



Structural Design
(801) 876-3501

1/26/2016

Structural Calculations

Net Zero Tiny House
1748 E 4600 S
Ogden, Utah

Prepared For:



1/26/2016

1/26/2016

STRUCTURAL CALCULATIONS

For:

Plan #: Net Zero Tiny House

Location: 1748 E 4600 S

From: York Engineering Inc.
2329 West Spring Hollow Road
Morgan, Utah 84050
(801) 876-3501

Design Criteria 2012 IBC:

Roof Loads:

Roof Snow Load (psf): 40

Roof Dead Load (psf): 15

Floor Loads:

Floor Live Load (psf): 40

Floor Dead Load (psf): 10

Seismic Design Category: D

Wind Speed: 115 mph for Exposure C

Material Properties:

Concrete (f_c'): 3000 psi (foundation) to 4000 psi (suspended slab)

Concrete Reinforcement: ASTM A615 Grade 60

Site Conditions: Dry & stable granular based, 1500 psf bearing capacity, granular based

Backfill: KH = 35 pcf, slope not to exceed 20%, setback from slopes is min. 25'

Dimensional Lumber: Doug Fir #2 or better

Steel: ASTM Grade 50

Use straps and tie downs, and meet nailing, reinforcement and other structural requirements as noted on the drawing and within the pages of this document. These structural calculations are based on conditions and assumptions listed above. If the conditions listed herein are not met or are different it shall be brought to the attention of the engineer. Prefab roof trusses to be engineered by the supplier. This engineering assumes that the building site is dry and stable, a high water table or adverse soils such as plastic clays, fills etc. could cause future flooding, settlement, site instability, or other adverse conditions. Verification of and liability for the soil bearing pressure, site stability, and all other site conditions, including site engineering as required, is the responsibility of others. These calculations and engineering are for the new building structure only and do not provide any engineering analysis of or liability/warranty for the non-structural portions of the building, or the site itself. York Engineering Inc. does not assume the role of "Registered Design Professional in Responsible Charge" on this project. The purpose of these calculations and engineering is to help reduce structural damage and loss of life due to seismic activity and/or high wind conditions.

The following general requirements shall be followed during construction:

1. Contractor to verify all dimensions, spans, & conditions and notify engineer of any errors, omissions, or discrepancies prior to construction.
2. If discrepancies are found, the more stringent specification shall be followed.
3. All 2-ply and 3-ply beams and headers to be nailed using 16d two rows @ 12" O.C.
4. Contractor shall assure that all materials are used per manufactures recommendations.
5. Site engineering and liability shall be provided by the owner/builder as required.
6. Contractor shall assure that footings are properly drained, soil is dry, footings rest on undisturbed native soil, building horizontal clearance from footings to adjacent slopes be a minimum of 25 feet, and that the intent of IRC Section R403.1.7.2 is met. If setback requirements of R403.1.7.2 cannot be met then contact engineer for further design requirements.
7. The contractor shall conform to all building codes and practices as per the 2012 IRC
8. Use balloon framing method when connecting floors in split level designs.
9. Provide solid blocking through structure down to footing for all load paths
10. Builder shall follow all recommendations found in all applicable geotechnical reports.
11. Stacking of two sill plates is permitted with 5/8" J-Bolts through both plates. Stacking more than
12. two plates is not permitted without special engineering.
13. Minimum strength requires 2,500 PSI concrete; however, as per IRC 402.2 3,000 PSI concrete shall
14. be used.
15. All exterior walls shall be sheathed with 7/16" APA rated structural wood panel.
16. Block all horizontal edges 1 1/2" nominal or wider.
17. Sheathing shall extend continuous from floor to top plate and be nailed at least 4" O.C. along sill plate. Nails shall be placed not less than 1/2" from edge of panel and driven flush but shall not fracture the surface of the sheathing. Extend sheathing over gable end to wall joints and over rim joist between floors and nail to rim and wall plates at 6" O.C.

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	PASS	PASS	PASS	PASS	PASS
LOCATION	Back	Front	Left	Right	Interior
	FS: 2.09	FS: 2.58	FS: 3.65	FS: 3.65	FS: 3.2
SOIL SPECS					
Density (pcf)	125	125	125	125	125
Soil Pressure (psf)	1500	1500	1500	1500	1500
Weight (k/lft)	0.04	0.04	0.04	0.04	0.03
BUILDING LOADS					
Roof Span (ft)	18	18	4	4	0
Floor Span (ft)	9	0	4	4	9
Wall Height (ft)	10	10	10	10	10
Suspended Slab Span (ft)	0	0	0	0	0
Total Load (k/lft)	0.92	0.70	0.41	0.41	0.43
FOOTING SPECS					
Footing Width (in)	20	20	20	20	16
Footing Width (ft)	1.67	1.67	1.67	1.67	1.33
Footing Height (ft)	0.83	0.83	0.83	0.83	0.67
FOUNDATION					
Height Above Grade (in)	8	8	8	8	8
Wall Thickness (in)	8	8	8	8	8
Weight (k/lft)	0.07	0.07	0.07	0.07	0.07
	150	150	150	150	150
	2500	2500	2500	2500	2500
Clear Cover Thickness (in)	3	3	3	3	3
CALCULATIONS					
Total Weight on Soil (k)	1.20	0.97	0.69	0.69	0.63
Soil Load (ksf)	0.72	0.58	0.41	0.41	0.47
FOOTING SELECTION	F-20	F-20	F-20	F-20	F-16

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LOADING SUMMARY	
Roof Live Load (psf):	40
Roof DeadLoad (psf):	15
Floor Live Load (psf):	40
Floor Dead Load (psf):	10
Exterior Wall Dead Load (psf):	20
Interior Wall Dead Load (psf):	10
Suspended Slab Dead Load (psf):	75
Suspended Slab Live Load (psf):	60
SNOW LOAD PARAMETERS	
Roof Slope (x/12):	8
Roof Pitch (θ):	33.69
Total Roof Load (psf):	55.00
SEISMIC LOAD PARAMETERS	
Site Class:	D
F _a :	1.00
R:	6.5
S _s :	1.375
S _{MS} :	1.375
S _{DS} :	0.916
C _s :	0.141
Redundancy Factor, ρ	1.30
ASD Load Combination Factor:	0.70
Factored C _s :	0.128
SHEAR DISTRIBUTION	
Base Shear Force lb:	3,480
Floor 1 Lateral Force lb:	0
Floor 2 Lateral Force lb:	1,890
Roof Lateral Force lb:	1,591
Diaphragm Loading (plf):	50
	4.63

DIAPHRAGM LOADING								
	Avg. Length (ft)	Avg. Width (ft)	Wall Height (ft)	Dead Wgt. (psf)	Snow Wgt. (psf)	Diaphragm Weight (lb)	Wall Weight (lb)	Total Weight (lb)
Roof	20	16	---	15	8	7,367	5,040	12,407
Floor 2	20	16	7	10		1,780	12,960	14,740
Floor 1	20	16	11	10		3,200	9,360	12,560

SEISMIC FORCE DISTRIBUTION							
	H _x (ft)	W _x (kip)	H _x x W _x	% Force	Total Shear (kip)	F _x	V _x
Roof	22.67	12.41	281	59%	2.07	2.07	2.07
Floor 2	12.00	14.74	192	41%	3.48	1.41	3.48
Floor 1	1.00	0.00	0	0%	3.48	0.00	2.07
TOTALS	0.01	27.15	473	3,480	---	---	3.48

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LEFT AND RIGHT

**Wind Loading Calculations using Main Windforce-Resisting System (MWFRS)
 Longitudinal Direction
 Table 27.5-1 Steps to Determine MWFRS Loads Enclosed Simple Diaphragm Buildings**

Risk Category	II	Table 1.5-1	
Wind speed	115	Figure 26.5-1 A-B or C	
Exposure Category	C	Section 26.7	
L/B upper floor	0.80		
L/B main floor	0.80		
Roof Height	5.33		
Mean roof Height	23.7		
Truss Span	16		
Roof Slope		8 /12	
Roof Angle (deg)	33.69		Sine = 0.5547
Lower Truss Span	16		
Lower roof Slope		8 /12	
Lower roof Angle (deg)	33.69		Sine = 0.5547
Load combination factor	0.6	(ASCE 7-10 2.4.1)	
Upper floor, p _n	28.4	Table 27.6-1	
Upper floor, p _o	28.3	Table 27.6-1	
Main floor, p _n	28.3		
Main floor, p _o	28.2		
Basement floor, p _n	28.2		
Basement floor, p _o	27.6		
Upper Floor (psf)			
Net Pressure	17.0	Windward	10.5
		Leeward	6.5
		Relative positioning	
		Left	9.2
		Right	9.2
Main Floor (psf)			
Net Pressure	16.9	Windward	10.5
		Leeward	6.5
		Left	9.2
		Right	9.2
Basement Floor (psf)			
	16.7	Windward	10.3
		Leeward	6.4
		Left	9.1
		Right	9.1
Roof (psf)			
	Zone 1	Zone 2	Exposure Adj. Factor 1.000
Load Case 1	-6.4	-11.1	
Load Case 2	7.9	-5.3	
Lower Roof (psf)			
Load Case 1	-5.8	-10.1	
Load Case 2	7.2	-4.9	
Roof Load			
Roof Height	Length	Area (ft ²)	Horizontal Force (lbs)
5.33	20.00	106.7	1410
Lower Roof Load			
Low Roof Height	Upper Length	Lower length	Low Roof Length(ft)
5.3	20	20	0
		Area (ft ²)	Horizontal Force (lbs)
		0.0	0.0
Wall Load			
	Basement	(height) 1	1st floor
		(height) 12	2nd floor
		(height) 8	
	ft ²	force (lbs)	ft ²
Windward	20	206.2	240
Leeward	20	128.5	240
		force (lbs)	ft ²
		2517.7	160
		1549.2	160
		force (lbs)	force (lbs)
		1686.1	1036.0
2nd Floor Diaphragm Shear			
Total Shear (lbs)	2772		
Right Wall Length	0		
Left Wall Length	0		
1st Floor Diaphragm Shear			
Total Shear (lbs)	6166		
Right Wall Length	0		
Left Wall Length	0		
Basement Diaphragm Shear			
Total Shear (lbs)	8367		
Right Wall Length	0		
Left Wall Length	0		
Base Wind Shear	8534		
Hurricane Ties			
Uplift		Factors of Safety	
	(lbs)	H1	H2.5
Roof (per truss)	-4.2	-137.97	-141.51
Low roof (per truss)	-	-	-
Lateral		H1	H2.5
	(lbs)		
Roof (per truss)	4.4	178.09	93.02
Low roof (per truss)	0.0	-	-

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FRONT AND BAC

**Wind Loading Calculations using Main Windforce-Resisting System (MWFRS)
 Transverse Direction
 Table 27.5-1 Steps to Determine MWFRS Loads Enclosed Simple Diaphragm Buildings**

Risk Category	II	Table 1.5-1	
Wind speed	115	Figure 26.5-1 A-B or C	
Exposure Category	C	Section 26.7	
L/B upper floor	1.25		
L/B main floor	1.25		
Roof Height	5.33		
Mean roof Height	23.7		
Truss Span	16		
Roof Slope		8 /12	
Roof Angle (deg)	33.69		Sine = 0.5547
Lower Truss Span	16		
Lower roof Slope		8 /12	
Lower roof Angle (deg)	33.69		Sine = 0.5547
Load combination factor	0.6	(ASCE 7-10 2.4.1)	
Upper floor, p _n	27.4	Table 27.6-1	
Upper floor, p _o	27.3	Table 27.6-1	
Main floor, p _n	27.3		
Main floor, p _o	27.2		
Basement floor, p _n	27.2		
Basement floor, p _o	26.7		
Upper Floor (psf)			
Net Pressure	16.4	Windward	10.6
		Leeward	5.8
		Left	8.5
		Right	8.5
Main Floor (psf)			
Net Pressure	16.4	Windward	10.6
		Leeward	5.8
		Left	8.4
		Right	8.4
Basement Floor (psf)			
	16.2	Windward	10.4
		Leeward	5.7
		Left	8.4
		Right	8.4
Roof (psf)			
	Zone 1	Zone 2	Exposure Adj. Factor 1.000
Load Case 1	-6.4	-11.1	
Load Case 2	7.9	-5.3	
Lower Roof (psf)			
Load Case 1	-5.8	-10.1	
Load Case 2	7.2	-4.9	
Roof Load			
Roof Height	Length	Area (ft ²)	Horizontal Force (lbs)
5.33	16.00	85.33333333	1128
Lower Roof Load			
Lower Roof Height	Upper Length	Lower length	Low Roof Length(ft)
5.3	16	16	0
		Area (ft ²)	Horizontal Force (lbs)
		0	0.0
Wall Load			
	Basement	1st floor	2nd floor
	(height)	(height)	(height)
	1	12	8
	ft ²	ft ²	ft ²
Windward	16	192	2030.2
Leeward	16	192	128
	force (lbs)	force (lbs)	force (lbs)
	166.4	192	1360.4
	92.0	192	742.6
		1110.0	128
2nd Floor Diaphragm Shear			
Total Shear (lbs)	2180		
Front Wall Length	0		
Back Wall Length	0		
1st Floor Diaphragm Shear			
Total Shear (lbs)	4801		
Front Wall Length	0		
Back Wall Length	0		
Basement Diaphragm Shear			
Total Shear (lbs)	6501		
Front Wall Length	0		
Back Wall Length	0		
Base Wind Shear	6630		
Hurricane Ties			
		Factors of Safety	
Uplift	(lbs)	H1	H2.5
Roof (per truss)	-4.2	-137.97	-141.51
Low roof (per truss)	-	-	-
Lateral	(lbs)	H1	H2.5
Roof (per truss)	70.5	11.13	5.81
Low roof (per truss)	0.0	-	-

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PASS

Moment: 2.89

JOIST SPECIFICATION

Truss Joists

Joist Type:	TJI
Joist Series:	210
Joist Depth (ft):	9.5
Joist Span (ft):	9
Joist Spacing (in):	24

LOAD PARAMETERS

Floor Dead Load	10
Floor Live Load	40
Total Floor Load	50

SIMPLE SPAN JOIST

Duration Increase	1
Joist Weight (plf)	2.6
Joist Loading (plf)	103
Max Reaction (lb)	462
Max Moment (ft-lb)	1039

JOIST DETERMINATION

Max Moment 100% (ft-lb)	3000
Moment FS	2.89
Max Shear 100% (lb)	1336
Shear FS	2.89
Bearing Required (in)	2.00
Live Load Deflection Limit	360
Live Load Deflection (in)	0.08
Allowable Live Load Deflection (in)	0.30
LL Deflection FS	3.67
Total Load Deflection Limit	240
	0.10
	0.45
	4.29
1 3/4" Allowable Reaction (lb)	1005
3 1/2" Allowable Reaction (lb)	1330

SELECTION

9 1/2" TJI 210 @ 24" O.C.

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Beam Page 1

RB-1	Sawn (2) 2X6's	DF #2
RB-2	Sawn (2) 2X6's	DF #2
RB-3	Sawn (2) 2X6's	DF #2
RB-4	Sawn (2) 2X6's	DF #2
RB-5	LVL (2) 7 1/4"	2.0E 2600 Fb
FB-1	Sawn (2) 2X6's	DF #2
FB-2	Sawn (2) 2X6's	DF #2
FB-3	(2) 9 1/4" LVL	2.0E 2600 Fb
FB-4	Sawn (2) 2X10's	DF #2
FB-5	Sawn (2) 2X10's	DF #2

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	PASS
	(2) 2x4 FS: 1.37 Fb-3/ FB-5 ---
Location:	
COLUMN DIMENSIONS:	
Total Column Length (ft):	11
X-Unbraced Length (ft):	11
Y-Unbraced Length (ft):	0
MATERIAL SPECS:	
Material:	Doug Fir #2
Depth-x (in):	3.5
Width-y (in):	1.5
# Members	2
Area (in ²):	10.50
Axial Load:	2,437
MATERIAL PROPERTIES:	
F _c	1,350
E	1,600,000
E _{min}	580,000
Lex/dx	37.71
Ley/dy	0.00
FACTORS:	
Cd	1
Cf	1.15
Ke	1
F _c *	1,553
F _{ce}	335
Cp	0.21
F' _c	319
Allowable Load	3,347