BARUN CORP

September 17, 2021

RE: CERTIFICATION LETTER

Project Address: Ruth Frame Residence
1296 Young Rd
Angier, NC 27501

Design Criteria:

- Applicable Codes = 2018 NCBC/NCRC, 2018 IEBC/IBC, 2018 IRC, ASCE 7-16, and 2018 NDS
- Risk Category = II
- Wind Speed = 120 mph, Exposure Category B, Partially/Fully Enclosed Method
- Ground Snow Load = 15 psf
- MP 1: 2x4 @ 16" OC, Roof DL = 7 psf, Roof LL/SL = 16 psf (Non-PV), Roof LL/SL = 6.9 psf (PV)
- MP 2: 2x8 @ 24" OC, Roof DL = 8 psf, Roof LL/SL = 15 psf (Non-PV), Roof LL/SL = 6.4 psf (PV)

To Whom It May Concern,

A jobsite survey of the existing framing system of the address indicated above was performed . All structural evaluation is based on the site inspection observations and the design criteria listed above.

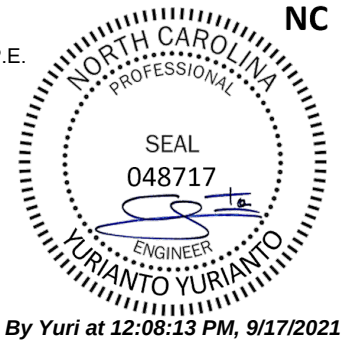
Existing roof structural framing has been reviewed for additional loading due to installation of PV Solar System on the roof. The structural review applies to the sections of roof that is directly supporting the solar PV system.

Based on this evaluation, I certify that the alteration to the existing structure by installation of the PV system meets the requirements of the applicable existing building and/or new building provisions adopted/referenced above.

Additionally, the PV module assembly including attachment hardware has been reviewed to be in accordance with the manufacturer's specifications and to meet and/or exceed the requirements set forth by the referenced codes.

Sincerely,

Yuri Yurianto, S.E., P.E.



By Yuri at 12:08:13 PM, 9/17/2021

MP 1

PV System Dead Load (PV-DL)		
PV module weight		2.5 psf
Hardware assembly weight		0.5 psf
	PV-DL	**3 psf**

Roof Dead Load (R-DL)	Material		Panel Area
Existing Roofing Material	Comp Roof	1 layers	2.5 psf
Underlayment			0.5 psf
Plywood Sheathing			1.5 psf
Rafter Size and Spacing	2 x 4	@ 16 in. O.C.	1.09 psf
Vaulted ceiling		No	0 psf
Miscellaneous			1.5 psf
Total Roof Dead Load		**R-DL**	**7 psf**

Reduced Roof Live Load (Lr)	Expression	Value	
Roof Live Load	L_o	20.0 psf	
Member Tributary Area	A_t	< 200 sf	
Roof 1 Roof Pitch		8/12	*or 34°*
Trubutary Area Reduction	R_1	1	
Slope Roof Reduction	R_2	0.8	
Reduced Roof Live Load	**$Lr = L_o (R_1) (R_2)$**	**16.0 psf**	

Snow Load	Value	
Ground Snow Load	p_g	15
Effective Roof Slope		34°
Snow Importance Factor	I_s	1.0
Snow Exposure Factor	C_e	1.0
Snow Thermal Factor	C_t	1.1
Minimum Flat Roof Snow Load	$p_{f\text{-}min}$	15
Flat Roof Snow Load	**p_f**	**11.55**

Slope Roof Snow Load on Roof	(All other surfaces)	
Roof Slope Factor	$C_{s\text{-}roof}$	1.00
	$p_{s\text{-}roof}$	**11.60**

Sloped Roof Snow Load on PV	(Unobstructed slippery surfaces)	
Roof Slope Factor	$C_{s\text{-}pv}$	0.60
	$p_{s\text{-}pv}$	**6.90**

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	Sep. 17, 2021 18:00	MP 1

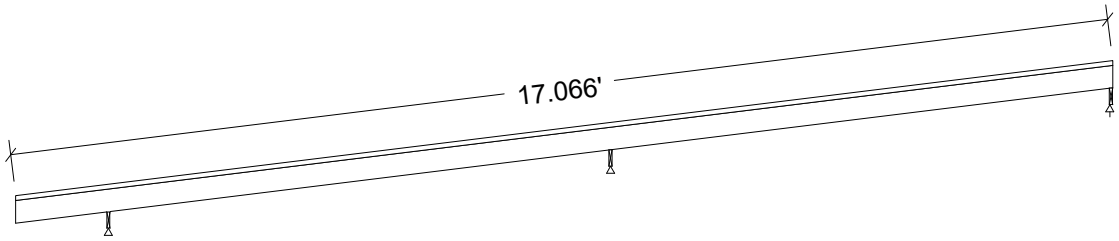
Design Check Calculation Sheet

WoodWorks Sizer 2019 (Update 2)

Loads:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
DL	Dead	Full Area	No			7.00(16.0")		psf
DL-PV	Dead	Partial Area	No	1.50	10.50	3.00(16.0")		psf
SL-PV	Snow	Partial Area	No	1.50	10.50	6.90(16.0")		psf
LL-RF1	Live	Partial Area	No	0.00	1.50	16.00(16.0")		psf
LL-RF2	Live	Partial Area	No	10.50	14.20	16.00(16.0")		psf

Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :



1.2' 7.7' 14.163'

Unfactored:						
Dead		57		114		31
Live		31		26		54
Snow		23		58		2
Factored:						
Total		98		177		85
Bearing:						
F'theta		546		546		537
Capacity						
Joist		717		717		403
Support		586		586		469
Des ratio						
Joist		0.14		0.25		0.21
Support		0.17		0.30		0.18
Load comb		#3		#3		#2
Length		0.50*		0.50*		0.50*
Min req'd		0.08**		0.15**		0.11
Cb		1.75		1.75		1.00
Cb min		1.75		1.75		1.00
Cb support		1.25		1.25		1.00
Fcp sup		625		625		625

*Minimum bearing length setting used: 1/2" for end supports and 1/2" for interior supports

**Minimum bearing length governed by the required width of the supporting member.

MP 1

Lumber-soft, S-P-F, No.1/No.2, 2x4 (1-1/2"x3-1/2")

Supports: All - Timber-soft Beam, D.Fir-L No.2

Roof joist spaced at 16.0" c/c; Total length: 17.25'; Clear span(horz): 1.188', 6.438', 6.438'; Volume = 0.6 cu.ft.; Pitch: 8/12

Lateral support: top = continuous, bottom = at end supports; Repetitive factor: applied where permitted (refer to online help);

This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2018 :

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	fv = 19	Fv' = 135	psi	fv/Fv' = 0.14
Bending(+)	fb = 380	Fb' = 1509	psi	fb/Fb' = 0.25
Bending(-)	fb = 476	Fb' = 1247	psi	fb/Fb' = 0.38
Live Defl'n	0.08 = < L/999	0.39 = L/240	in	0.20
Total Defl'n	0.13 = L/724	0.52 = L/180	in	0.25

Additional Data:

FACTORS:	F/E(psi)	CD	CM	Ct	CL	CF	Cfu	Cr	Cfrt	Ci	Cn	LC#
Fv'	135	1.00	1.00	1.00	-	-	-	-	1.00	1.00	1.00	2
Fb'+	875	1.00	1.00	1.00	1.000	1.500	-	1.15	1.00	1.00	-	2
Fb'-	875	1.15	1.00	1.00	0.719	1.500	-	1.15	1.00	1.00	-	3
Fcp'	425	-	1.00	1.00	-	-	-	-	1.00	1.00	-	-
E'	1.4 million	1.00	1.00	1.00	-	-	-	-	1.00	1.00	-	2
Emin'	0.51 million	1.00	1.00	1.00	-	-	-	-	1.00	1.00	-	2

CRITICAL LOAD COMBINATIONS:

```
 Shear     : LC #2  = D + L
 Bending(+): LC #2  = D + L
 Bending(-): LC #3  = D + 0.75(L + S)
 Deflection: LC #2  = D + L  (live)
             LC #2  = D + L  (total)
 Bearing   : Support 1 – LC #3 = D + 0.75(L + S)
             Support 2 – LC #3 = D + 0.75(L + S)
             Support 3 – LC #2 = D + L
 D=dead L=live S=snow
 All LC's are listed in the Analysis output
 Load combinations:
```

CALCULATIONS:

```
 V max = 70, V design = 67 lbs; M(+) = 97 lbs-ft; M(-) = 122 lbs-ft
   EIy = 7.50 lb-in^2
 "Live" deflection is due to all non-dead loads (live, wind, snow…)
 Total deflection = 1.5 dead + "live"
 Bearing: Allowable bearing at an angle F'theta  calculated for each support
 as per NDS 3.10.3
 Lateral stability(-):  Lu = 15.56'  Le = 23.31'  RB = 20.9; Lu based on full span
```

Design Notes:

1. Analysis and design are in accordance with the ICC International Building Code (IBC 2018) and the National Design Specification (NDS 2018), using Allowable Stress Design (ASD). Design values are from the NDS Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Continuous or Cantilevered Beams: NDS Clause 4.2.5.5 requires that normal grading provisions be extended to the middle 2/3 of 2 span beams and to the full length of cantilevers and other spans.
4. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.
5. SLOPED BEAMS: level bearing is required for all sloped beams.
6. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

MP 2

PV System Dead Load (PV-DL)		
PV module weight		2.5 psf
Hardware assembly weight		0.5 psf
	PV-DL	**3 psf**

Roof Dead Load (R-DL)	Material		Panel Area
Existing Roofing Material	Comp Roof	1 layers	2.5 psf
Underlayment			0.5 psf
Plywood Sheathing			1.5 psf
Rafter Size and Spacing	2 x 8	@ 24 in. O.C.	1.56 psf
Vaulted ceiling		No	0 psf
Miscellaneous			1.5 psf
Total Roof Dead Load		**R-DL**	**8 psf**

Reduced Roof Live Load (Lr)	Expression	Value	
Roof Live Load	L_o	20.0 psf	
Member Tributary Area	A_t	< 200 sf	
Roof 2 Roof Pitch		9/12	*or 37°*
Trubutary Area Reduction	R_1	1	
Slope Roof Reduction	R_2	0.75	
Reduced Roof Live Load	**$Lr = L_o (R_1) (R_2)$**	**15.0 psf**	

Snow Load	Value	
Ground Snow Load	p_g	15
Effective Roof Slope		37°
Snow Importance Factor	I_s	1.0
Snow Exposure Factor	C_e	1.0
Snow Thermal Factor	C_t	1.1
Minimum Flat Roof Snow Load	$p_{f\text{-}min}$	15
Flat Roof Snow Load	**p_f**	**11.55**

.

Slope Roof Snow Load on Roof	(All other surfaces)	
Roof Slope Factor	$C_{s\text{-}roof}$	1.00
	$p_{s\text{-}roof}$	**11.60**

Sloped Roof Snow Load on PV	(Unobstructed slippery surfaces)	
Roof Slope Factor	$C_{s\text{-}pv}$	0.55
	$p_{s\text{-}pv}$	**6.40**

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	Sep. 17, 2021 18:02	MP 2

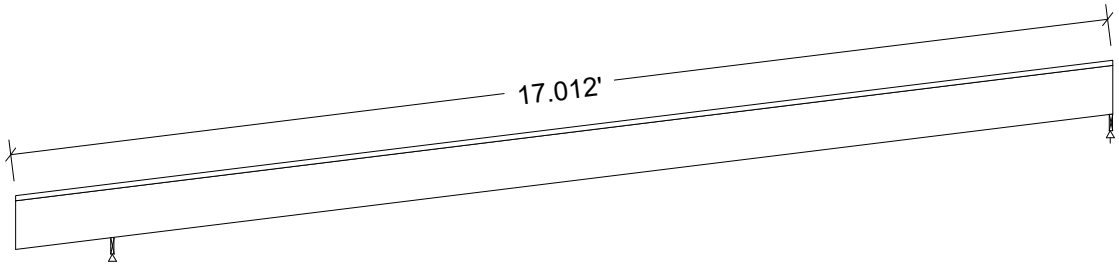
Design Check Calculation Sheet

WoodWorks Sizer 2019 (Update 2)

Loads:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
DL	Dead	Full Area	No			8.00(24.0")		psf
DL-PV	Dead	Partial Area	No	1.50	10.00	3.00(24.0")		psf
SL-PV	Snow	Partial Area	No	1.50	10.00	6.40(24.0")		psf
LL-RF1	Live	Partial Area	No	0.00	1.50	15.00(24.0")		psf
LL-RF2	Live	Partial Area	No	10.00	13.61	15.00(24.0")		psf

Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :



Unfactored:				
Dead		189		147
Live		62		92
Snow		69		40
Factored:				
Total		287		246
Bearing:				
F'theta		567		567
Capacity				
Joist		744		425
Support		586		469
Des ratio				
Joist		0.39		0.58
Support		0.49		0.52
Load comb		#3		#3
Length		0.50*		0.50*
Min req'd		0.24**		0.29
Cb		1.75		1.00
Cb min		1.75		1.00
Cb support		1.25		1.00
Fcp sup		625		625

*Minimum bearing length setting used: 1/2" for end supports and 1/2" for interior supports

**Minimum bearing length governed by the required width of the supporting member.

MP 2

Lumber-soft, S-P-F, No.1/No.2, 2x8 (1-1/2"x7-1/4")

Supports: All - Timber-soft Beam, D.Fir-L No.2

Roof joist spaced at 24.0" c/c; Total length: 17.44'; Clear span(horz): 1.188', 12.375'; Volume = 1.3 cu.ft.; Pitch: 9/12

Lateral support: top = continuous, bottom = at supports; Repetitive factor: applied where permitted (refer to online help);

This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2018 :

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	fv = 23	Fv' = 135	psi	fv/Fv' = 0.17
Bending(+)	fb = 651	Fb' = 1389	psi	fb/Fb' = 0.47
Bending(-)	fb = 33	Fb' = 624	psi	fb/Fb' = 0.05
Live Defl'n	0.14 = < L/999	0.77 = L/240	in	0.18
Total Defl'n	0.62 = L/299	1.03 = L/180	in	0.60

Additional Data:

FACTORS:	F/E(psi)	CD	CM	Ct	CL	CF	Cfu	Cr	Cfrt	Ci	Cn	LC#
Fv'	135	1.00	1.00	1.00	-	-	-	-	1.00	1.00	1.00	2
Fb'+	875	1.15	1.00	1.00	1.000	1.200	-	1.15	1.00	1.00	-	3
Fb'-	875	1.00	1.00	1.00	0.516	1.200	-	1.15	1.00	1.00	-	2
Fcp'	425	-	1.00	1.00	-	-	-	-	1.00	1.00	-	-
E'	1.4 million	1.00	1.00	1.00	-	-	-	-	1.00	1.00	-	3
Emin'	0.51 million	1.00	1.00	1.00	-	-	-	-	1.00	1.00	-	3

CRITICAL LOAD COMBINATIONS:

```
 Shear     : LC #2  = D + L
 Bending(+): LC #3  = D + 0.75(L + S)
 Bending(-): LC #2  = D + L
 Deflection: LC #3  = D + 0.75(L + S)  (live)
             LC #3  = D + 0.75(L + S)  (total)
 Bearing   : Support 1 – LC #3 = D + 0.75(L + S)
             Support 2 – LC #3 = D + 0.75(L + S)
 D=dead L=live S=snow
 All LC's are listed in the Analysis output
 Load combinations:
```

CALCULATIONS:

```
 V max = 189, V design = 169 lbs; M(+) = 713 lbs-ft; M(-) = 36 lbs-ft
   EIy = 66.69 lb-in^2
 "Live" deflection is due to all non-dead loads (live, wind, snow…)
 Total deflection = 1.5 dead + "live"
 Bearing: Allowable bearing at an angle F'theta  calculated for each support
 as per NDS 3.10.3
 Lateral stability(-):  Lu = 15.50'  Le = 24.13'  RB = 30.5; Lu based on full span
```

Design Notes:

1. Analysis and design are in accordance with the ICC International Building Code (IBC 2018) and the National Design Specification (NDS 2018), using Allowable Stress Design (ASD). Design values are from the NDS Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Continuous or Cantilevered Beams: NDS Clause 4.2.5.5 requires that normal grading provisions be extended to the middle 2/3 of 2 span beams and to the full length of cantilevers and other spans.
4. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.
5. SLOPED BEAMS: level bearing is required for all sloped beams.
6. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.