Norton & Schmidt

Consulting Engineers, LLC
Established 1967
Kansas City ● Atlanta

November 29, 2018

Jesse Wiederin
Wiederin Enterprise
1300 NW 67th St
Kansas City, MO 64118
email: jesse@wiederinenterprise.com

RE: TWIN LAKES INSURANCE, SOLAR PANEL REVIEW **JOB #2018-1677**
2641 NE MCBAINE DR
LEE'S SUMMIT, MO

Dear Mr. Wiederin:

This letter is regarding our review of the possibility of adding solar electric panels on the roof truss framing of the above referenced building. I have reviewed the information provided regarding the proposed rooftop solar panel weight and installation method, proposed solar panel layout, and the wood roof truss information.

General

The conventionally wood framed one story building faces west for the purpose of this report and is reportedly bearing on shallow concrete foundation walls and a poured concrete slab-on-grade located. The roof of the building was framed with pre-engineered wood trusses and a truss layout drawing (Quality Truss Company) and individual sealed truss drawings (MiTek) were provided for review.

Information regarding support beams, headers, the foundation, etc. was not included, and review of these items is beyond the scope of this report. Further, a review of the actual construction of the building is beyond the scope of this review and such a review is recommended prior to the installation of the solar panels.

Review

It is my understanding that the proposed solar panel array system being installed has an additional weight of approximately 2.42 psf added to the roof. This is based on information from

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the provided drawings from Wiederin Enterprise PV-1 thru PV-6 dated 10/22/18 and Neo Solar Power (NSP) mechanical date for model # D6M_E4A solar panels.

The truss layout plan by Quality Truss Company and the truss drawings provided from MiTek USA, show location as well as design for each type of truss including design loads. These drawings indicate that the wood truss system was designed for a 25 psf top chord roof live load.

Our calculations indicate a 20 psf top chord live load due to snow is adequate based on a ground snow load (Pg=20 psf) as required by the City of Lee's Summit, MO. Therefore, the roof trusses are "overdesigned" by 5psf. This difference will account for the added 2.5psf weight for the solar panels. Our calculations show that the truss top chords are able to support the additional "L" foot loads. A wind load based on 115 mph (3 sec. gust) was considered and this was not the controlling load case for the trusses. However, the wind load does control the support/attachment of the "L foot" design to the roof.

The attachment of the solar panel support rails to the roof of the building must be minimum of four (4) "L" foot supports spaced evenly for each solar panel. Attach each of the "L foot" with four (4) ¼" x 2" RSS Pheinox screw fasteners through the shingles into APA rated, minimum 7/16" thick, 24/16 OSB roof sheathing. This must be field verified by the general contractor.

Scope and Terms

This review was of the wood truss roof system ability to support the added dead load (2.5 psf) of solar panels. Information regarding support beams, the foundation etc. was not included and review of these items is beyond the scope of this report. No opportunity was provided to review the site of the building structure. When making a review of a building or its components, it is required that certain assumptions be made regarding the existing conditions. Because these assumptions may not be verifiable without expending added sums of money, or destroying adequate or serviceable portions, the owner or recipient of this report agrees that we will be held harmless, and indemnified and defended, by you from and against all claims, loss, liability or expense, including legal fees arising out of the services provided by this report. Use of this report constitutes acceptance of these terms and the scope.

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Conclusions

It is my opinion that the wood truss roof framing of the above referenced building is adequate to support the D6M_E4A solar panels as shown on the attached Wiederin Electric Plans PV1 through PV6, provided the "L foot" supports are a minimum of four (4) "L" foot supports spaced evenly for each solar panel and attached as noted previously in this report.

If there are any questions, please call.

Sincerely,

11/29/18

Laurence C. Fehner, P.E.
Principal

STATE OF MISSOURI
LAURENCE C. FEHNER
NUMBER E-21803
REGISTERED PROFESSIONAL ENGINEER

Enclosure: Norton & Schmidt calculation sheets
Wiederin Electric Plans PV1 through PV6 dated 10/22/18 with NSP & PLP attachments
MiTek, truss drawings Q160278
Quality Truss Company, truss layout drawing
Billing Invoice

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Project: Twin Lakes Insurance- Solar Panel Installation
Address: 2641 NE McBaine Dr, Lee's Summit, MO 64064
Date: 21-Nov-18 Calc'd by: AGR Checked by: LCF
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Governing Building Code: 2012 International Building Code and its appropriate supplements, per Lee's Summit, MO

Loads

ground snow load	p_g	20 psf		Figure 7-1 ASCE 7-10
exposure factor	C_e	1.0		Table 7-2 ASCE 7-10
thermal factor	C_t	1.0		Table 7-3 ASCE 7-10
importance factor	I_s	1.00		Table 1.5-2 ASCE 7-10
warm roof slope factor	C_s	1.0		Figure 7-2 ASCE 7-10
sloped roof snow load	p_f	$=C_s 0.7 C_e C_t I_s p_g =$	14.0 psf	(7.4-1) ASCE 7-10
roof dead load	D_r	10 psf		
roof live load	L_r	20 psf		Table 1607.1 IBC 2012
wind speed (3s gust)	V	115 mph		Figure 26.5-1A ASCE 7-10
wind uplift	W_u	21.1 psf		

Design loads per MiTek truss drawings:

snow load	P_s/P_f	25 psf	per 2016 MiTek drawings, Job #Q160278
top chord live load	TCLL	25 psf	per 2016 MiTek drawings, Job #Q160278
top chord dead load	TCDL	10 psf	per 2016 MiTek drawings, Job #Q160278
bottom chord dead load	BCDL	10 psf	per 2016 MiTek drawings, Job #Q160278

single panel weight	W	50.7 lb	D6M_E4A Neo Solar Power panel
panel width	w	39.1 in	D6M_E4A Neo Solar Power panel
panel length	ℓ	77.0 in	D6M_E4A Neo Solar Power panel
uniform, distributed panel weight		$=W/w_P\ell_P$ = 2.4 psf	
weight on single "L" foot	P_1	$=W/2$ = 25.4 lb	
uplift on single "L" foot	P_2	$=W_u * w\ell/2$ = 220.6 lb	

Roof Sheathing Check

rated sheathing bending strength	F_bS	385 in-lb/ft	24/16 span-rated OSB	Table 8 APA D510 2012
load duration factor 1	C_{D1}	1.15 2 mo		Table 5 APA D510 2012
sheathing length between trusses	ℓ_{Sh}	$=2ft-1.5in$ = 1.9 ft		
moment due to panel weight	M_P	$=3P\ell_P/16$ = 8.9 ft-lb	pin/fix, mid-span point load	
moment due to roof load	M_r	$=(L_r+D_r)\ell^2/8$ = 13.2 ft-lb	pin/pin, uniform distr. load	
total moment		$=M_P+M_r$ = 265.1 in-lb		
sheathing bending stress ratio	$\sigma_{b.Sh}$	$=(M_P+M_{Lr})/C_{D1}F_bS$ = 0.60	okay	

The added weight for the solar panel does not overstress the wood roof sheathing.

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load duration factor for wind	C_{D1}	1.6	wind	Table 5 APA D510 2012
moment due to wind uplift	M_W	$=(P_2-0.9P_1)\ell_{Sh}/4=$	1112.4 in-lb	
wind sheathing bending stress ratio	$\sigma_{b.Sh}$	$=M_W/C_{D2}F_bS$	1.81	

The solar panel foot creates a point load on the sheathing that is too high during wind uplift loading. Therefore, panel supports shall be installed either directly over trusses below or four supports used per panel.

Top Chord Point Load Check

ref. bending design value	F_b	1100 psi	SP No.2	Table 4B NDS 2018
load duration factor	C_D	1.15	2 mo	Table 2.3.2 NDS 2018
wet service factor for F_b	C_M	1.0	m.c.<19%	Table 4B NDS 2018
temperature factor for F_b, F_v, F_c, $F_{c\perp}$	C_t	1.0	T≤100°F	Table 2.3.3 NDS 2018
incising factor for F_b, F_t, F_c, F_v	C_i	1.00	not incised	Table 4.3.8 NDS 2018
repetitive member factor	C_r	1.15		Sect. 4.3.9 NDS 2018
adj. bending design value	F_b'	$=F_b * C_D C_M C_t C_i C_r =$	1454.8 psi	Table 4.3.1 NDS 2018

weight on single "L" foot	P_1	$=W/2 =$	25.4 lb	
max top chord length	ℓ	7.73 ft	truss T2A, per 2016 MiTek drawings, Job #Q160278	
moment due to "L" foot load	M	$=3P_1\ell/16 =$	36.7 ft-lb	pin/fix, mid-span point load

top chord section modulus	S	$=bd^2/6 =$	3 in³	
actual bending stress due to "L" foot	f_b	$=M/S =$	144.0 psi	
top chord bending stress ratio increase	$\sigma_{b.TC}$	$=f_b/F_b' =$	0.10	stress ratio increase
max top chord stress ratio at 30psf TC dead & live load & panel point load		$=\sigma+\sigma_{b.TC} =$	0.99	okay

Solar Panel Load Analysis

The top chord live load is 20psf, due to roof live load. The trusses were designed for 25psf. This leaves an extra 5psf capacity in the roof framing, therefore the roof is able to support the ±2.5psf solar panel load.

ratio stress down to 20psf LL σ = (TCLL(20)+TCDL(10)+BCDL(10))/(TCLL(25)+TCDL(10)+BCDL(10))= 0.89

The highest combined stress index (CSI) in the truss top chord runs is 1.00 at 25psf+10psf+10psf (refer to truss H1PP per 2016 MiTek drawings, Job #Q160278). Thus the stress ratio with 20psf+10psf+10psf, a 5psf live load decrease, is 1.00*0.889=0.889. The added stress from the point load plus the CSI based on 20psf TCLL is 0.99, therefore the added point load on the TC does not create a higher stress ratio on the truss considering 20psf roof live load.