VSE Project Number: U2513.0172.201

February 17, 2020

Third Sun Solar
762 West Union Street, Suite C
Athens, OH 45701

REFERENCE: Marxen Residence: 227 North Ardmore Road, Columbus, OH 43209
Solar Array Installation

To Whom It May Concern:

Per your request, we have reviewed the existing structure at the above referenced site. The purpose of our review was to determine the adequacy of the existing structure to support the proposed installation of solar panels on the roof as shown on the panel layout plan.

Based upon our review, we conclude that the existing structure is adequate to support the proposed solar panel installation.

Design Parameters

Code: Ohio Building Code (2015 IBC) & 2019 Residential Code of Ohio (2018 IRC)
Design wind speed for risk category II structures: 115 mph (3-sec gust) per ASCE 7-10
Wind exposure category: C
Ground snow load: 20 psf

Existing Roof Structure

Roof structure: 2x6 rafters @ 16" O.C.
Roofing material: composite shingles
Roof slope: 27°

Conclusions

Based upon our review, we conclude that the existing structure is adequate to support the proposed solar panel installation. In the area of the solar array, other live loads will not be present or will be greatly reduced (Ohio Building Code, Section 1607.12.5). The glass surface of the solar panels allows for a lower slope factor per ASCE 7, resulting in reduced design snow load on the panels. The gravity loads, and thus the stresses of the structural elements, in the area of the solar array are either decreased or increased by no more than 5%. Therefore, the requirements of Section 3404.3 of the Ohio Building Code are met and the structure is permitted to remain unaltered.

The solar array will be flush-mounted (no more than 6" above the roof surface) and parallel to the roof surface. Thus, we conclude that any additional wind loading on the structure related to the addition of the proposed solar array is negligible. Because the increase in lateral forces is less than 10%, this addition meets the requirements of the exception in Section 3404.4 of the Ohio Building Code. Thus the existing lateral force resisting system is permitted to remain unaltered.

Limitations

Installation of the solar panels must be performed in accordance with manufacturer recommendations. All work performed must be in accordance with accepted industry-wide methods and applicable safety standards. The contractor must notify Vector Structural Engineering, LLC should any damage, deterioration or discrepancies between the as-built condition of the structure and the condition described in this letter be found. Connections to existing roof framing must be staggered, except at array ends, so as not to overload any existing structural member. The use of solar panel support span tables provided by others is allowed only where the building type, site conditions, site-specific design parameters, and solar panel configuration match the description of the span tables. The design of the solar panel racking (mounts, rails, etc.), the connection of the racking to the roof and electrical engineering is the responsibility of others. Waterproofing around the roof penetrations is the responsibility of others. Vector Structural Engineering assumes no responsibility for improper installation of the solar array.

VECTOR STRUCTURAL ENGINEERING, LLC
OH Firm License: 3392

02/17/2020

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Roger Alworth, P.E.
OH License: PE 73372 - Expires: 12/31/2020
Principal

Enclosures

RTA/bcs

JOB NO.: U2513.0172.201
SUBJECT: WIND PRESSURE

PROJECT: Marxen Residence

Components and Cladding Wind Calculations

Label: Solar Panel Array

Note: Calculations per ASCE 7-10

SITE-SPECIFIC WIND PARAMETERS:

Basic Wind Speed [mph]:	115
Exposure Category:	C
Risk Category:	II

Notes:

ADDITIONAL INPUT & CALCULATIONS:

Height of Roof, h [ft]:	25	(Approximate)		
Comp/Cladding Location:	Gable/Hip Roofs 7° < θ ≤ 27°		Hip?	No
Enclosure Classification:	Enclosed Buildings			
Zone 1 GC_p:	0.9	Figure 30.4-2B	(enter largest abs. value)	
Zone 2 GC_p:	1.7		(enter largest abs. value)	
Zone 3 GC_p:	2.6		(enter largest abs. value)	
α:	9.5	Table 26.9-1		
z_g [ft]:	900	Table 26.9-1		
K_h:	0.95	Table 30.3-1		
K_{zt}:	1	Equation 26.8-1		
K_d:	0.85	Table 26.6-1		
Velocity Pressure, q_h [psf]:	27.2	Equation 30.3-1		
GC_{pi}:	0	Table 26.11-1		

PRESSURES:

$$p = q_h\left[(GC_p) - (GC_{pi})\right]$$ Equation 30.9-1

Zone 1, p [psf]:	24.5	psf (1.0 W, Interior Zones*)
Zone 2, p [psf]:	46.2	psf (1.0 W, End Zones*)
Zone 3, p [psf]:	70.7	psf (1.0 W, Corner Zones* within a) (a= 3 ft)

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SUBJECT: CONNECTION

PROJECT: Marxen Residence

Lag Screw Connection

Capacity:

Lag Screw Size [in]:	5/16	
C_d:	1.6	NDS Table 2.3.2
Embedment[1] [in]:	2.5	
Grade:	DF (G = 0.5)	
Capacity [lbs/in]:	266	NDS Table 12.2A
Number of Screws:	1	
Prying Coefficient:	1.4	
Total Capacity [lbs]:	760	

Demand:

Zone	Pressure (0.6 Wind) (psf)	Max Tributary Width (ft)	Max. Trib. Area[2] (ft^2)	Max. Uplift Force (lbs)
1	14.7	4.0	11.2	164
2	27.7	4.0	11.2	310
3	42.4	4.0	11.2	474

Demand< Capacity: **CONNECTION OKAY**

1. Embedment is measured from the top of the framing member to the beginning of the tapered tip of the lag screw. Embedment in sheathing or other material is not effective. The length of the tapered tip is not part of the embedment length.
2. 'Max. Trib Area' is the product of the 'Max. Tributary Width' (along the rails) and 1/2 the panel width/height (perpendicular to the rails).

JOB NO.: U2513.0172.201
SUBJECT: GRAVITY LOADS

PROJECT: Marxen Residence

CALCULATE ESTIMATED GRAVITY LOADS

ROOF DEAD LOAD (D)				Increase due to pitch	Original loading	
Roof Pitch/12		6.1				
Composite Shingles		2.2		1.12	2.0	psf
1/2" Plywood		1.1		1.12	1.0	psf
Framing		3.0	psf			
Insulation		0.0	psf			
1/2" Gypsum Clg.		0.0	psf			
M, E & Misc		0.0	psf			
	DL	6	psf			
	PV Array DL	3	psf			

ROOF LIVE LOAD (Lr)

Existing Design Roof Live Load [psf]	20	ASCE 7-10, Table 4-1
Roof Live Load With PV Array [psf]	0	Ohio Building Code, Section 1607.12.5

SNOW LOAD (S):	Existing	w/ Solar Panel Array	
Roof Slope [x:12]:	6.1	6.1	
Roof Slope [°]:	27	27	
Snow Ground Load, p_g [psf]:	20	20	ASCE 7-10, Section 7.2
Terrain Category:	C	C	ASCE 7-10, Table 7-2
Exposure of Roof:	Fully Exposed	Fully Exposed	ASCE 7-10, Table 7-2
Exposure Factor, C_e:	0.9	0.9	ASCE 7-10, Table 7-2
Thermal Factor, C_t:	1.1	1.1	ASCE 7-10, Table 7-3
Risk Category:	II	II	ASCE 7-10, Table 1.5-1
Importance Factor, I_s:	1.0	1.0	ASCE 7-10, Table 1.5-2
Flat Roof Snow Load, p_f [psf]:	14	14	ASCE 7-10, Equation 7.3-1
Minimum Roof Snow Load, p_m [psf]:	0	0	ASCE 7-10, Section 7.3.4
Unobstructed Slippery Surface?	No	Yes	ASCE 7-10, Section 7.4
Slope Factor Figure:	Figure 7-2b	Figure 7-2b	ASCE 7-10, Section 7.4
Roof Slope Factor, C_s:	1.00	0.72	ASCE 7-10, Figure 7-2
Sloped Roof Snow Load, p_s [psf]:	14	10	ASCE 7-10, Equation 7.4-1
Design Snow Load, S [psf]:	14	10	

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SUBJECT: LOAD COMPARISON

PROJECT: Marxen Residence

Summary of Loads

	Existing	With PV Array
D [psf]	6	9
Lr [psf]	20	0
S [psf]	14	10

Maximum Gravity Loads:

	Existing	With PV Array	
(D + Lr) / Cd [psf]	21	10	ASCE 7-10, Section 2.4.1
(D + S) / Cd [psf]	18	17	ASCE 7-10, Section 2.4.1

(Cd = Load Duration Factor = 0.9 for D, 1.15 for S, and 1.25 for Lr)

Maximum Gravity Load [psf]:	21	17

Ratio Proposed Loading to Current Loading:	**80%**	**OK**

The gravity loads and; thus, the stresses of the structural elements, in the area of the solar array are either decreased or increased by no more than 5%. Therefore, the requirements of Section 3404.3 of the Ohio Building Code are met and the structure is permitted to remain unaltered.