Date: 06/10/2025

Job Number: 24-02955

Prepared for : Renewable Energy Design Group, 90 Beechwood Dr Lewisville, North Carolina 27023

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The following calculations are for the structural engineering design of the photovoltaic panels and are valid only for the structural info referenced in the stamped plan set. The verification of such info is the responsibility of others. After review, I certify that the roof structure has sufficient structural capacity for the applied PV loads. All PV mounting equipment shall be designed and installed per manufacturer's approved installation specifications.

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Exp. Date: 12/31/2025
Date Certified and
Signed:06/10/2025

Solar Module Details

Module Type	Hanwha
Module Quantity	24
Module Model Number	400 watt

Design Criteria

Code: 2018 North Carolina Residential Code ASCE 7-16

Live Load (psf)	20
Ult Wind Speed (mph)	125
Exposure Cat	C
Ground Snow (psf)	25

Structure Geometry

Eave Height, he (ft)	15 to 20ft
Pitch of main roof (deg)	37
Building Length, L (ft)	60
Building Width, B (ft)	55
Roof Area (Module Area) ft2	3300.00
Standoff(i.e., Roof Mount) Spacing Feet	4`

NOTE: attachments should be installed in a staggered configuratiion to properly destributor loading.

Roof Properties

Roof Geometry type	Gable Roof
Roof Type	Truss
Roof Pitch (deg)	37

Roofing Type	Comp Shingles
Sheathing Type	1/2" OSB Board
Wood species	No. 2, Douglas Fir-Larch
Wood Fb (psf)	900
Wood Fv (psf)	180
Wood E (psf)	1600000
Purlin C/C Spacing (in)	12
Rafter C/C. Spacing (in.)	24

Purlin

Section Thickness, b (in.)	2
Section Depth, d (in.)	4

Rafter

Section Thickness, b (in.)	2
Section Depth, d (in.)	4
Maximum Rafter Span (ft)	7

Factors

Cd(wind)	1.60
Cd(Snow)	1.60
CLS	1.15
CM	1
Ct	1
CL	0.75
CF	1.5
Cfu	1
Cv	1
Cr	1
M allowable_wind	413.44
M allowable_snow	297.16

Dead Load(psf)

Comp Shingles	3.00 psf
1/2" OSB Board	2.00 psf
Insulation	2.00 psf
Total Roof 1DL	7 psf
No. 2, Douglas Fir-Larch	31.00 lb/ft^3
Solar Panel DL	3.00 psf

	Roof 1
Roof_Dist_DL	7.00 psf
M_Roof_Dist_DL	2493.86
Def_Roof_Dist_DL	1.48
PV_uni_Dist_DL	3.00 psf
M_PV_uni_Dist_DL	10.54
Def_PV_uni_Dist_DL	0.01
Total_Uni_DL	11.00 psf
M_Total_DL	2504.40
Def_Total_DL	1.49

Snow Load(psf)

Ground Snow Load, pg	25
Importance Factor, Ic	1
Thermal Factor, Ct	1
Exposure Factor, Ce	1
Flat roof snow, pF	25
Slope Factor, Cs	1
Sloped Row Snow, ps	25
Uni_Dist_S	25.00
M_uni_Dist_s	153.13
Def_uni_Dist_S	0.09

Notation

A = Effective wind area, in ft^2 (m^2).
A_n = Normalized wind area, non-dimensional.
d_1 = For rooftop solar array, horizontal distance orthogonal to the panel edge to an adjacent panel or the building edge, ignoring any rooftop equipment in Fig. 29.4-7, in ft (m).
d_2 = For rooftop solar arrays, horizontal distance from the edge of one panel to the nearest edge in the next row in Fig. 29.4-7, in ft (m).
h = Mean roof height of a building except that eave height shall be used for roof angle θ less than or equal to 10°, in ft (m).
h_1 = Height of the gap between the panels and the roof surface, in ft (m).
h_2 = Height of a solar panel above the roof at the upper edge of the panel, in ft (m).
h_{pt} = Mean parapet height above the adjacent roof surface for use with Eq. (29.4-5), in ft (m).
L_p = Panel chord length.
W_L = Width of a building on its longest side in Fig. 29.4-7, in ft (m).
W_S = Width of a building on its shortest side in Fig. 29.4-7, in ft (m).
γ_E = Array edge factor as defined in Section 29.4.4.
θ = Angle of plane of roof from horizontal, in degrees.
ω = Angle that the solar panel makes with the roof surface in Fig. 29.4-7, in degrees.

Notes

1. (GC_{rn}) acts toward (+) and away (-) from the top surface of the panels.
2. Linear interpolation is allowed for ω between 5° and 15°.
3. $A_n = (1,000/[\max(L_b, 15)^2]$A, where A is the effective wind area of the structural element of the solar panel being considered, and L_b is the minimum of $0.4(h\mathrm{W_L})^{0.5}$ or h or W_s in ft (m).

FIGURE 29.4-7 (*Continued*). Design Wind Loads (All Heights): Rooftop Solar Panels for Enclosed and Partially Enclosed Buildings, Roof θ ≤ 7°

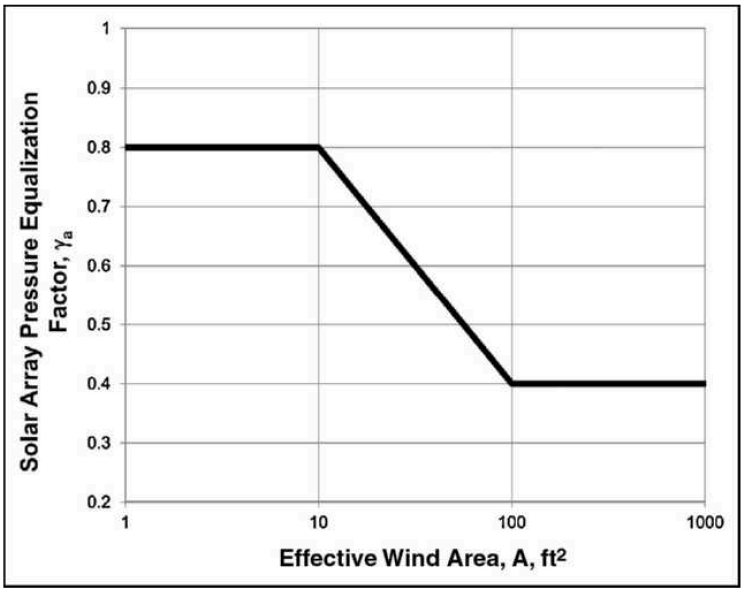


FIGURE 29.4-8 Solar Panel Pressure Equalization Factor, γ_a, for Enclosed and Partially Enclosed Buildings of All Heights

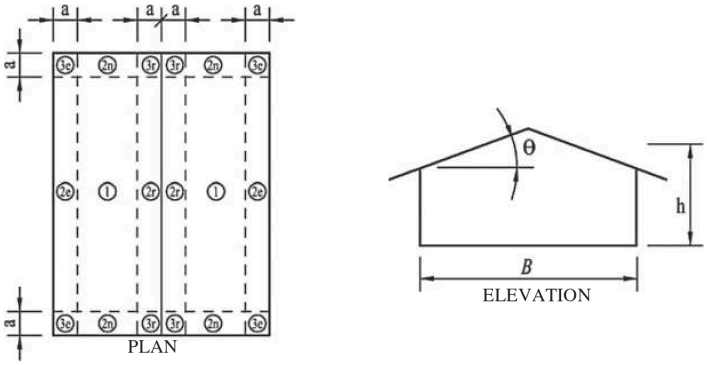
The roof shall be designed for both of the following:

1. The case where solar panels are present. Wind loads acting on solar collectors in accordance with this section shall be applied simultaneously with roof wind loads specified in other sections acting on areas of the roof not covered by the plan projection of solar collectors. For this case, roof wind loads specified in other sections need not be applied on areas of the roof covered by the plan projection of solar collectors.
2. Case where the solar panels have been removed.

29.5 PARAPETS

Wind loads on parapets are specified in Section 27.3.5 for buildings of all heights designed using the Directional Procedure

Diagrams



Notation

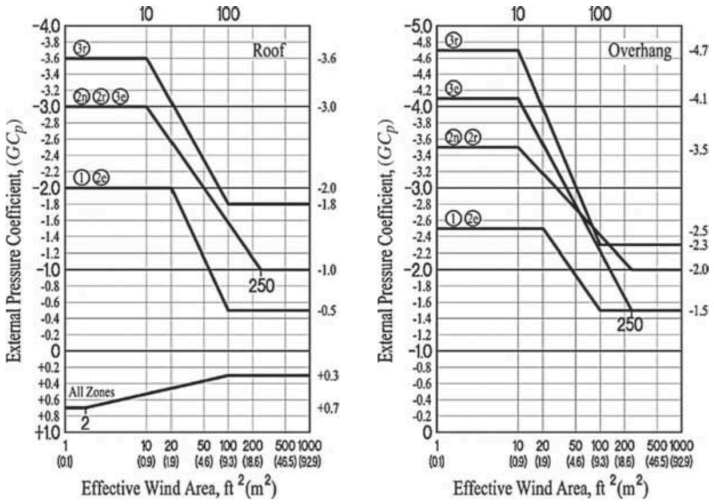
a = 10% of least horizontal dimension or 0.4h, whichever is smaller, but not less than either 4% of least horizontal dimension or 3 ft (0.9 m). If an overhang exists, the edge distance shall be measured from the outside edge of the overhang. The horizontal dimensions used to compute the edge distance shall not include any overhang distances.

B = Horizontal dimension of building measured normal to wind direction, in ft (m).

h = Mean roof height, in ft (m), except that eave height shall be used for $\theta \le 10°$.

θ = Angle of plane of roof from horizontal, in degrees.

External Pressure Coefficients



Notes

1. Vertical scale denotes (GC_p) to be used with q_h.
2. Horizontal scale denotes effective wind area, in ft^2 (m^2).
3. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
4. Each component shall be designed for maximum positive and negative pressures.
5. Values of (GC_p) for roof overhangs include pressure contributions from both upper and lower surfaces.
6. If overhangs exist, the lesser horizontal dimension of the building shall not include any overhang dimension, but the edge distance, a, shall be measured from the outside edge of the overhang.

FIGURE 30.3-2B Components and Cladding [$h \le 60$ ft ($h \le 18.3$ m)]: External Pressure Coefficients, (GC_p), for Enclosed and Partially Enclosed Buildings—Gable Roofs, $7° < \theta \le 20°$

Wind Load

Ultimate Wind Speed	125
Directionality Factor,kd	0.85
Topographic factor	1.00
Velocity pressure exposure factor,kz	0.88
Ground Elevation Factor,ke	-0.48
Side Wall Width	55
Median Roof Height	-28.74
Velocity pressure,qz	29.92
External Pressure Up,GCp_1	0.08
External Pressure Up,GCp_2	-0.6
External Pressure Up,GCp_3	-0.9
External Pressure Down,GCp	0.4
Design Pressure Up,p_1	2.00
Design Pressure Up,p_2	-15.01
Design Pressure Up,p_3	-22.51
Design Pressure Up,p	10.01
Uni_Dist_W_up	-22.51
M_uni_Dist_W_up	-137.87
Def_uni_Dist_W_up	-0.08
Uni_Dist_W_down	10.01
M_uni_Dist_W_down	61.31
Def_uni_Dist_W_down	0.04

Lag Screw Uplift Check (ASD)

5/16" Lag Screw Withdrawl value	205.00 lb/in
Lag Screw Penetration	2.5 inches
Roof1 0.6D+0.6W(up z1)	1711.272 > 512.5
Roof1 0.6D+0.6W(up z2)	1701.066 > 512.5

Framing Check (ASD):

Roof1 uni 1.0D+0.6W	2541.19 > 413.44
Lag Screw Penetration	2646.84 > 413.44
Roof1 0.6D+0.6W(up z1)	2657.53 > 297.16
Roof1 0.6D+0.6W(up z2)	1419.92 > 413.44

Seismic Check:

Wood	5.00 psf	
2x4 Studs @ 16"	2.00 psf	
Gypsum	3.00 psf	
Misc(insulatioon,etc)	2.00 psf	
Total wall DL	12.00 psf	
Total Wall Area (Approx)	2765.00 ft^2	
Total Wall W	33180 lbs	
Total Roof DL	7.50 psf	
Total Roof Area (Approx)	1652.41 ft^2	
Total Roof W	12393.075 lbs	
PV Panel W	3.00 psf	
Area of panel	480.00 ft^2	
Total Roof W	1157.02 lbs	
% increase=(Wadditional)/Wexisting	2.74%	**OK**

The increase in weight as a result of the solar system is less than 10% of the existing structure and therefore no further seismic analysis is required.

Limits of Scope of Work and Liability

Existing structure is assumed to have been designed and constructed following appropriate codes at time of erection, and assumed to have appropriate permits. The calculations produced are only for the roof framing supporting the proposed PV installation referenced in the stamped planset and were completed according to generally recognized structural analysis standards and procedures, professional engineering and design experience, opinions and judgements. Existing deficiencies which are unknown or were not observable during time of inspection are not included in this scope of work. All PV modules, racking, and mounting equipment shall be designed and installed per manufacturer's approved installation specifications. The Engineer of Record and Engineerinc assume no responsibility for misuse or improper installation. This analysis is not stamped for water leakage. Framing was determined based on information in provided plans and/or photos, along with engineering judgement. Prior to commencement of work, the contractor shall verify the framing sizes, spacings, and spans noted in the stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any discrepancies prior to starting construction. Contractor shall also verify that there is no damaged framing that was not addressed in stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any concerns prior to starting construction. Prior to the commencement of work, the contractor shall verify the existing roof and framing conditions. Notify Engineerinc and the engineer of record of any Discrepancies prior to starting construction. Prior to the commencement of work, the contractor shall inspect framing for any damage such as water damage, cracked framing, etc. and notify the E.O.R. if any issues are found.These plans/calculations are stamped for structural code compliance of the roof framing supporting the proposed PV installation reference only. These plans/calculations are not stamped for water leakage. PV modules, racking, and attachment components must follow manufacturer guidelines and requirements.