Footing Size Calculations in Post Foundation Structures

A guide for understanding footing size calculations in post-supported structures

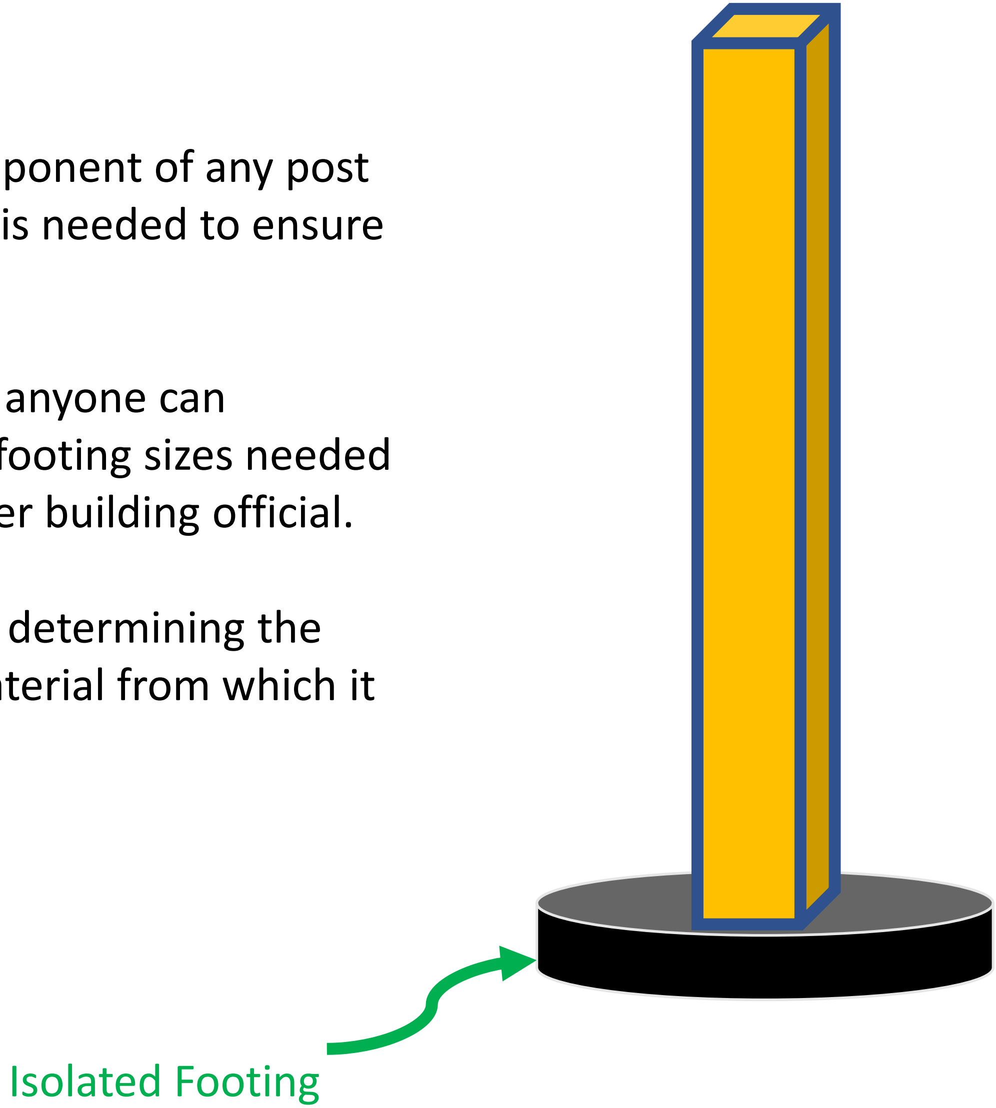
with details on how the FootingPad® calculator works

I. Introduction

Footings are an important structural component of any post supported structure. Some simple math is needed to ensure the footing is the correct size.

Armed with the knowledge in this guide, anyone can understand and comfortably discuss the footing sizes needed for their project with an inspector or other building official.

The methodology in this guide applies to determining the footing size needed, regardless of the material from which it is made.



II. Determining the footing size needed for post-in-the-ground structures

Isolated footings describe a foundation type that supports a post or column that is not part of a continuous footing. The footing is "isolated", and therefore it is straight-forward to calculate the load capacity of this footing type because there is no shared weight. All the weight carried by one post is transferred to one footing.

Regardless from what material an isolated footing is made, it functions by spreading the load carried by the post over a larger surface area. As long as the footing is stronger than the soil on which it sits, the larger the surface area of footing, the larger the load it will carry. If stronger than the soil AND overloaded, a footing will simply sink into the ground.

By knowing two things:

1) Weight on the footing
2) Load capacity of the soil

You can determine the footing size needed to support the load by using this formula:

$A = B/C$

Where
A = Surface area of the footing
B = Load on the footing in pounds
C = Load carrying capacity of the soil in pounds per square foot (psf)

Please Note: Because each post is sitting on an individual footing, we use "post" and "footing" interchangeably throughout this guide.

III. Surface Area of FootingPad and other round footings

FootingPad diameter	Surface area of FootingPad (sq. ft)
10”	.5451
12”	.7850
16”	1.3956
20”	2.1806
24”	3.14

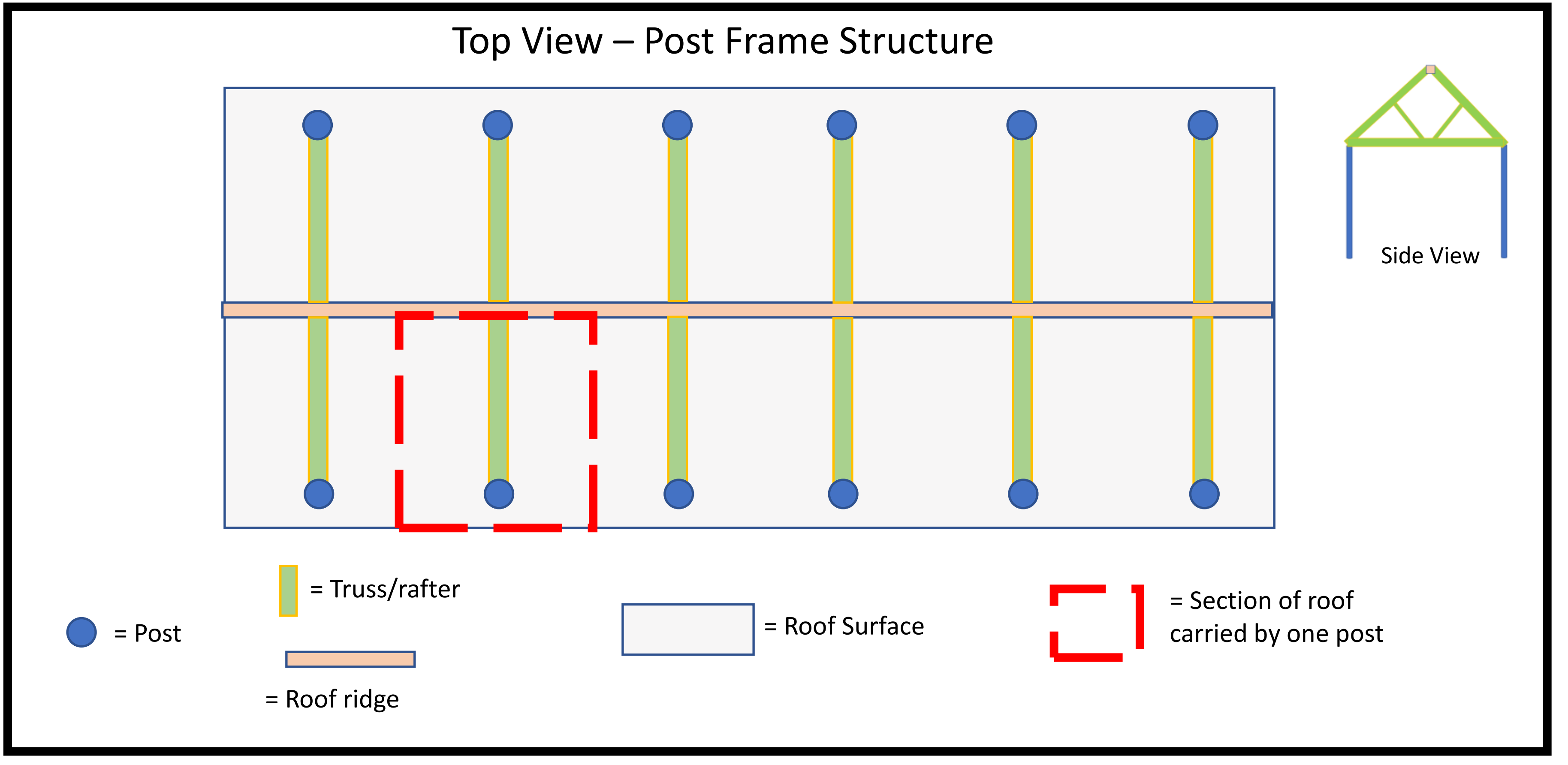
FootingPad post foundations are round, and the surface area of any circle is determined by the formula:

Pi r^2 Or: 3.14 x (radius x radius)

The surface area of a square or rectangle is determined by length x width. For example, a 12” x 12” square has a surface area of 1 sq. foot.

III. Load Calculation formula applied to post frame (pole barn) construction

Post frame construction footing size calculations are easily determined because of its simple load bearing structure. Typical post frame construction involves a series of posts opposite each other with a truss or rafters spanning the distance. The ultimate load is the defined by area of the roof carried by each post.



The farther apart the posts are spaced, both in building width and side wall post spacing, the more load on each post. As typical post frame construction will have sidewall posts spaced equally, each post carries approximately the same weight. There is little weight on the end walls, so to calculate the load on the footing, the only data points needed are the building width and post spacing. The FootingPad calculator pre-fills the dead weight load of a common steel-roofed at 5 lbs. per square foot.

IV. Example – Post Frame footing calculation

If the following data is entered into the FootingPad calculator, the footing size recommended is a 16" diameter FootingPad. Here's how we get there:

Building Width: 40 feet
Soil Capacity: 3000 psf
Post Spacing: 8 feet
Snow Load 20 lbs. / square foot

Surface area of footing (in sq. ft) = Total load (in lbs.) on footing / Soil Capacity

Total load = (½ building width x Post spacing) x (5 lbs. dead load[1] + snow load[2])
= 20' x 8' x (5 + 20 lbs. / square foot)
= 160 square feet x 25 lbs. / square foot
= 4000 lbs.

Surface area of footing (in sq. ft) = 4000 / 3000
Surface area of footing (in sq. ft) = 1.33

(continued next page)

[1] 5 lbs. per square foot of roof surface is used for a simple structure with a sheet metal roof and siding and no sheathing, shingles, etc

[2] Snow loads are measured in pounds per square foot (psf). Snow load information can be found from your local building officials of from maps on the internet.

Using the chart below, any footing larger than 1.33 square feet will work in our example.

The 16” FootingPad will be recommended by our calculator using the data supplied in this example

FootingPad diameter	Surface area of FootingPad (sq. ft)
10”	.545
12”	.785
16”	1.39
20”	2.18
24”	3.14

V. Footing Load Calculation formula applied to deck construction

To determine the footing size needed for a deck post, the same formula is used:

A = B/C

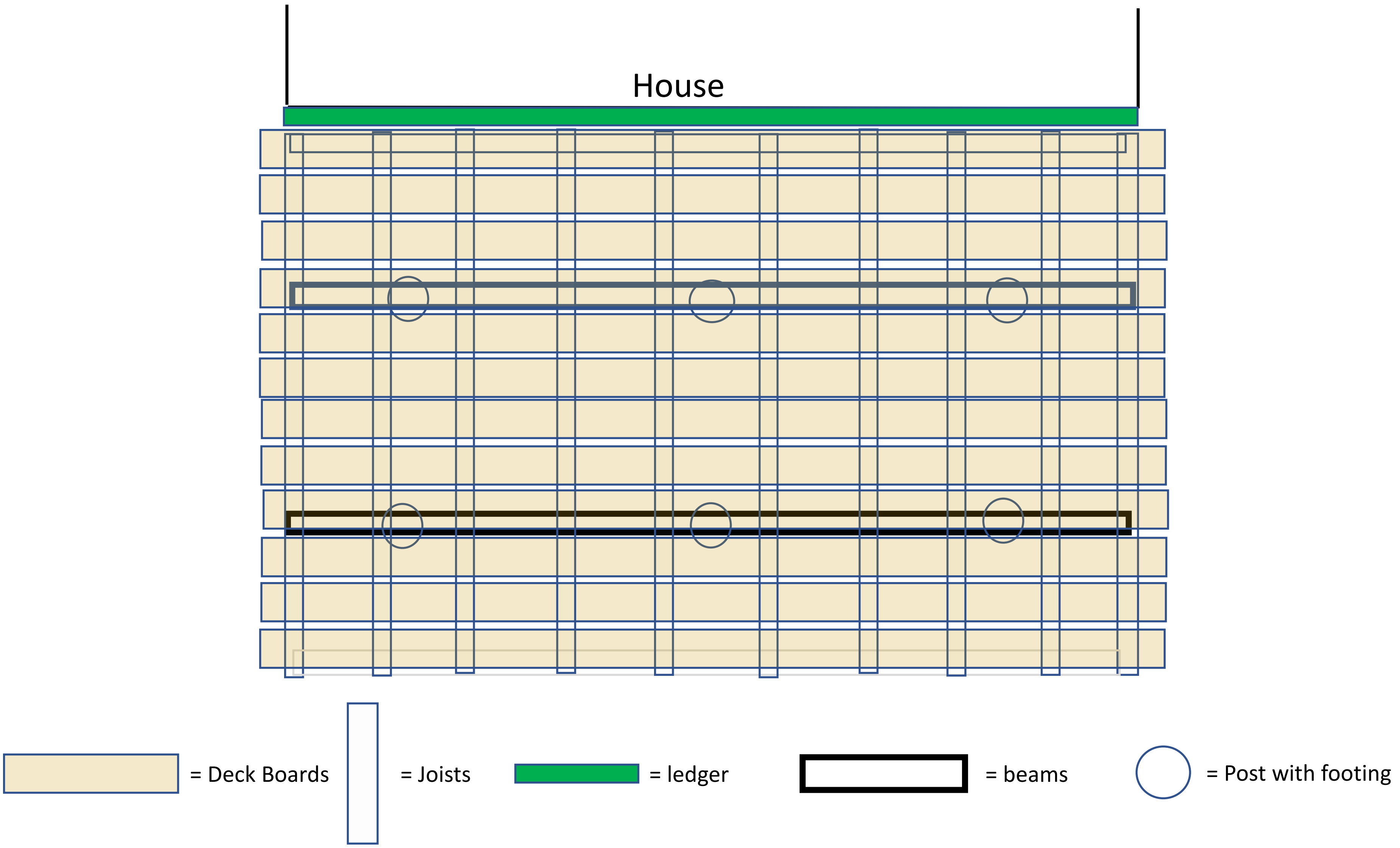
Where
A = Surface area of the footing
B = Load on the footing in pounds
C = Load carrying capacity of the soil in pounds per square foot

Because decks are not uniform in construction, defining the load carried by each footing, called the tributary area (TA), is dependent on design of the deck, especially the placement of beams and posts.

In our footing size calculator, the data you input is used to identify the footing which has the largest tributary area, and subsequently, the largest load. This allows the calculator to provide a FootingPad large enough for all posts. In practice, once you understand the calculations, you can easily determine the footing size needed for each individual post for each project.

VI. Basic deck components: A top view of a rectangular deck

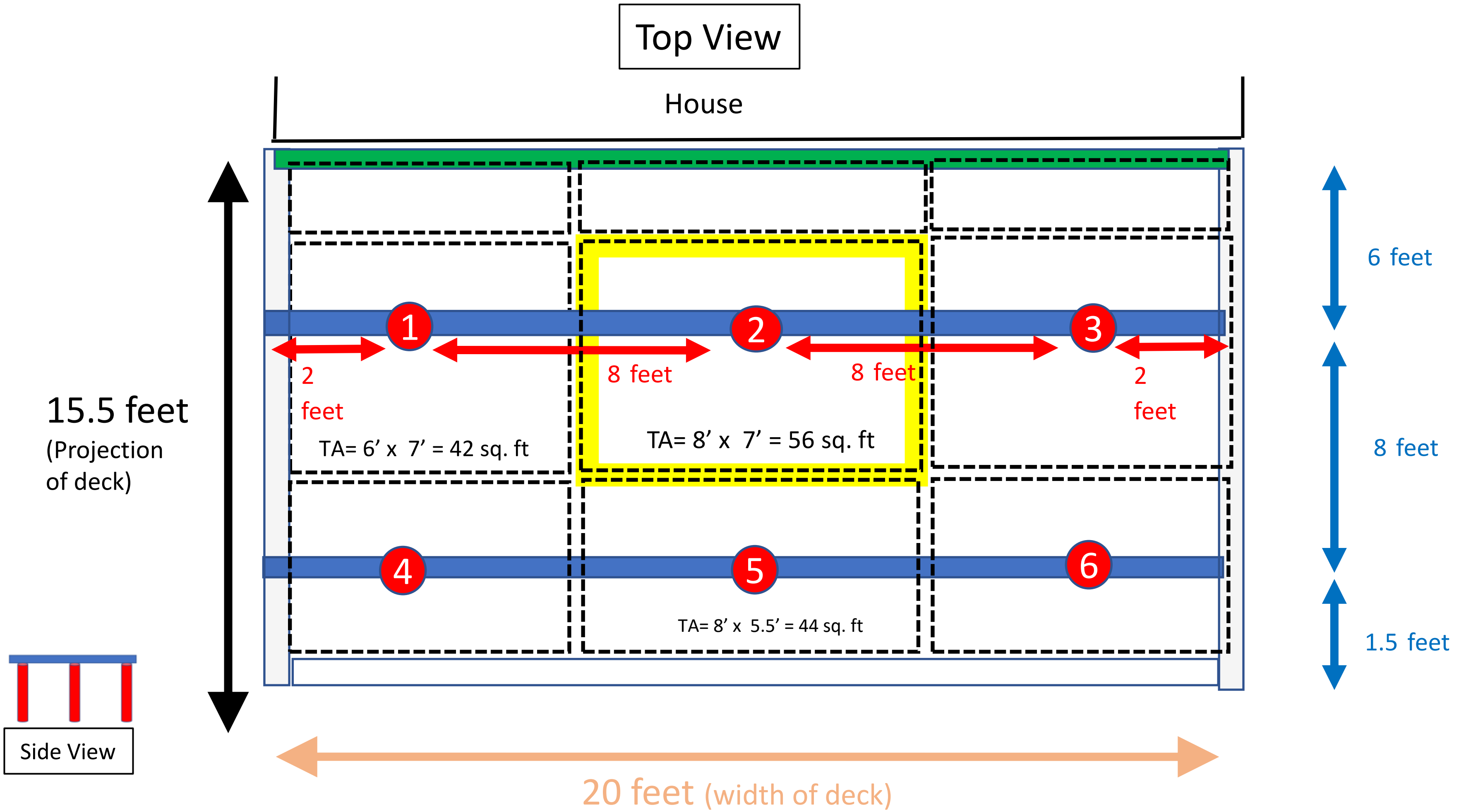
Below is a drawing of a deck viewed from above. The deck boards are transparent so you see the structural components underneath



VII. Example – Deck post footing size calculation

Using the same deck as on prior page, we show how to identify the load on any given footing, which we use to determine footing size.

To determine the tributary area of each post/footing, you must know the distance between posts and between beams. The TA is a measure of the length and the width that a post and footing carry. By taking ½ the distance between one post in each direction you can determine how much surface area of the deck that post and footing will carry.



Red arrows = distance between posts
Blue Arrows = distance between beams/overhang
= post / footing
= beam
Dotted lines = Trib Area of each post/footing
Yellow outline = Largest Trib Area
= ledger

Note this deck has a ledger (green), which means the deck is connected to the house, which will carry part of the load.

In our example, we can look at any post/footing to determine its tributary area. We will examine the calculations for Post 1 and Post 2. A single post will have one footing to support its load. They are identified in our example by the red circle with a number.

In this example Footing 1 carries half the distance to the house (half of 6' = 3') in one direction and half the distance to the post under the nearest beam (post # 4) (half of 8' = 4') in the other. So post #1 carries 7 feet (3' + 4') in one direction (projection of the deck away from the house)

In the other direction (width of the deck), Footing #1 will carry the overhang (the distance between the post and the edge of the deck = 2') and half the distance to post #2 (half of 8' = 4'). For a total of 6'

Therefore the tributary area of Footing #1 = 6' x 7' or 42 square feet. This is 6' of width and 7' of projection.

Normal decks are considered to have a dead load of 10 lbs. per square foot and a live load of 40 lbs. per square foot. This example applies to areas where the snow load is LESS THAN 40 pounds per square foot (psf). See Appendix 2 for an example of a snow load HIGHER THAN 40 psf

The 42 square feet of Footing 1 multiplied by 50 lbs./per square foot = 2100 lbs. of total load on Footing #1. See next page for calculations of the footing size.

With the data we collect on the footingpad.com calculator, we need to identify the *largest* tributary area (TA) of the deck. In the example, that TA is identified by a yellow border carried by Footing #2. As the beam that post/footing #2 supports is 6' from the house and the next beam is 8' away the projection carried by #2 is 7' (½ of 6 feet + ½ of 8 feet). The width of post 2's TA is dependent on the spacing of the posts along the beam. Since they are 8' apart, post #2 carries 4' in both directions, for a total of 8 feet.

The TA of post #5 is 7' projection + 8' width or 8 x 8 = 56 square feet.

Often, as in this example, an interior footing will have the largest tributary area.

Now that we know the tributary area size in square feet carried by post #1 and post #2, we only need to know the soil load capacity to calculate the size of the footing.

Using the formula below

A = B/C

Where
A = Surface area of the footing
B = Load on the footing in lbs.
C = Load carrying capacity of the soil in psf

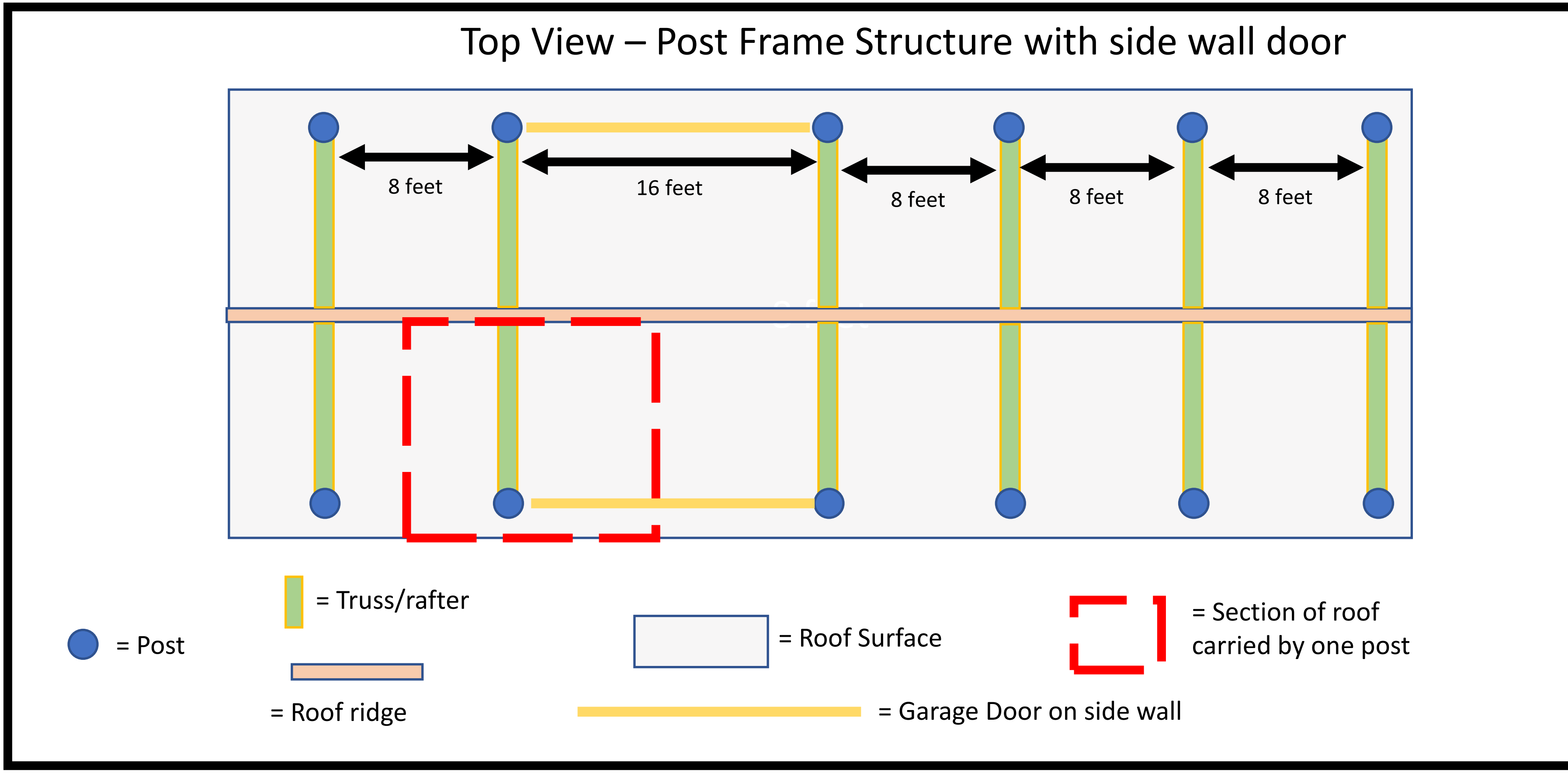
Post #1
Calculate the load:
B = 42 square feet x 50 lbs. = 2100 lbs.
C = Soil Capacity = 3000 psf
A = 2100 / 3000
A = 0.7
As .7850 > .70, a 12” or larger FootingPad will work for post #1

Post #2
Calculate the load:
B = 56 square feet x 50 lbs. = 3200 lbs.
C = Soil Capacity = 3000 psf
A = 3200 / 3000
A = 1.0667
As 1.3556 > 1.0667, a 16” or larger FootingPad will work for post #2

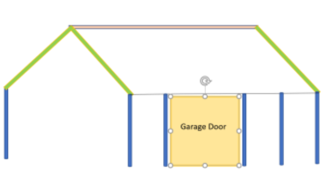
FootingPad diameter	Surface area of FootingPad (sq. ft)
10”	.545
12”	.785
16”	1.39
20”	2.18
24”	3.14

Appendix 1: Load Calculation formula for post frame door on SIDE wall

Many post frame buildings have overhead or other large doors on the end walls, which carry little structural weight. If your post frame building has a door on the SIDE wall, and that door is WIDER than your post spacing, you will have extra weight on the posts on either side of the door. This will require a separate footing size calculation.

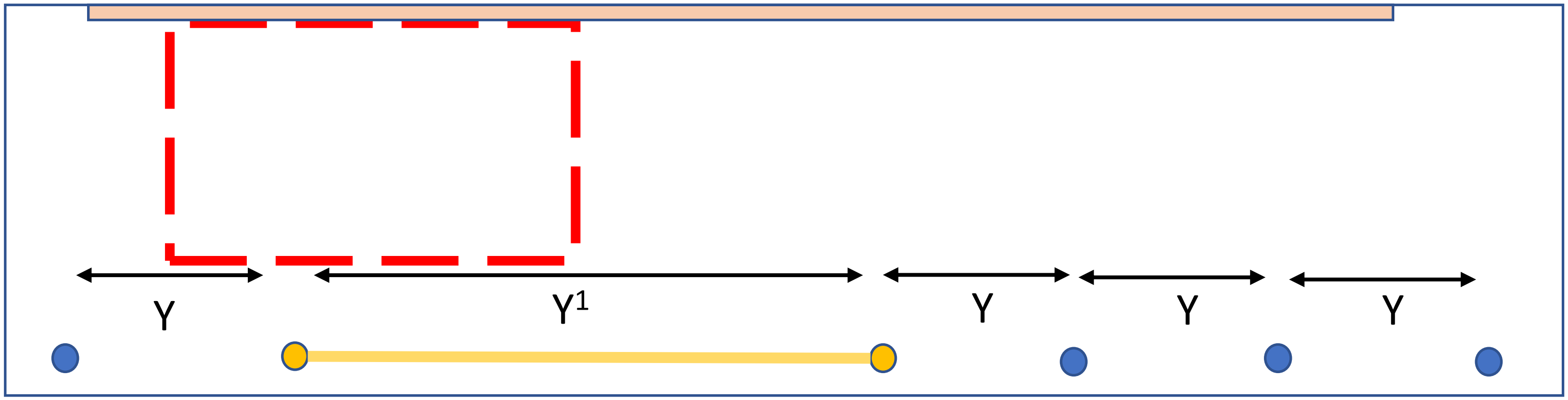


Side View



Because of the wider spacing of the posts on either side of the wide garage door, there is more roof carried by those posts which increases the load. Therefore the calculation changes slightly. See next page.

Top View – one side



Using the same data from the earlier post frame example:

Building Width:	40 feet
Soil Capacity:	3000 psf
Post Spacing (Y):	8 feet
Post Spacing – door (Y^1):	16 feet
Snow Load	20 lbs. / square foot

Surface area of footing (in sq. ft) = Total load (in lbs.) on footing / Soil Capacity

Total load = (½ building width x (½ Y + ½ Y^1 Post spacing) x (5 lbs. dead load[1] + snow load[2])
= 20' x (1/2 of 8' + ½ of 16') x (5 + 20 lbs. / square foot)
= 20' x (4' + 8') = 240 square feet x 25 lbs. / square foot
= 6000 lbs.

Surface area of footing (in sq. ft) = 6000 / 3000
Surface area of footing (in sq. ft) = 2.0

As the 20" FootingPad is larger than the required 2.0 square feet, this size is needed for those posts on either side of the door.

FootingPad diameter	Surface area of FootingPad (sq. ft)
10"	.545
12"	.785
16"	1.39
20"	2.18
24"	3.14

Appendix 2: Load Calculation formula for high snow loads on decks

Snow loads also impact the load on a deck. Unlike post frame buildings, the snow load on a deck is considered only if it is higher than the live load of the deck, generally assumed to be 40 lbs. per square foot (psf). The assumption is that there will not be both live load (people) and snow on the deck at the same time. Consequently, the load formula changes slightly when the snow load is greater than 40 lbs. psf.

Using our earlier example of tributary area size, except that now we have a snow load of 50 lbs. psf:

FootingPad diameter	Surface area of FootingPad (sq. ft)
10”	.545
12”	.785
16”	1.39
20”	2.18
24”	3.14

Post #1

Calculate the load:

B = 42 square feet x (10 lbs. dead load + 50 lbs. snow load)

B = 42 square feet x (60 lbs. per square foot) = 2,520 lbs.

C = Soil Capacity = 3000 psf

A = 2520 / 3000

A = 0.84

We now need to move to a 16” footing (1.39 > .84) for post #1

Post # 5

Calculate the load:

B = 64 square feet x (10 lbs. dead load + 50 lbs. snow load)

B= 64 square feet x 60 lbs. per square foot = 3,840 lbs.

C = Soil Capacity = 3000 psf

A = 3840 / 3000

A = 1.28

As 1.39 > 1.28, we are able to stay with a 16” or larger FootingPad will for post #5