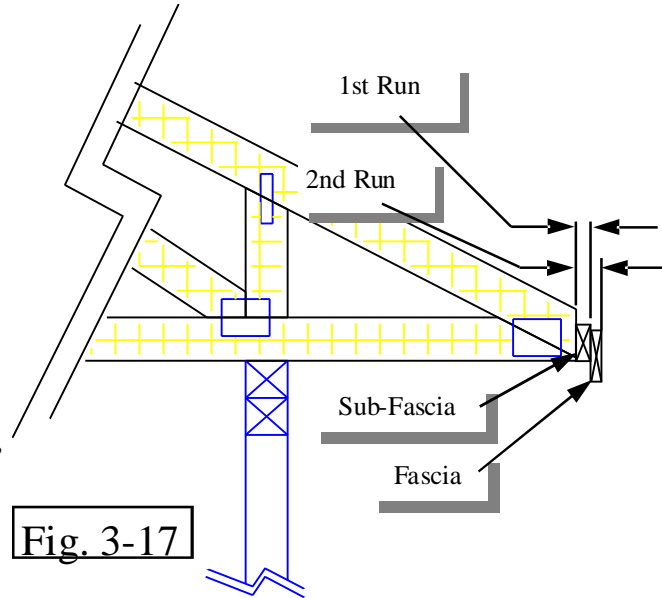
Sub-Fascia

Fascia

Fig. 3-17

Heel Hgt of Dual Pitch Cantilever

point is the heel height of the lowest pitch. Then by subtracting the rise of the sub-fascia *and fascia* of the first pitch you add the rise of the sub-fascia *and fascia* of the steeper pitch. Let's continue using figure 3-17.

Example: 2nd Pitch has a 8/12, 1 1/2" x 5 1/2" " sub-fascia, 3/4"x 9 1/4" fascia

Using the "2nd Run" of figure 3-18 to get the "rises"

- 6/12 heel height is 6 1/4"- 1 1/8" (rise) = 5 1/8" Hgt
  (1 1/2" + 3/4" run, 6/12 pitch = 1 1/8" rise)
- 5 1/8" (hgt) + 1 1/2" (rise) = 6 5/8" heel for 8/12
  (1 1/2" + 3/4" run, 8/12 pitch = 1 1/2" rise)
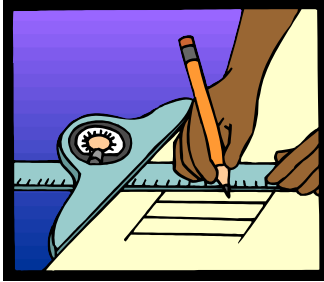
Worksheet for **Heel Heights and Overhangs**

Job

Note: Remember to find the heel height of the lowest pitch first on a dual pitch roof

Heel Hgt of Single Pitch Worksheet

_____ /12 Pitch

_____ " Rise

Hgt of Top chord:

Hgt of Fascia top:

Hgt of Fascia bottom:

Top of Wall Plt:

____" Overhang

Top of Window:

_____ "

Heel Hgt

_____ " Soffit

Start with "Top of Window"
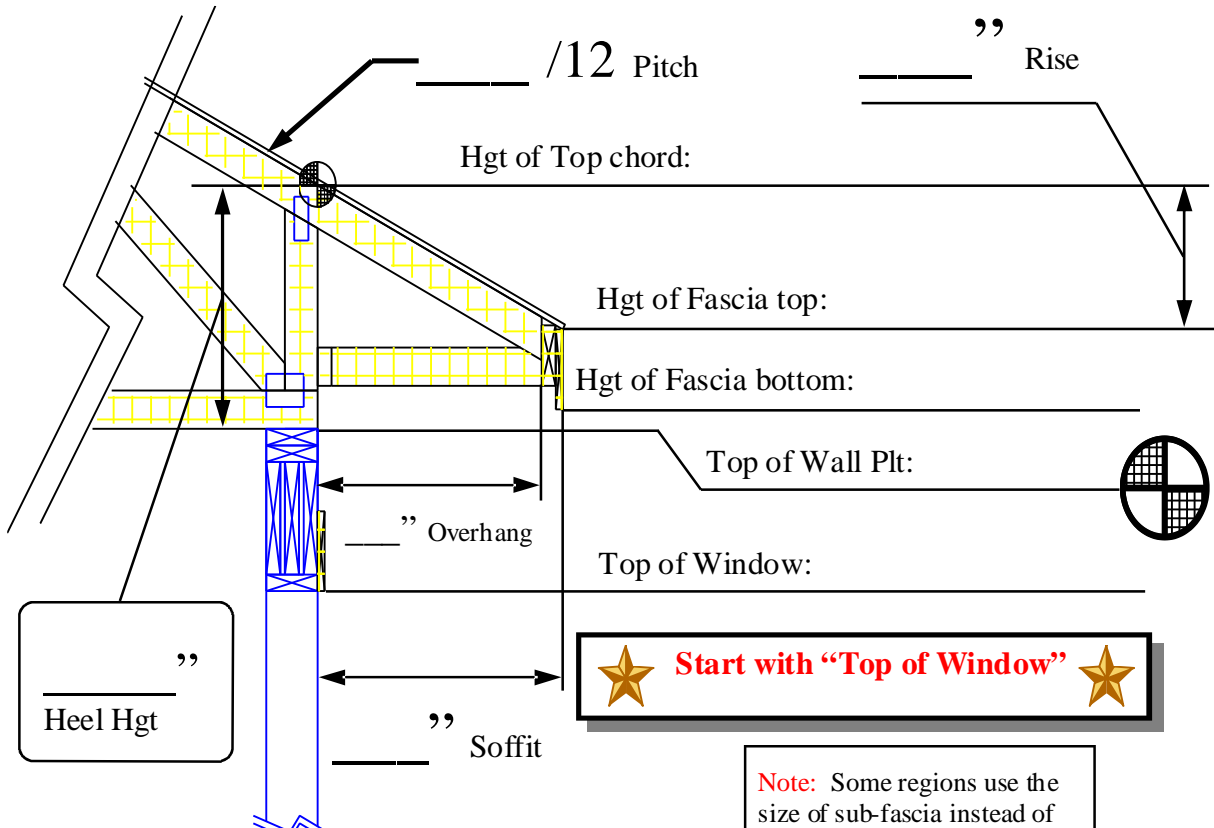
Note: Some regions use the size of sub-fascia instead of fascia to determine heel hgt.

Match Soffit Hgt of Dual Pitch Worksheet

___ /12 Pitch

___ " Rise

Hgt of Top chord:

Hgt of Fascia top:

Top of Wall Plt:

_____ "

Heel Hgt

____ " Overhang

____ " Soffit

Note:
⇒ To adjust **HEEL HGT**, start with "Hgt of fascia top"
⇒ To adjust **OVERHANG**, start with "Top of Wall Plt"
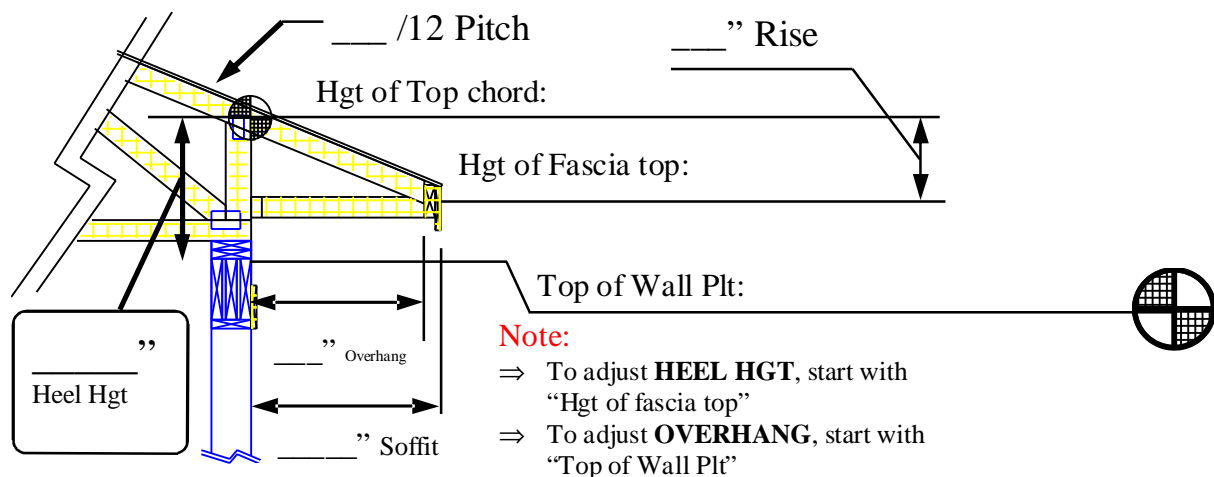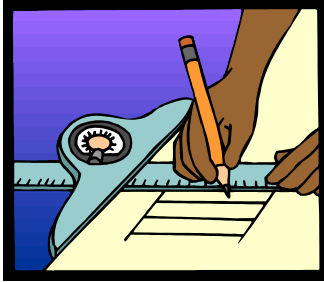
Heel Hgt Worksheet for Single Pitch

⭐ **Start with "Bottom Chord = 0" Hgt"** ⭐

_____ /12

Heel height

Sub-Fascia Hgt

Bottom Chord = 0"

____" Cantilever

Fascia Hgt

(Fascia Hgt needed for Dual Pitch)
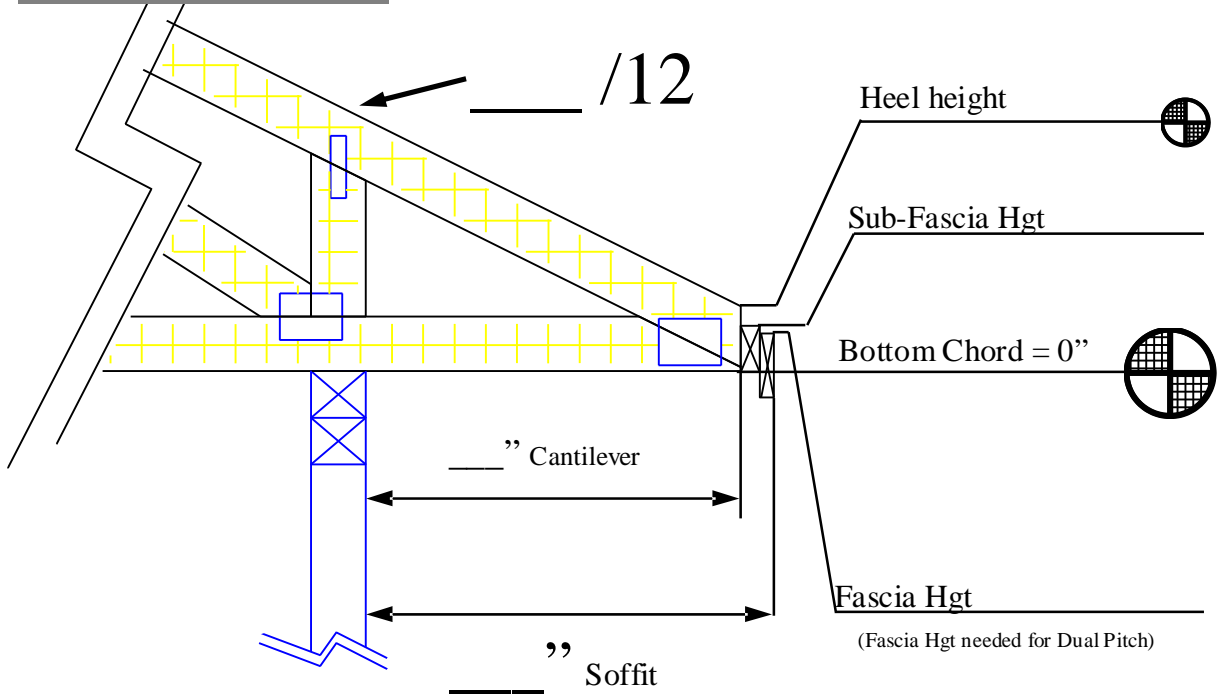
_____" Soffit

Match Soffit Hgt of Dual Pitch Worksheet for Cantilevers

_____ /12

Heel height

____" Cantilever

Fascia Hgt of 1st Pitch
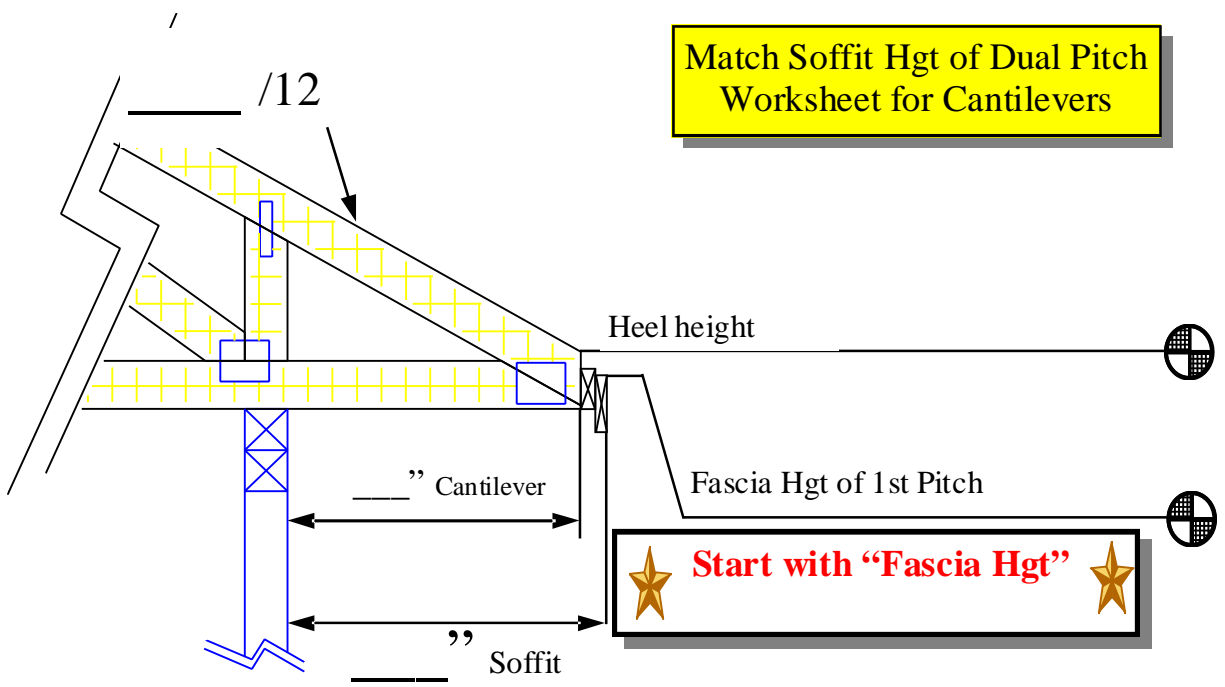
⭐ **Start with "Fascia Hgt"** ⭐

____" Soffit

Loading

It is critical that a truss designer properly apply the necessary special loads to all the trusses. This chapter will go into detail about understanding and figuring special loading.

All buildings are designed structurally from the top down. Think about how each level of a building must be able to withstand the forces from the levels that are above it. Any building designer requires knowing the loading being applied to each level. You, as a truss designer, will be asked repeatedly what loads are being applied to beams and walls. It is imperative that you understand not only how much loading, but also what kind of loading. You will need to figure the loading of a section of roof that will have to be applied to a girder truss that you are creating.

Loading
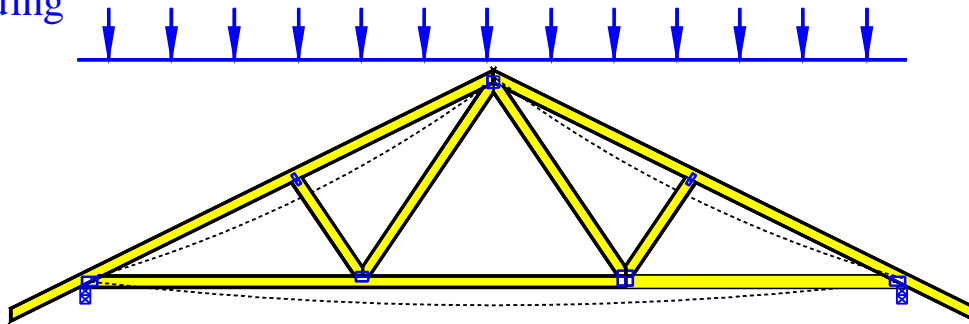
Each project has its own conditions that a truss designer must understand and apply them to the trusses. These conditions may include loads from floor, wall, roof, and mechanical units. Once you have identified the conditions, you will need to be able to understand how much loads they generate. After you figure the actual loading, it is necessary to divide them up and properly apply the loads to the trusses affected.

Understanding the forces applied to trusses requires an understanding of what kind of load is actually being applied. There are different types of loads such as concentrated or uniform. There can be variations and combinations of different loads all being applied to a single truss. To understand loading it is necessary to understand the effect it has on the supporting members.

Span loading

There are two distinct ways of calculating loads. One is span loading and the other is area loading. Span loading is the length of the supporting member supporting a loading. Area loading is the square feet of loading on multiple carrying members. In this section, we will analyze the effect a load has on a beam and what kind of reaction it creates on the ends of the beam.

A reaction is the amount of pounds a beam or truss creates on the end. If you where to support a truss by using a hanger, you would need the reaction of the truss being carried to properly size the hanger.

Reaction in LBS	Load	Reaction in LBS

Beam

A   B
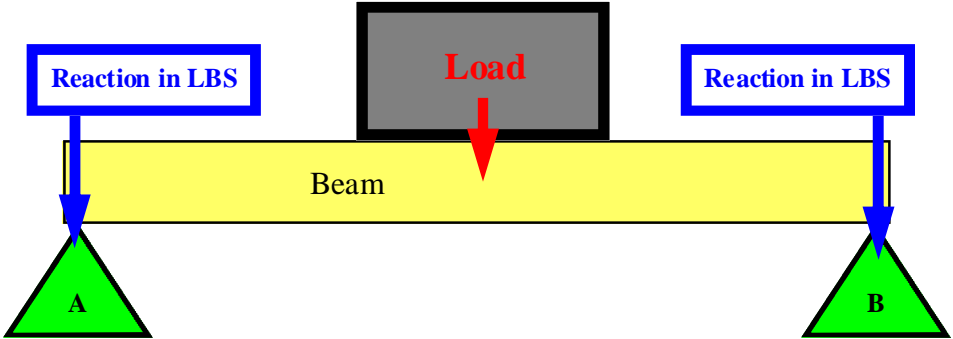
(This section will ignore the weight of the beam when calculating the reactions)

Concentrated Load in Center of Support; A load that is not spread over the length of a supporting member is called a concentrated load. If the load is centered in the middle of the support (having same distance from both ends), the reaction of the loading is Load ÷ 2 = Reaction

Weight ÷ 2 = Reaction on each Support

1,000 lbs

Beam

A   B
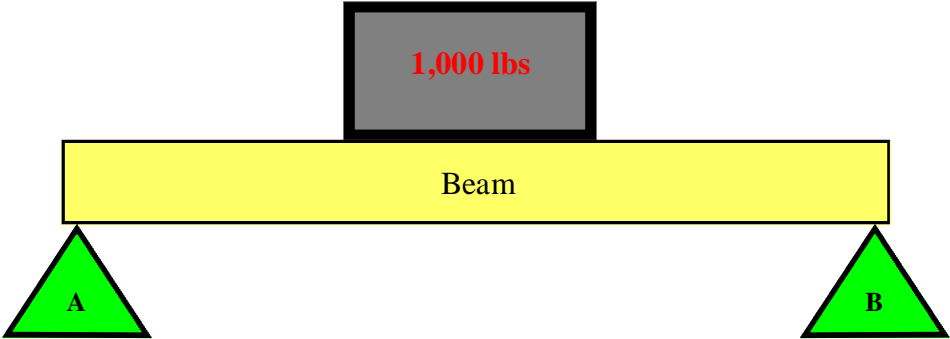
1000 ÷ 2 = 500 lbs on each support

Off Centered Concentrated Load; A concentrated load that is not in the center of the supporting member must be calculated in a different manner than the centered one. The weight is multiplied by the percentage of distance from the overall length, for the opposite end. Just remember that the larger load must be on the end closest to the load.

(Distance ÷ Length) x (Load) = Reaction on Opposite End

"L" = 10'

"a" = 6'   C̬ L   "b" = 4'

1,000 lbs

Beam

A

(b ÷ L) x load = Reaction of Support "A"
(a ÷ L) x load = Reaction of Support "B"

(4' ÷ 10') x 1,000 = 400 lbs at Support "A"
(6' ÷ 10') x 1,000 = 600 lbs at Support "B"

B
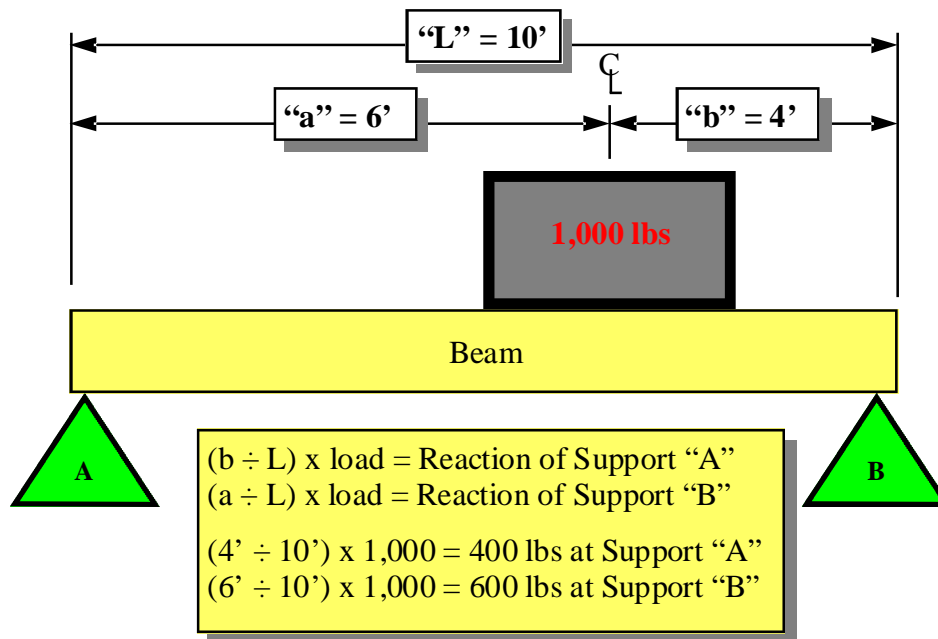
Uniform Load over Length of Supporting Member; This is normally referred to as "Pounds Per Lineal Foot". A load that is spread evenly over the length of the supporting member is called a uniform load. To find the reaction on each end you would add up the total load and divide it by 2.

Total Weight ÷ 2 = Reaction on each Support

100 lbs / Ft. for 10'

| 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs |

Beam

A

(Load per Foot) x Length = Total Weight
Total Weight ÷ 2 = Reactions at "A" & "B"

(100 x 10) ÷ 2 = 500 lbs

B
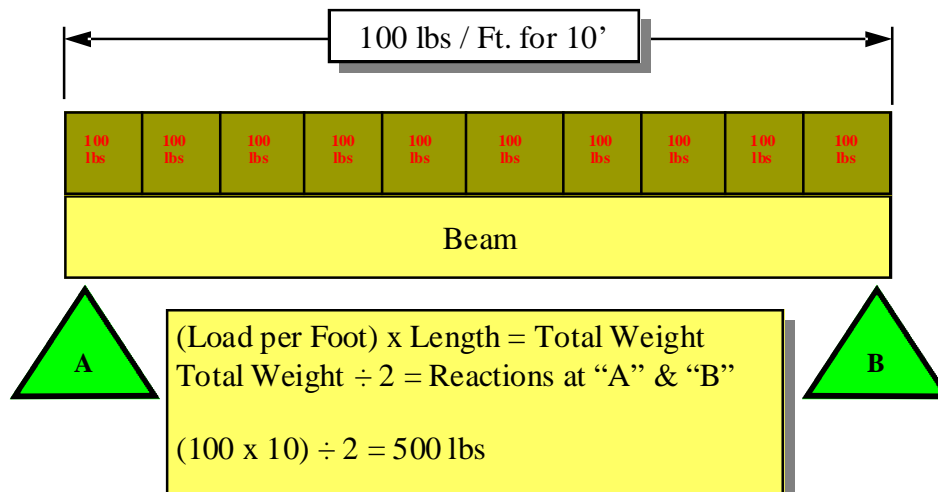
Off Centered Uniform Load ; A uniform load that is not in the center of the supporting member is calculated just like the "Off centered concentrated load" formula. The total weight is multiplied by the percentage of distance of the overall length, from the center of the uniform load for the opposite end. Just remember that the larger load must be on the end closest to the load.

(Distance ÷ Length) x (Total Load) = Reaction on Opposite End

"L" = 10'

"a" = 7'6"   C$_L$ "b" = 2'6"

100 lbs / Ft. for 5'

| 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs |

Beam

A   B

(b ÷ L) x Total load = Reaction of Support "A"
(a ÷ L) x Total load = Reaction of Support "B"

(2.5' ÷ 10') x (5 x 100) = 125 lbs at Support "A"
(7.5' ÷ 10') x (5 x 100) = 375 lbs at Support "B"
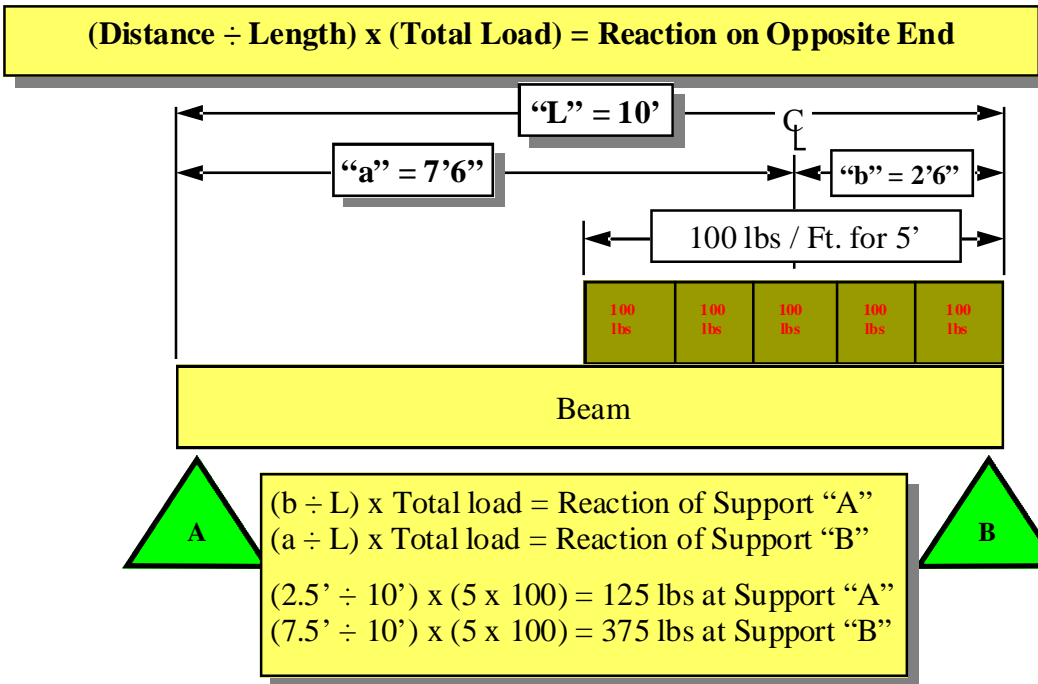
Trapezoid Loading; A trapezoid loading is a load that gradually increases from one point to another point. For this example, the formula needs the loading diminishing to zero. The reactions of both ends start by multiplying the length by the load on high end and than divided by two. Then for the end loading of zero you will multiply the result by .33 or 1/3rd. The end with loading would be multiplied by .67 or 2/3rd.

((Length x Starting Load) ÷ 2) x (.33) = Reaction Low End
((Length x Starting Load) ÷ 2) x (.67) = Reaction High End

"L" = 10'

"SL" Start Loading 1000 LBS / Ft

End Loading 0 LBS / Ft

Beam

A   B

((SL x L) ÷2) x .67 = Reaction of Support "A"
((SL x L) ÷2) x .33 = Reaction of Support "B"

((1000 x 10) ÷ 2) x .67 = 3350 lbs at Support "A"
((1000 x 10) ÷ 2) x .33 = 1650 lbs at Support "B"
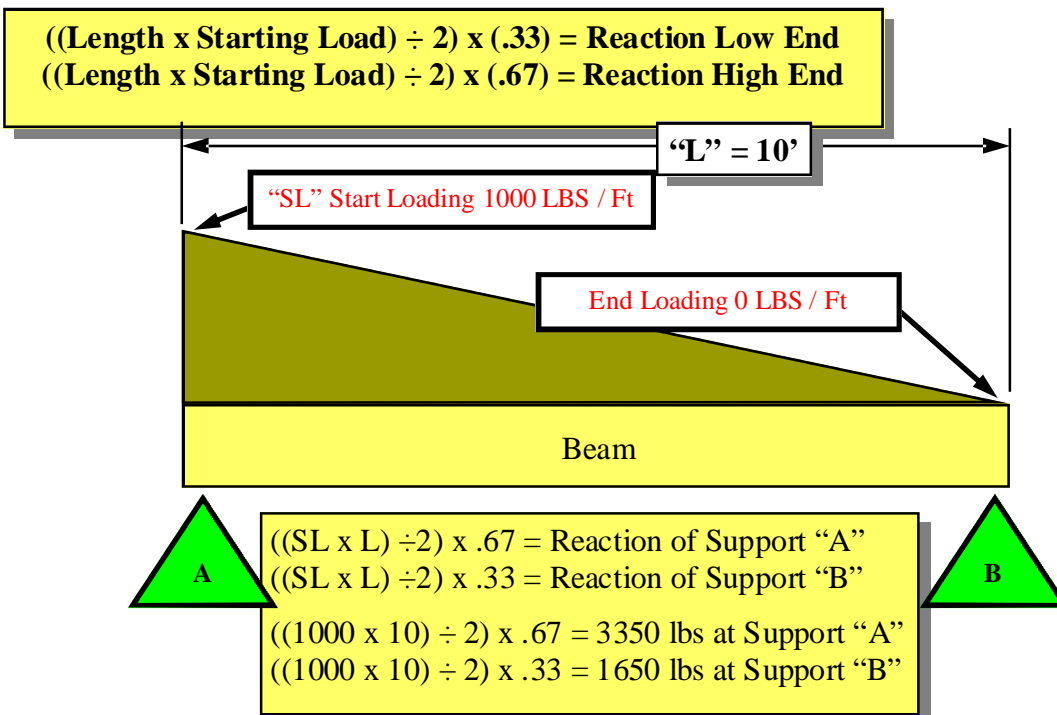
Trapezoid Loading with Uniform Loading; A trapezoid loading that does not start or end with a zero loading is really a uniform load with a trapezoid load. Start by subtracting the uniform load from the trapezoid. The uniform load would be the lowest loading multiplying the length of the loading (L2) by the load on high end and than divided by two. Then for the end loading of zero you will multiply the result by .33 or $1/3^{rd}$. The end with loading would be multiplied by .67 or $2/3^{rd}$.

((L2 x Starting Load) ÷ 2) x (.33) = Reaction Low End
((L2 x Starting Load) ÷ 2) x (.67) = Reaction High End

"L1" = 10'

"SL" Start Loading 1000 LBS / Ft

End Loading 100 LBS / Ft

Beam

(b ÷ L) x Total load = Reaction of Support "A"
(a ÷ L) x Total load = Reaction of Support "B"

(2.5' ÷ 10') x (5 x 100) = 125 lbs at Support "A"
(7.5' ÷ 10') x (5 x 100) = 375 lbs at Support "B"

A   B

"L" = 17'

"a" = 5'   "b" = 12'

3,000 lbs

| 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs | 100 lbs |

Beam

A   B
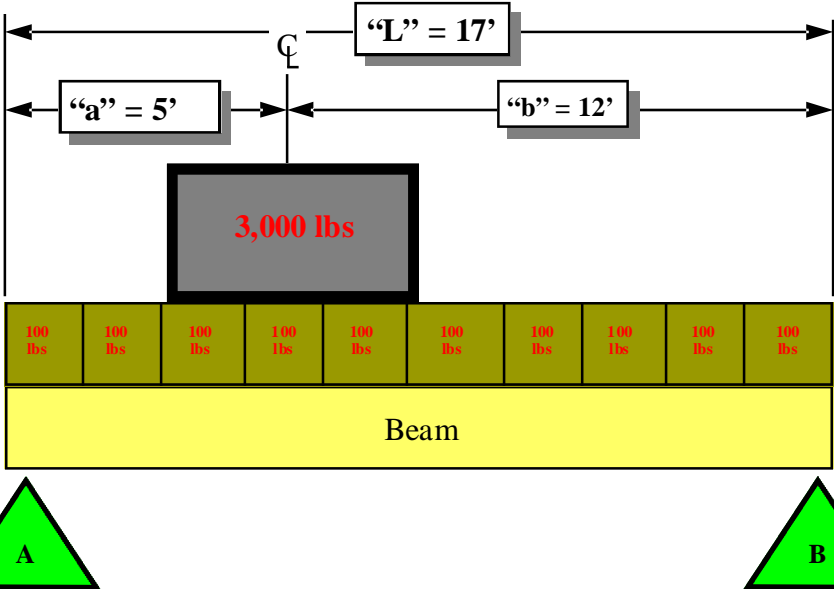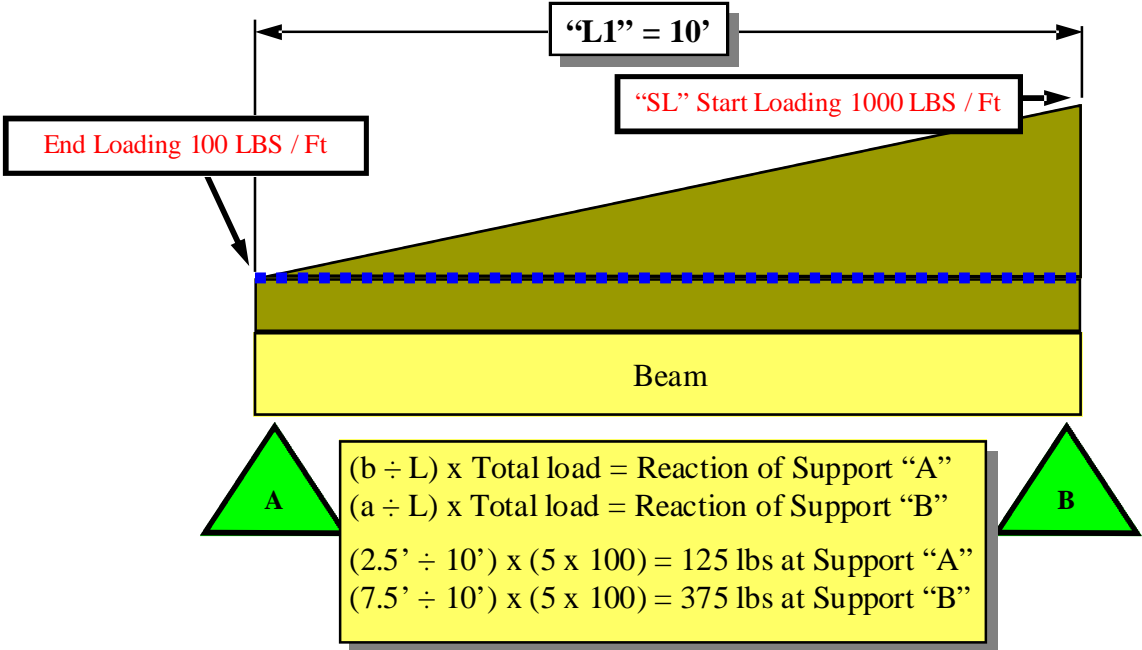
Loading & References

There are two types of loads, which are called Live and Dead. A Live Load is a loading that will come and go over a given time period, such as snow. A Dead Load is a loading that is permanent, such as shingles and insulation. The weight of the truss itself is also considered part of the dead load.

Most loading for roof and floor structures are uniform expressed in **P**er **S**quare **F**oot or as PSF. Per Square Foot is an area that measures 12 inches by 12 inches. Typical loading displayed as PSF is broken down to live load top chord, dead load top chord, and live bottom chord and dead load bottom chord.

My brain is fried!!

Usually displayed as one of the following;
- 40 LL 7 DL 0 LL 10 DL
- 40/7/0/10
- 40 TL, 7 TD, 0 BL, 10 BD
  Which is **T**op chord **L**ive, **T**op chord **D**ead etc..
- 40,7,10
  With only three loads displayed than live load on bottom chord is "0"

Sometimes, in rare cases, loading is called out as pounds per lineal foot or as PLF. You will need to determin wether you should convert it to pounds square footage or input the loading as pounds per lineir foot.

When you create a truss you will need to specify the live and dead loads. There are 5 groups that can be called on to obtain information for the live loads for roof or floor loads.

1) Building structural engineer
2) Local building codes
3) National codes
4) Regional codes
5) The truss designer (This means *YOU*)

Building structural engineer;

Prints stamped with an engineer's seal are usually commercial structures. Commercial jobs are structures not used for single dwelling homes. An example of a commercial structure would be an office or an apartment complex. A structural engineer is responsible calling out the loading for the building as a whole. This loading would include the roof and floors. You usually can find the loading on commercial prints on the first page of the structural sheets labeled as "S1". They should also specify which national or regional

code they require. Also look in the project manual or specification book for additional info. The wood section in the specification book is usually in the 6100 section.

Local building codes;

If a print does not have the loading specified on them than you must rely on the local codes that the building will be built in. Most cities and counties have a building department that you can call and get their required minimum loading for that area. Usually they have adopted a national code and have made stricter elements to it. All truss programs will require additional requirements of specifying a national code or regional building code.

National codes;

There are 5 different national codes
1)BOCA - **B**uilding **O**fficials and **C**ode **A**dministrators International
2)UBC   - **U**niform **B**uilding **C**ode
3)ICBO   - **I**nternational **C**onference of **B**uilding **O**fficials
4)SBCC   - **S**outhern **B**uilding **C**ode **C**ongress
5)FHA   - **F**ederal **H**ousing **A**uthority
You will have to specify which national code you are using in your truss engineering program. Each of these national codes has load charts for different regions of the nation. The also have other requirements, but for now lets move on.

Regional codes;

Some states have their own codes that are in place of the national codes. Wisconsin is an example where they have created their own codes. In California it can be by county such as San Francisco area. Call the areas building official department to find which code they are requiring. You need to specify which code you are using in the truss engineering program.

The truss designer;

Well guess what, you are still responsible if you fail to add needed loads to the trusses. Even if no one else informs you of additional loads that does not release you from the responsibility of looking into all conditions. It may be a load from a mechanical unit or snow drifting from an upper roof. Play it smart and look into all the proper loads that each truss will be subject too.

Did I include that AC unit?

Minimum dead loads that are required by the same reference you found the live loads. (See References for Live Loads) You must remember that they are only the minimum loading required and may not be the actual dead load needed.

Duration Factor & Repetitive Stress Increase

Wood has a unique characteristic in its ability to sustain heavy loads for short time periods and lighter loads for long periods of time. The same piece of lumber that can carry a load for 10 years can carry 15% more for 2 months, 25% more for 7 days or 60% more for 10 minutes. The time that the load is applied to the truss is called the Duration. With this in mind we can use what is called duration of load factor. Duration of load factor is the load increase that can be used for live loads. (See Figure 1-1) The duration of load factor can also be referred to by the **D**uration **O**f **L**oad, "DOL". Dead loads use a **.**9 duration of load. Remember that a 1.00 DOL is for a 10-year duration, but dead loads are for the life of the structure.

Using the duration factor is extremely easy. You type the value needed in your engineering truss program, usually in the loading input box. You do not increase or decrease the actual loading by this factor; the computer will properly account for this adjustment for you. The dead load will not have a DOL input box, because it is a set value of **.**9 increase.

Another type of increase is called a Repetitive Stress Increase. The Repetitive Stress

Figure 1-1

Load Type	Duration of Loads	Duration Factor
Wind	1 day	1.33
Earthquake	1 day	1.33
Construction	7 days	1.25
Snow	2 months	1.15
Floor	10 years	1.0
Dead Loads	Permanent	.9

Warning!
Snow duration lower with extreme loading. >30 lbs./sq.ft.

Increase is a 1.15 increase for 3 or more trusses carrying the same type of loading which are spaced no more than 24 inches on center. An example would be a run of 3 or more common trusses could use the repetitive stress increase, but a girder truss that carries the commons would not have a repetitive increase. A girder truss is a truss that supports other trusses, so it does not share the same loading with other trusses. To use the repetitive stress increase on a truss, in most programs, it is usually an on or off box in the truss engineering program for each truss. Some truss programs automatically turn off the repetitive stress increase when any special loads are added to the truss.

Forces Within a Truss

Each member of a truss is subject to a wide variety of forces. Depending on the members location in the truss, the truss engineering program and the truss designer must decide which species (type), grade and size that is needed. The truss engineering programs have settings that the truss designer can set to allow the program to automatically upgrade members. The designer must understand cause and effect for his design of the truss to optimize his creation.

As loading is applied to a truss the forces are then transferred to each member in deferent directions. (See Figure 1-2) A truss must be able to withstand the forces over the life of the structure. Each member has to be properly sized and each joint must be properly plated to hold up to each and every force the truss is subject to in the design criteria.

Loading

Members Are In **Compression**

Arrows Denote Direction of Forces

Members Are In **Tension**
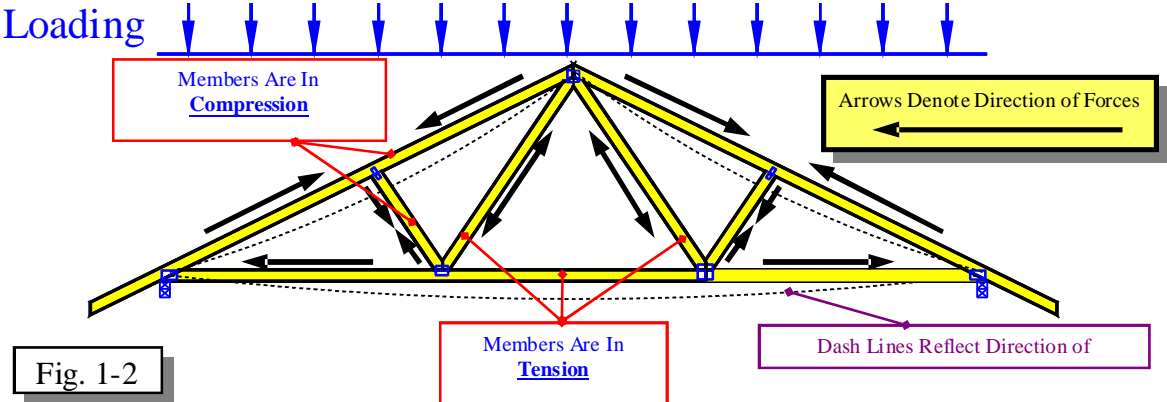
Dash Lines Reflect Direction of

Fig. 1-2

You should **always** **triangulate** each truss with the web patterns. See the red triangles below in figure 1-3. The triangulation of the webbing transfers the forces though out the truss even though the truss itself may not be a triangle.
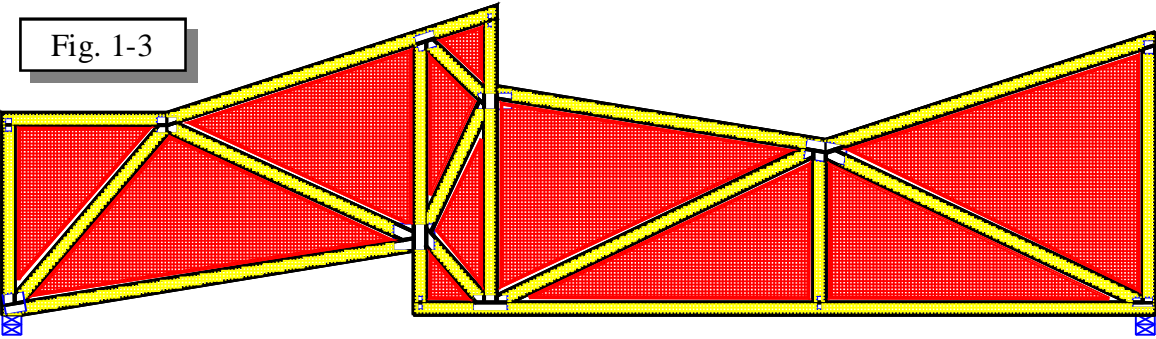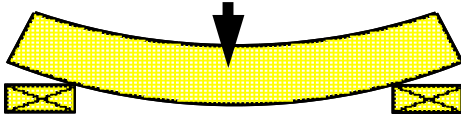
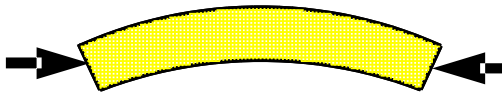Fig. 1-3

Forces on Truss Members

Bending Stress

When a member is deflecting it is called Bending Stress. Bending is measured by the value of F_b

Tensile Stress

When a member is in tension (pulled by the ends) it is called Tensile Stress. Bottom chords are normally in tension. Tension is measured by the value of F_t

Compressive Stress
Parallel to Grain

When a member is in compression (pushed at the ends) it is called Compressive Stress. Top chords are normally in compression. Compression is measured by the value of F_c

Compressive Stress
Perpendicular to Grain
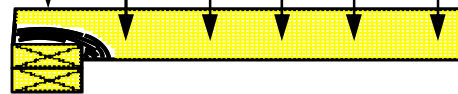
Crushing the grains is called Compressive Stress Perpendicular to Grain. Bottom chords bearing on the support have this type of stress. This type of compression is measured by the value of $F_c\perp$

Horizontal Sheer

Horizontal Sheer is created when opposing forces are sliding by one another parallel to grain. Compressive stress creates horizontal sheer. Horizontal Sheer is measured by the F_v the

Vertical Sheer
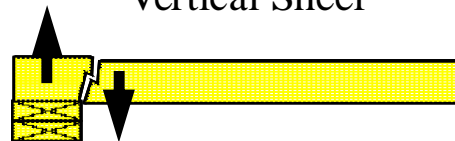
Vertical Sheer is created when opposing forces are sliding by one another perpendicular to grain. Compression stress creates vertical sheer. Bottom chords bearing on the support have this type of stress.

Plated Joints & Forces

No other material is as durable and as customizable as the steel plate. The plates are formed from rolled steel that goes through a punch press. Each plate has teeth that are formed from dies as the steel is cut during the pressing of the plate. The cutting of the teeth form slots in the plate.

Plates have two functions, griping and strength. The number of teeth per square inch and design of the teeth determine the gripping of the plate to the wood. The gauge of the steel and the square inches of steel left over after the teeth are formed give the plate its strength.

Each joint has at least one plate on each face of the joint's members. Every plate must be placed correctly as the engineering drawings show their placement. The forces on the joint and the type of lumber that the plate must grip determine the size, gauge and placement.

See figure 1-4 for the following example;
For plating a joint an engineering program has to determine the...
    1)Gripping of the lumber
    2)Strength of plate needed
    3)Placement

Gripping;

Gripping of the lumber usually is the deciding factor of the plate size. This is done analyzing the force of each member and figuring the square inches of wood needed to get the proper number of teeth. For instance M5 needs 2 1/2" of horizontal by 6" of vertical to get enough square inches.

Strength;

Strength determination is simply based on gauge of steel, grade of steel, steel type and plate size.

Placement;

The placement has to be so that each member has enough teeth in them and must not go outside the profile of the truss.

The horizontal placement is figured by the M1 and M2 need 6" horizontal along with M4 and M5 needing 2 1/2" horizontal plate. So knowing that 6" [M1 & M2] + 3 1/2" [M3] + 2 1/2" [M4 & M5] = 12" wide plate needed with 6" to the left of M3 and 2 1/2" to the right of M3.
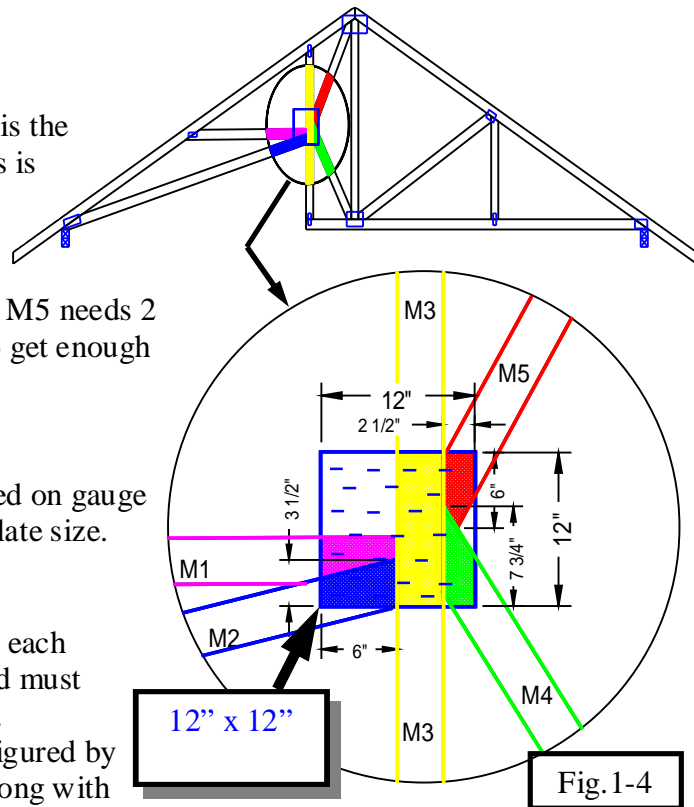

Fig.1-4

The bottom of M2 and M5 needing 6" of vertical grip determines the vertical placement. If the plate were to hang down below M2 than it would be outside the profile of the truss since M2 forms the bottom chord. M5 is 6" above M2 and M5 needs 6" of vertical grip which then adds up to 12" in height. The forces on the plate determine the direction of the slots in the plate.

Rules of Thumb
Never replace a required plate with one that is less in width or height even if they have the same total square inches. (example; 3x4 verses a 2x6, both have 12 sq inches but can't be used for the same joint) Never use a plate of a lesser gauge than the one needed and analyze higher gauges before they are used in place of the one needed.

Glossary

C

Cantilever: bottom chord extended beyond the bearing (Ch 3 pg. 2)

Commercial: multiple residential homes such as a duplex or buildings used for other than
residential homes

D

Dual Pitch Roof: a roof that has more than one common pitch (Ch 3 pg. 6)

E

Energy Heel: a heel height that is taller than a standard heel, may also be called a
Raised Heel. (Ch 3 pg. 2)

F

Fascia: the outer trim board on the eaves and soffit

H

Heel height: is the measurement where the top and bottom chords intersect or end.
(Ch 3 pg. 2)

O

Overhang: extension of top chord (Ch 3 pg. 2)

P

Pitch : the slope of a chord usually measured by the number of inches risen for every
12" run. (Example 6/12 = 6" rise for 12" run)

Profile: the outer shape of a truss, the exterior dimensions define the shape

R

Raised Heel: a heel height that is taller than a standard heel, may also be called a
Energy Heel. (Ch 3 pg. 2)

Residential: single dwelling homes

S

Soffit: the eave or overhang on the edge of a roof, usually creating a barrier so that

the windows and walls are protected from the elements running off the roof
    (Ch 3 pg. 2)

Soffit Return: a nailer used for tying the overhang to the wall (Ch 3 pg. 1)

Standard Heel: the plumb cut of a top chord plus the butt cut (Ch 3 pg. 2)
    example: 6/12 pitch, 2x4 top chord, 1/4" butt cut = 4 3/16" heel

Sub-fascia: the supporting member used to tie the ends of the overhangs together
    and a nailer for the fascia