POW TECHNOLOGIES
DIV OF PPA ENGINEERING TECHNOLOGIES INC.

December 16, 2022
Ref: 21-15-0039

TOJA Grid Inc.
3-450 South Service Road West
Oakville, Ontario
L6K 2H4

RE: TOJA Grid, Modular Bracket Analysis

Reff: TOJA Bracket analysis, June 17, 2021 – Prepared by POW
TOJA Bracket Summary Tables, June 18, 2021 – Prepared by POW

TOJA Grid Inc. previously retained POW Technologies to conduct a structural analysis of a series of metal connectors and brackets used in the TOJA Grid modular pergola system. Please refer to the referenced reports prepared by POW for TOJA.

At your request, we have conducted additional structural analysis and review of the metal connectors for use in applications, including covered gazebos, decks, sheds and similar structures. Our review is limited to the analysis of the metal connectors and brackets only. A review of the wood framing, foundations, supporting elements, and all other items is outside our work scope

The bracket and connector resistances/capacities in the referenced table were calculated using effective section properties. Capacities were determined based on the Limit States Design method, with load factors and resistances as outlined by CSA S136-16, CSA S16-14, CSA-086-09, and the National Building Code of Canada 2015. Brackets and connectors are fabricated with steel conforming to ASTM A1008. Strength increases from cold work of forming were not considered.

Based on our review, with the information provided by TOJA and of the shop drawings received, POW Technologies is of the opinion that the brackets and connectors are capable of supporting roof design loads, including dead, live and snow, in a variety of applications. Factored design forces determined based on local design codes can be compared with the factored capacities in the referenced load table prepared by POW and summarized below. The values provide are the factored resistances and capacities based on the load factors and resistance factors outlined in NBC 2015 and other referenced codes.

Connector		Connector Load Rating (Factored Shear)			Lumber					Result Summary (Factored Loads)		
Member	Member Thickness	Beam (Cavity) Member (lbs)	Sloped (Cavity) Member (lbs)	Total (lbs)	Beam Member	Factored Shear Capacity (lbs)	Post Member	Factored Compressive Capacity at 8' post height (k=2.0) (lbs)	Grade	Max Beam (Cavity) Rating (lbs)	Min. Fasteners Per member (#12 x 1.5" S.S. Screw)	Comment
4x4 T	14 GA	2,000	-	4,000	4x4	2,720	4x4	3,050	SPF #2	1,525	8	Wood Framing Governs
6x6 T	12 GA	3,000	-	6,000	6x6	4,100	6x6	7,935	SPF #2	3,000	12	Bracket Capacity Governs
6x6R T	12 GA	3,600	-	7,200	6x6	4,100	6x6	7,935	SPF #2	3,600	12	Bracket/Fasteners Governs
4x4 L	14 GA	2,000	-	4,000	4x4	2,720	4x4	3,050	SPF #2	1,525	8	Wood Framing Governs
6x6 L	12 GA	3,000	-	6,000	6x6	4,100	6x6	7,935	SPF #2	3,000	12	Bracket Capacity Governs
6x6R L	12 GA	3,600	-	7,200	6x6	4,100	6x6	7,935	SPF #2	3,600	12	Bracket/Fasteners Governs
6x6R KNECT	12 GA	3,000	-	3,000	6x6	4,100	6x6	7,935	SPF #2	3,000	10	Bracket Capacity Governs
4x4 Solo	14 GA	-	-	2,500	4x4	2,720	4x4	3,050	SPF #2	2,500	12	Base Plate /Anchorage Governs
4x4 Solo 30	14 GA	-	1,700	1,700	4x4	2,720	4x4	3,050	SPF #2	1,150	6 Main + 4 Anchors	1/4" dia. Anchorage Governs
4x4 Solo 45	14 GA	-	1,450	1,450	4x4	2,720	4x4	3,050	SPF #2	1,150	6 Main + 4 Anchors	1/4" dia. Anchorage Governs
6x6 Solo	12 GA	-	-	3,300	6x6	4,100	6x6	7,935	SPF #2	3,300	12 Main + 4 Anchors	Base Plate /Anchorage Governs
6x6R Solo	12 GA	-	-	3,600	6x6	4,100	6x6	7,935	SPF #2	3,300	12 Main + 4 Anchors	Base Plate /Anchorage Governs
6x6 Solo 30	12 GA	-	2,500	2,500	6x6	4,100	6x6	7,935	SPF #2	2,000	6 Main + 4 Anchors	3/8" dia. Anchorage Governs
6x6 Solo 45	12 GA	-	2,100	2,100	6x6	4,100	6x6	7,935	SPF #2	2,000	6 Main + 4 Anchors	3/8" dia. Anchorage Governs
4x4 Trio	14 GA	2,000	-	4,000	4x4	2,720	4x4	3,050	SPF #2	1,525	8	Wood Framing Governs
4x4 Trio 30	14 GA	2,000	1,700	5,700	4x4	2,720	4x4	3,050	SPF #2	1,017	4	Wood Framing Governs
4x4 Trio 45	14 GA	2,000	1,450	5,450	4x4	2,720	4x4	3,050	SPF #2	1,017	4	Wood Framing Governs
4x4 Trio 120	14 GA	2,000	1,700	5,700	4x4	2,720	4x4	3,050	SPF #2	1,017	4	Wood Framing Governs
4x4 Quad	14 GA	1,800	-	5,400	4x4	2,720	4x4	3,050	SPF #2	1,017	4	Wood Framing Governs
4x4 Quad 30	14 GA	1,800	1,400	6,800	4x4	2,720	4x4	3,050	SPF #2	763	4	Wood Framing Governs
4x4 Quad 45	14 GA	1,800	1,200	6,600	4x4	2,720	4x4	3,050	SPF #2	763	4	Wood Framing Governs
4x4 Quad 120	14 GA	1,800	1,080	6,480	4x4	2,720	4x4	3,050	SPF #2	763	4	Wood Framing Governs
4x4 Quint	14 GA	1,800	-	7,200	4x4	2,720	4x4	3,050	SPF #2	763	4	Wood Framing Governs
6x6 Trio	12 GA	3,000	-	6,000	6x6	4,100	6x6	7,935	SPF #2	3,000	12	Bracket Capacity Governs
6x6R Trio	12 GA	3,400	-	6,800	6x6	4,100	6x6	7,935	SPF #2	3,400	12	Bracket and Fasteners Govern
6x6 30 Trio	12 GA	3,000	2,500	8,500	6x6	4,100	6x6	7,935	SPF #2	2,500	12	Sloped Member /Post Governs
6x6 45 Trio	12 GA	3,000	2,100	8,100	6x6	4,100	6x6	7,935	SPF #2	2,100	8	Sloped Member /Post Governs
6x6 120 Trio	12 GA	3,000	2,500	8,500	6x6	4,100	6x6	7,935	SPF #2	2,500	12	Sloped Member /Post Governs
6x6 Quad	12 GA	2,650	-	5,300	6x6	4,100	6x6	7,935	SPF #2	2,645	12	Sloped Member /Post Governs
6x6R Quad	12 GA	3,000	-	6,000	6x6	4,100	6x6	7,935	SPF #2	2,645	12	Sloped Member /Post Governs
6x6 Quad 30	12 GA	2,650	2,120	10,070	6x6	4,100	6x6	7,935	SPF #2	2,120	8	Sloped Member /Post Governs
6x6 Quad 45	12 GA	2,650	1,855	9,805	6x6	4,100	6x6	7,935	SPF #2	1,855	8	Sloped Member /Post Governs
6x6 Quad 120	12 GA	2,650	1,590	9,540	6x6	4,100	6x6	7,935	SPF #2	1,590	8	Sloped Member /Post Governs
6x6 Quint	12 GA	2,650	-	10,600	6x6	4,100	6x6	7,935	SPF #2	1,984	8	Wood Framing Governs
6x6R Quint	12 GA	2,750	-	11,000	6x6	4,100	6x6	7,935	SPF #2	1,984	8	Wood Framing Governs

In the table above, roof design loads are to be compared to the max beam (cavity) ratings listed. The capacities are in pounds. For instance, the 6x6 Trio 30 has a maximum rating of 3,000lbs per cavity with SPF No 2 wood framing. The maximum loading of the brackets is determined based on the wood framing species.

Our analysis assumes static and uniformly distributed loading conditions. The wood members are to extend fully into the connectors, and all fasteners are to be completely driven. Where lateral loads are present, segments of walls are added or roofing is installed, bracing and/or sheathing must be used. Do not rely solely on these brackets for lateral support in these applications. 4"x4" Knee bracing with TOJA 45 Degree bracket can be used. End users and designers using the tables are responsible for all considerations, assumptions, and reviews of the factored capacities with the local design codes. Design and review of foundations is not included. For higher values, different fasteners may be required.

Sample Design Calculation

The enclosed sample calculation is to determine the vertical loading on the bracket for a double 10ftx12ft framed structure with a flat roof.

<u>Residential Snow Loading</u>
Dead Load = 10 PSF (including self weight)
Snow Load = 40PSF

Roof Design Load (Load factors per NBCC 2015)
= 1.5LL + 1.25DL
= 1.5x40PSf + 1.25x10PSF
= 72.5 PSF

Size Double 10ft wide x 12ft long (Total 10ft x 24ft)

Assuming one way loading

Inside Post bracket load, per arm.

= (10ft/2 x 12ft/2)*72.5PSF
= 2175lbs (per Arm)

Vertical Post Load

= (10ft/2 x 12ft)72.5PSF
= 4350lbs (intermediate post)

Use 6x6 Trio post brackets where max cavity capacity is 3,000lbs.

Corner Post bracket load, per arm.

= (10ft/2 x 12ft/2)*72.5PSF
= 2175lbs (per Arm)

Vertical Post Load

= (10ft/2 x 12/2ft)72.5PSF
= 2175 lbs (Corner post)

Select 6x6 Trio post brackets where max cavity capacity is 3,000lbs and fastening is with 10 screws

Lateral support to be provided by tying into existing structure and/or knee bracing. Use TOJA 4x4 45 degree brackets for knee bracing.

Limitations

This report was prepared by POW Technologies for the account of TOJA Grid Inc. The material in this report reflects our findings based on a limited scope of work and the documentation received at the time of preparation. Consideration of our findings, coordination and further investigation is by the project design team.

Any use which a third party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Parties. POW Technologies accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

If you have any questions, please contact this office. Thank you.

Best Regards,
Pow Technologies,

Walter Santarelli P.Eng., M.Eng.