

POLE BUILDING STRUCTURES DESIGN GUIDE

(For Carrier Headers and Footing Sizes)

Section 1: Calculation Method.....When you know your site conditions.

**Section 2: Short Cut Table Method...When you do not know your site conditions
Or prefer designing to “Worst Case Scenario”.**

**Section 3: Sample Plans.....Minimum Structural Information Needed
To complete a Plan Review.**

**BENZIE COUNTY BUILDING SAFETY and CODE ENFORCEMENT
DEPARTMENT**

July 1st, 2009

EXPLANATION of this Design Criteria

TO: DESIGNERS, BUILDERS, & HOME OWNERS

RE: Sizing Pole Barn Carriers, Footings and Building Headers.

As many of you know,

- * The Michigan Bldg Code and The Michigan Residential Code now both tie the Roof design criteria found in ACSE 7-05 for all buildings in Benzie County.
- * While the State Code previously provided for the use of a single design load for All roofs in the County, now the design loads are a product of specific site Conditions, uses and methods of construction.
- * The truss manufacturers have adapted to this by creating a worst case scenario Truss that covers most site conditions using design loads of 47lb Snow and 17lbs Dead.

Unfortunately these changes have not been as easily accepted when it comes to Pole Building Carriers, Footings and Residential Headers. Through we request site condition information we typically do not receive it, therefore our only options are to use the Worst Case Scenario tables for the plan review or stall the plan review. These "Short Cut Tables" (based on the 47/17 loads), that we have been providing, though easy to use, sometimes create a building that has been over designed for its site conditions.

In another effort to try to make this easier to handle, our office has developed an additional Pole Building Booklet to help with this transition.

Section 1 of the booklet is a step by step process for builders, designers and homeowners to identify their absolute minimum design loads based on specific site conditions and uses. Of special note, when used, the actual resulting loads are often found to be lower than that required of the previous code. Unfortunately though, unless the site conditions are indicated with the plans, our only choices will be to continue to use the short cut tables found in Section 2 of the booklet, or delay the plan review until sufficient design data has been supplied.

A third option for Residential Accessory Buildings, is to use the header sizing charts found in the Michigan Residential Code after interpolating for the 60lb Ground Snow Load.

POLE BUILDING DESIGN CALCULATION METHOD

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1. Select **ROOF SNOW LOAD** (live load) based on site conditions.

- Unheated / non-sheltered / suburban utility building = 41 lbs / sq. ft snow load
- Unheated / sheltered / suburban utility building = 49 lbs / sq. ft snow load
- Heated / non-sheltered / suburban utility building = 37 lbs / sq. ft snow load
- Heated / sheltered / suburban utility building = 45 lbs / sq. ft snow load

2. Select **ROOF DEAD LOAD**.

- Trusses 48" o.c. / steel roofing / stl. Ceiling / no attic load = 6 lbs. / sq. ft dead load
- Trusses 24" o.c. / shingled roof / stl. Ceiling / no attic load = 10 lbs / sq. ft dead load
- Trusses 24" o.c. / shingled roof / drywll ceiling / no attic load = 17 lbs / sq. ft dead load

3. Determine **LOAD ON CARRIERS**

IN SQ. FT

$$\text{Roof snow load} \times \frac{(\text{roof width} + \text{overhangs})}{2} = (\quad \#) \times \left(\frac{ \quad ' + \quad ' }{2} \right) = \text{Live load per foot} = \quad \#$$

on carriers

$$\text{Live load per ft on carriers} \times \text{truss spacing in feet} = (\quad \#) \times (\quad ') = \text{Live load per truss} = \quad \#$$

$$\text{Roof dead load} \times \frac{(\text{roof width} + \text{overhangs})}{2} = (\quad \#) \times \left(\frac{ \quad ' + \quad ' }{2} \right) = \text{Dead load per} = \quad \#$$

ft on carrier

$$\text{Dead load per ft on carriers} \times \text{truss spacing in feet} = (\quad \#) \times (\quad ') = \text{Dead load per} = \quad \#$$

On carrier

4. Select **SOIL CLASSIFICATION**

- crystalline bedrock 12,000 psf bearing capacity
- sedimentary and foliated rock 4,000 psf bearing capacity
- sandy gravel and or gravel 3,000 psf bearing capacity
- sand, silty sand, clayey sand
Silty gravel, clayey gravel 2,000 psf bearing capacity
- clay, sandy clay, clayey silt, 1,500 psf bearing capacity

POLE BUILDING DESIGN CALCULATION METHOD

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5. Determine FOOTING SIZE

(Live load per ft on carrier + dead load per ft on carrier) x post spacing in feet = Load on column

(_____ # + _____ #) x (_____ ') = _____ # = Load on column

$\frac{\text{Load on column}}{\text{Soil bearing capacity}} = \text{Square ft of footing required}$

$\frac{(\text{ _____ } \#)}{(\text{ _____ } \#)} = \text{ _____ Sq. ft}$

NOTE: OVERHEAD DOORS ON EAVE SIDES REQUIRE SPECIAL FOOTING DESIGN EACH SIDE OF HEADER FOR OPENINGS GREATER THAN TYPICAL POST SPACING.

For Square Footings: Length in feet x width in feet = area of footing in sq. ft.

(_____ ') x (_____ ') = _____ Sq. Ft.

For round footings: $\frac{3.14 \times \text{diameter in feet} \times \text{diameter in feet}}{4} = \text{Area of footing in Sq. Ft.}$

$\frac{3.14 \times (\text{ _____ ' }) \times (\text{ _____ ' })}{4} = \text{ _____ Sq. Ft.}$

NOTE: 1. AREA OF FOOTING PROVIDED MUST MEET OR EXCEED AREA OF FOOTING REQUIRED.

2. FOOTING PROJECTION SHALL NOT EXCEED THE THICKNESS OF THE FOOTING.

6. Information required to determine CARRIER SIZE AND NUMBER

A. Select Species and Grade of carrier to be used NO. _____
1,2,3 SPF, HF, SYP, Other

B. Live load per truss on carrier _____ #

C. Dead load per truss on carrier _____ #

D. Truss spacing _____ 'O.C.

NOTE: FOR TRUSSES 2' ON CENTER, One 2 x 12, #2, HF, that spans 8', can support a total Uniform load of 2432 lbs or 304 lbs/ft.

Sample: 24' wide pole building with 1' OH, 2' o.c. trusses, 13' Trib. 41/10 loading on sand/gravel 13' Trib x 51 lbs x 6' = 13' Trib x 51 lbs x 6' = 3978 uniform LBS.....Thus (2) 2 x 12's are needed

NOTE: FOR TRUSSES 4' ON CENTER, One 2 x 12 of HF #2, that spans 8' can support one Concentrated truss load of 1266 Lbs., at mid span.

Sample: 24' wide pole building with 1' OH, 13' Trib, 41/6 loading on sandy/gravel, 13' Trib x 47 lbs x 4' = 2444 LBS.....
 Thus (2) 2 x 12's are needed

Shortcut Table 1 of 5

POLE BUILDING TRUSS CARRIERS (SOUTHERN PINE)

Carrier Size: 2 x 10

Grade & Species: #2 & better, southern pine

Truss Span	No. of Carries each side of building
24'	3
26'	3
28'	4
30'	4
32'	4
34'	4
36'	4
38'	Exceeds 4 carriers, provide calculations

Carrier Size: 2 x 12

Grade & Species: #2 & better, southern pine

Truss Span	No. of Carriers each side of building
24'	3
26'	3
28'	3
30'	3
32'	3
34'	3
36'	4
40'	4
42'	4
44'	4
46'	4
48'	Exceeds 4 carriers, provide calculations

DESIGN ASSUMPTIONS:

1. Columns are 6 x 6, spaced 8'-0" o.c. max.
2. Trusses are spaced 2'-0" o.c., uniform loading
3. Carriers are continuous two span
4. Loading based on 47psf, TC LL, 7psf, TC DL, 10 psf, BC DL, 64psf, TOT LD
5. Truss span includes overhang

Shortcut Table 2 of 5

POLE BUILDING TRUSS CARRIERS (hem-fir)

Carrier Size: 2 x 10

Grade & Species: #2 & better, hem-fir

<u>Truss Span</u>	<u>No. of Carriers each side of building</u>
24'	4
26'	4
28'	4
30'	Exceeds 4 carriers, provide design calculations

Carrier Size: 2 x 12

Grade & Species: #2 & better, hem-fir

<u>Truss Span</u>	<u>No. of Carriers each side of building</u>
24'	3
26'	3
28'	3
30'	4
32'	4
34'	4
36'	4
38'	4
40'	Exceeds 4 carriers, provide design calculations

DESIGN ASSUMPTIONS:

1. Columns are 6 x 6, spaced 8'-0" o.c. max.
2. Trusses are spaced 2'-0" o.c., uniform loading
3. Carriers are continuous two span.
4. Loading based on 47psf, TC LL, 7psf, TC DL, 10psf, TOT LD
5. Truss span includes overhang

Shortcut Table 3 of 5

POLE BUILDING TRUSS CARRIERS (SPF)

Carrier Size: 2 x 10

Grade & Species: #2 & better, spruce, pine, fir

<u>Truss Span</u>	<u>No. of Carriers each side of building</u>
24'	4
26'	4
28'	Exceeds 4 carriers, provide design calculations

Carrier Size: 2 x 12

Grade & Species: #2 & better, spruce, pine, fir

<u>Truss Span</u>	<u>No. of Carriers each side of building</u>
24'	3
26'	3
28'	4
30'	4
32'	4
34'	4
36'	4
38'	Exceeds 4 carriers, provide design calculations

DESIGN ASSUMPTIONS:

1. Columns are 6 x 6, spaced 8'-0" o.c. max.
2. Trusses are spaced 2'-0" o.c., uniform loading
3. Carriers are continuous two span.
4. Loading based on 47psf, TC LL, 7psf, TC DL, 10psf, BC DL, 64psf, TOT LD
5. Truss span includes overhang

Shortcut Table 4 of 5

POLE BUILDING FOOTINGS (Minimum Sizes)

<u>Roof Loading</u>		<u>Soil Bearing Capacity</u>					
Building Span ft.	Load on Columns lbs.	2000 psf		2500 psf		3000 psf	
		square l & w x d	round dia. X d	square l & w x d	round dia. X d	square l & w x d	round dia. X d
12	3072	16" x 8"	18" x 8"	14" x 8"	16" x 8"	14" x 8"	14" x 8"
14	3584	16" x 8"	18" x 8"	16" x 8"	18" x 8"	14" x 8"	16" x 8"
16	4096	18" x 8"	20" x 8"	16" x 8"	18" x 8"	14" x 8"	16" x 8"
18	4608	20" x 8"	22" x 8"	18" x 8"	20" x 8"	16" x 8"	18" x 8"
20	5120	20" x 8"	24" x 10"	18" x 8"	20" x 8"	16" x 8"	18" x 8"
22	5632	22" x 8"	24" x 10"	20" x 8"	22" x 8"	18" x 8"	20" x 8"
24	6144	24" x 10"	24" x 10"	20" x 8"	22" x 8"	18" x 8"	20" x 8"
26	6656	24" x 10"	26" x 10"	20" x 8"	24" x 10"	18" x 8"	22" x 8"
28	7168	24" x 10"	26" x 10"	22" x 8"	24" x 10"	20" x 8"	22" x 8"
30	7680	24" x 10"	28" x 12"	22" x 8"	24" x 10"	20" x 8"	24" x 10"
32	8192	26" x 10"	28" x 12"	24" x 10"	26" x 10"	20" x 8"	24" x 10"
34	8704	26" x 10"	30" x 12"	24" x 10"	26" x 10"	22" x 8"	24" x 10"
36	9216	26" x 10"	30" x 12"	24" x 10"	26" x 10"	22" x 8"	24" x 10"
38	9728	28" x 12"	30" x 12"	24" x 10"	28" x 12"	24" x 10"	26" x 10"
40	10240	28" x 12"	32" x 15"	26" x 10"	28" x 12"	24" x 10"	26" x 10"
42	10752	30" x 12"	32" x 15"	26" x 10"	30" x 12"	24" x 10"	26" x 10"
44	11264	30" x 12"	34" x 15"	26" x 10"	30" x 12"	24" x 10"	28" x 12"
46	11776	30" x 12"	34" x 15"	26" x 10"	30" x 12"	24" x 10"	28" x 12"
48	12288	30" x 12"	36" x 15"	28" x 12"	32" x 15"	26" x 10"	28" x 12"
50	12800	32" x 15"	36" x 15"	30" x 12"	32" x 15"	26" x 10"	30" x 12"
52	13312	32" x 15"	36" x 15"	30" x 12"	32" x 15"	26" x 10"	30" x 12"
54	13824	32" x 15"	36" x 15"	30" x 12"	32" x 15"	26" x 10"	30" x 12"
56	14336	32" x 15"		30" x 12"	34" x 15"	26" x 10"	30" x 12"
58	14848	34" x 15"		30" x 12"	34" x 15"	28" x 12"	32" x 15"
60	15360	34" x 15"		30" x 12"	36" x 15"	28" x 12"	32" x 15"

DESIGN ASSUMPTIONS:

1. Minimum concrete strength is 2500 psi.
2. Load on column is based on column spacing of 8'-0" o.c.
3. Loading based on 47psf, TC LL, 7psf, TC DL, 10psf, BC DL, 64psf, TOT LD
4. Building span includes overhang
5. Openings in bearing walls greater than 8'-0" require footing design each side of opening.

SOIL CLASSIFICATIONS:

Class of material	allowable foundation pressure (psf)
1. Sandy gravel and/or gravel (GW and GP)	3000
2. Sand, silty sand, clayey sand, silty gravel and Clayey gravel, (SW< SP< SM< SC< GM< GC)	2,000
3. Clay, sandy clay, silty clay, clayey silt, silt and Sandy silt (CL< ML< MH< CH)	1,500

Shortcut Table 5 of 5

POLE BUILDING FOOTINGS

Load on Column lbs.	Roof Loading		Soil Bearing Capacity			
	2000 psf		2500 psf		3000 psf	
	square l & w x d	round dia. x d	square l & w x d	round dia. x d	square l & w x d	round dia. x d
3000 – 4000	18" x 8"	20" x 8"	18" x 8"	18" x 8"	14" x 8"	16" x 8"
4001 – 5500	20" x 8"	24" x 10"	18" x 8"	20" x 8"	18" x 8"	20" x 8"
5501 – 7500	24" x 10"	28" x 12"	20" x 8"	24" x 10"	20" x 8"	22" x 8"
7501 – 9500	28" x 12"	30" x 12"	24" x 10"	28" x 12"	22" x 8"	26" x 10"
9501 – 11500	30" x 12"	34" x 15"	26" x 10"	30" x 12"	24" x 10"	28" x 12"
11501 – 14000	32" x 15"	36" x 15"	30" x 12"	32" x 15"	26" x 10"	30" x 12"

Inches to feet Conversion

18" = 1.5'	28" = 2.33'
20" = 1.67'	30" = 2.5'
22" = 1.83'	32" = 2.67'
24" = 2.0'	34" = 2.83'
26" = 2.17'	36" = 3.0'

SOIL CLASSIFICATIONS:

Class of material	allowable foundation pressure (psf)
1. Sandy gravel and/or gravel (GW and GP)	3,000
2. Sand, silty sand, clayey sand, silty gravel and Clayey gravel (SW ,SP ,SM, SC, GM, GC)	2,000
3. Clay, sandy clay, silty clay, clayey silt, silt and Sandy silt (CL, ML, MH, CH)	1,500

Typical snow load design assumptions for Benzie County based on ASCE 7-05 for flat roofs.

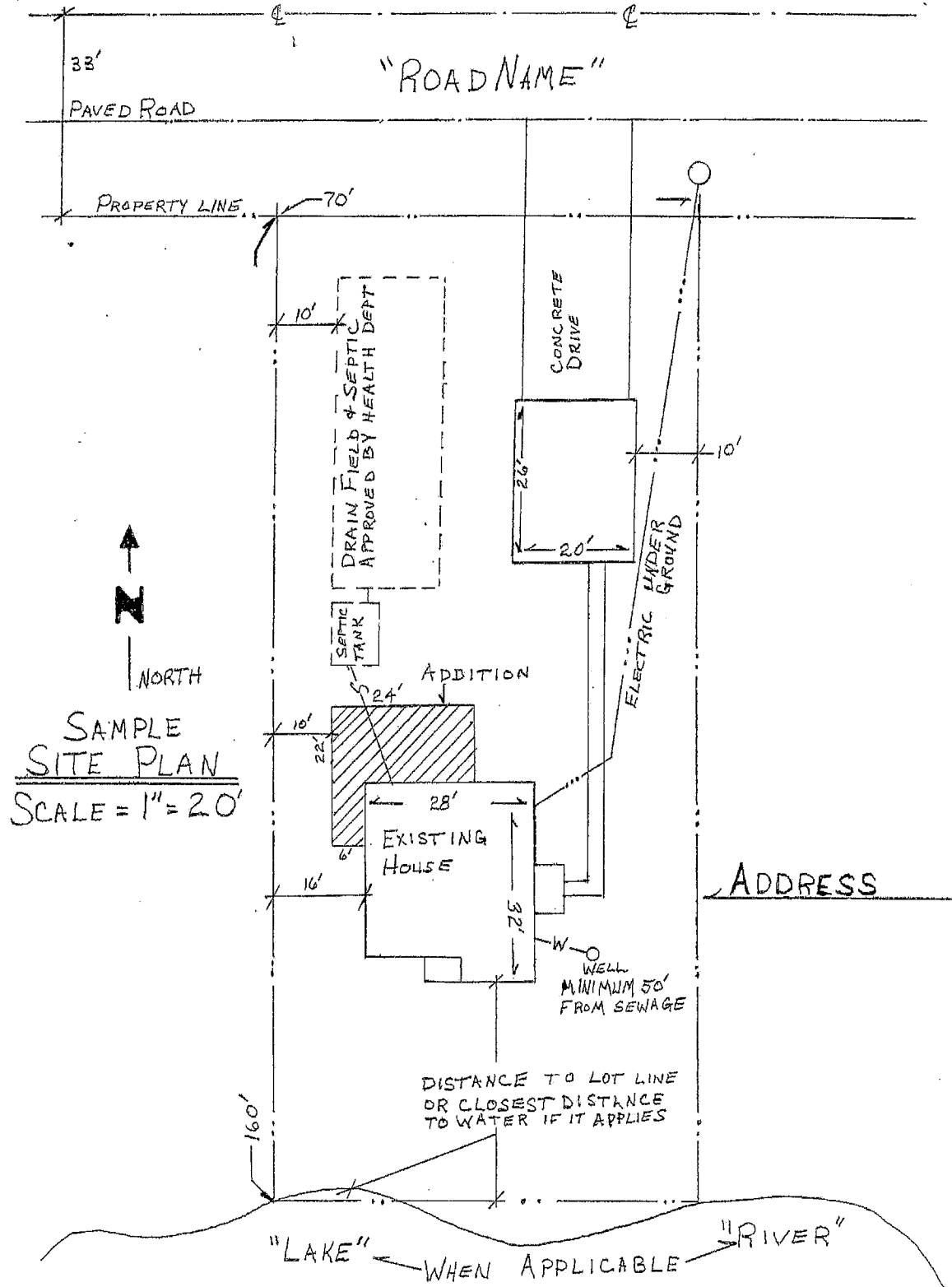
- 60 PSF GROUND SNOW LOAD (Pg) (for all areas of Benzie County)
- Important Factors (I) (for most garages and utility buildings will not exceed 0.8)
- Exposure Factors (Ce) (1.0 for open areas) (1.2 for sheltered areas with trees)
- Thermal Factors (Ct) (for heated buildings typically will not exceed 1.1)
 (for unheated buildings typically will not exceed 1.2)
- ASCE'S GIVEN CALCULATION **Pf, snow load = 0.7 Ce Ct I Pg**

Explanations/Definitions

Provide two (2) sets of plans for job.

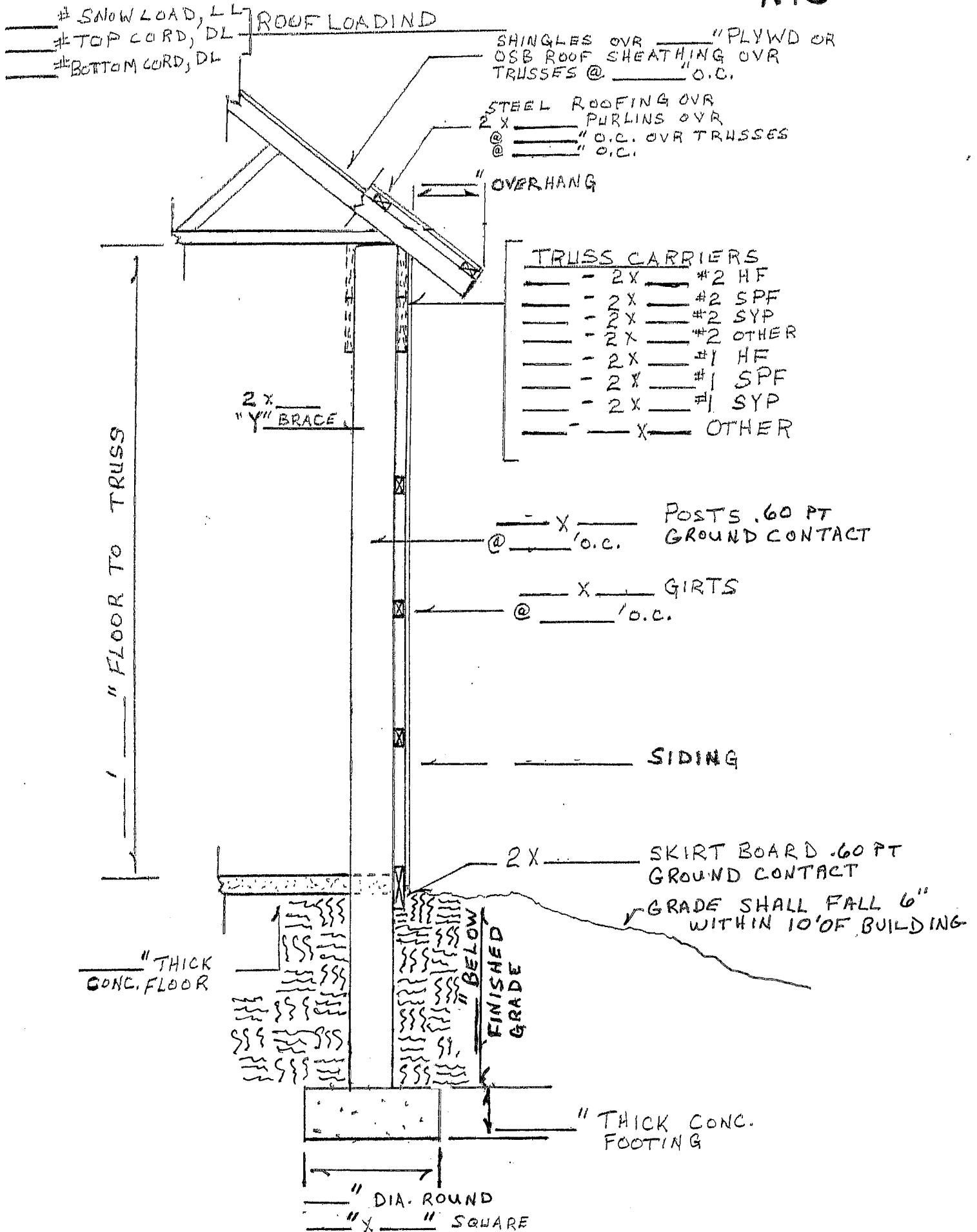
All plans need to include engineered truss drawing, from owner/builder or truss company.

BC.....	bottom cord	Ce.....	Snow exposure factor
Conc.....	Concrete	Ct.....	Thermal factor
DL.....	dead load	HDR.....	Header
HF.....	Hem fir	I.....	Important factors
LD.....	load	LL.....	live load
NTS.....	Not to scale	O.C.....	On center
OVR.....	Over	Pf.....	Flat-roof snow load
Pg.....	Ground Snow load	Plywd.....	Plywood
Psf.....	Pounds per square foot	Psi.....	Pounds per square inch
SPF.....	Spruce, Pine, Fir	PT.....	Pressure Treated
TC.....	top cord	SYP.....	Southern yellow pine
TYP.....	Typical	TOT.....	total

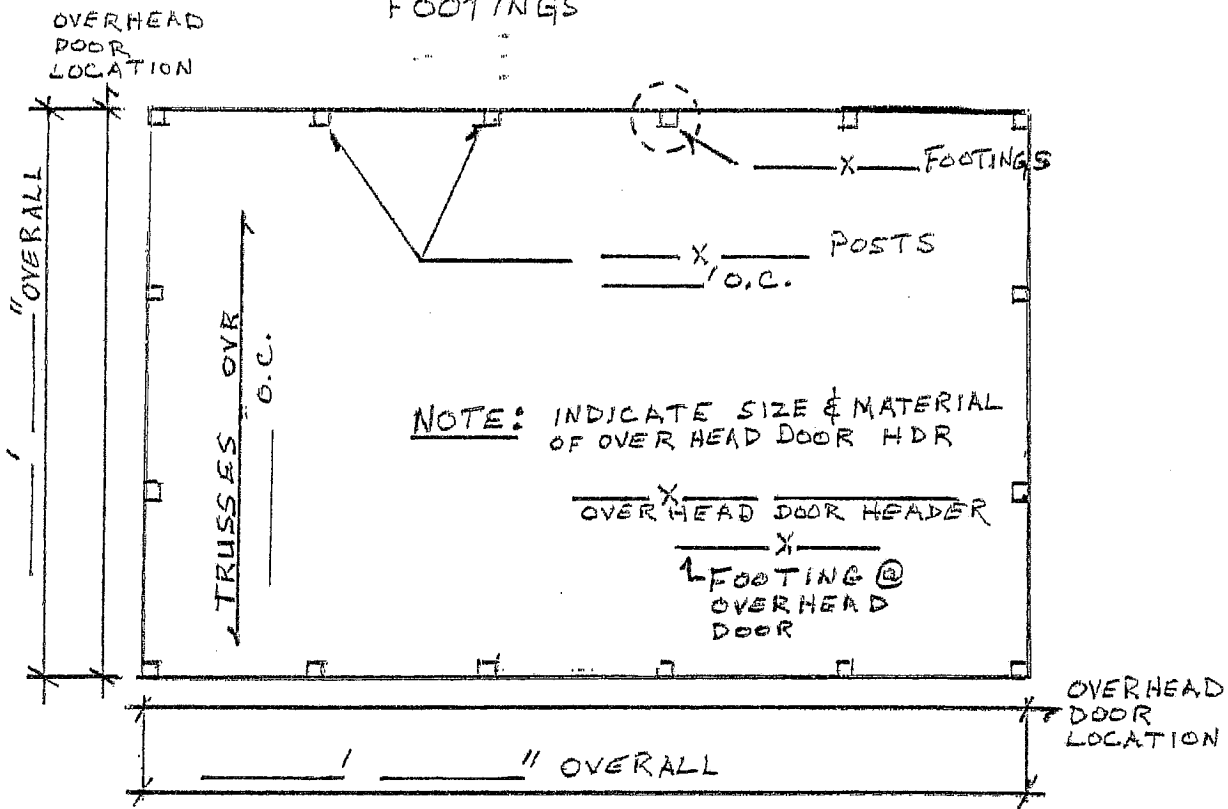


PROVIDE SITE PLAN

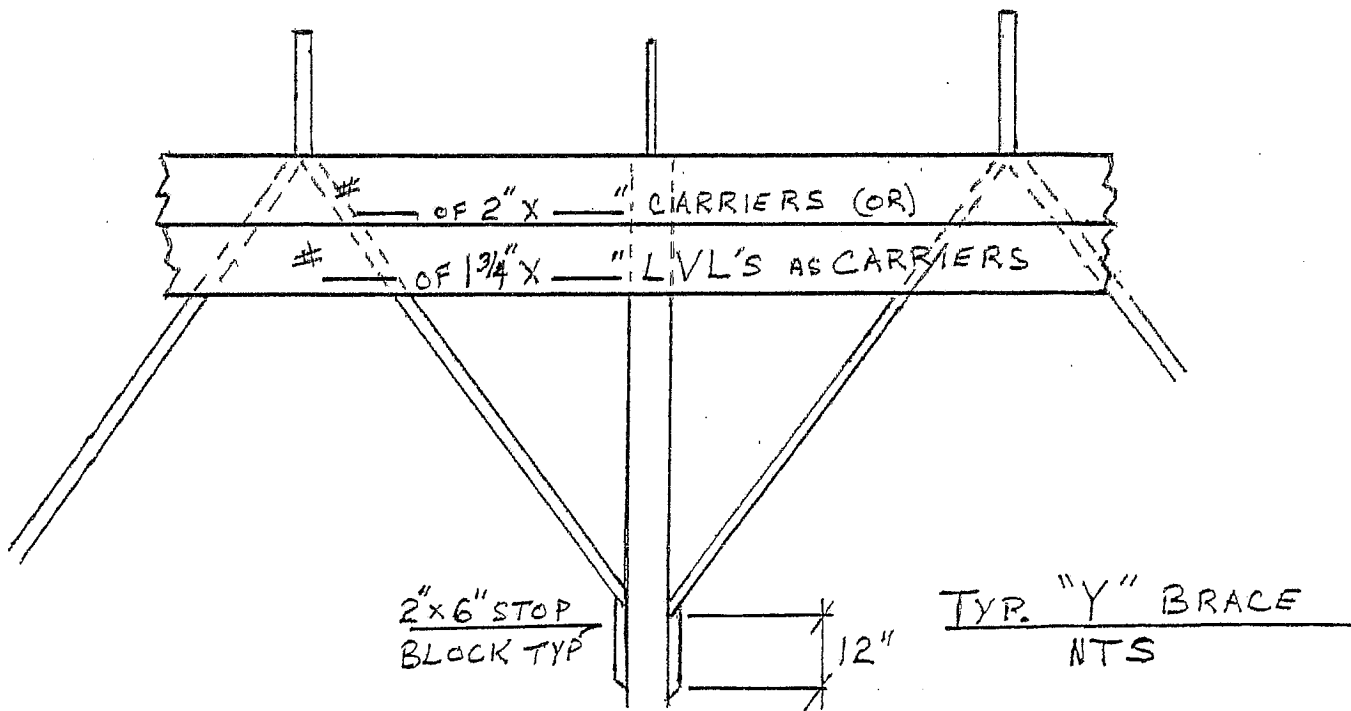
TYPICAL POLE BUILDING SECTION "NTS"



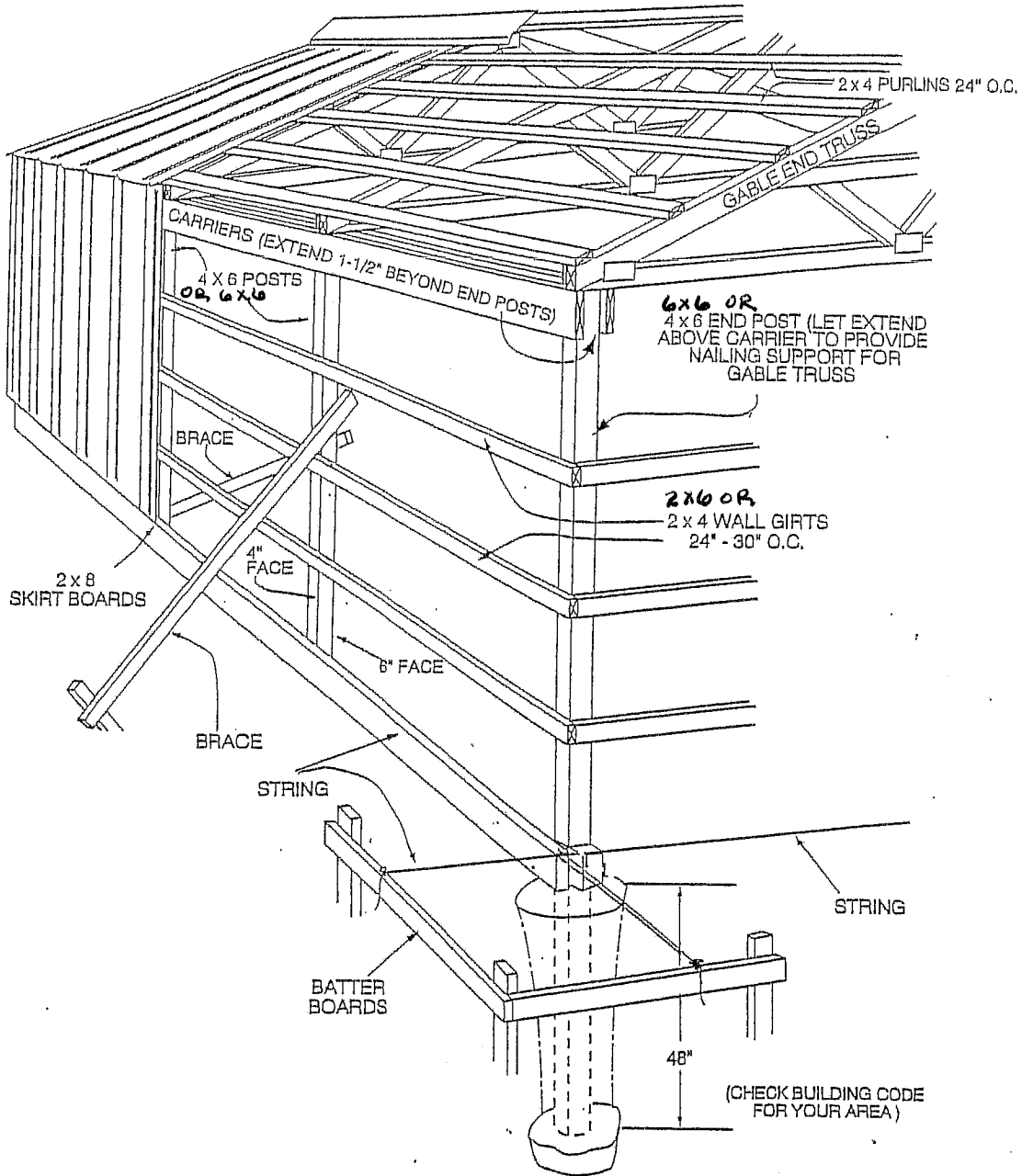
NOTE: OVERHEAD DOOR OPENING
WIDER THAN TYPICAL POST SPACING
REQUIRE SPECIAL HEADERS AND
FOOTINGS



TYPICAL POLE BUILDING PLAN "NTS"



BASIC POLE BARN CONSTRUCTION



Note: A building at this stage is very easily damaged by wind. It should be well braced and never left for any length of time without siding.

