

Attn: Corey Geiger, COO, IronRidge Inc.

Date: November 29th, 2021

Re: Structural Certification for IronRidge *Knockout Tile* Roof Attachment with Open-End Slot L-foot.

This letter addresses the structural capacity of IronRidge *Knockout Tile* with Open-End Slot L-foot (simplified as *Knockout Tile*) for use as a tile roof attachment for flush mounted PV solar systems. *Knockout Tile* assembly consists of an extruded aluminum base (pedestal), an open-end rail mounting bracket (L-foot), and an aluminum tile replacement flashing fastened to the assembly. The pedestal is attached to an underlying roof rafter using one (1) 5/16" stainless steel lag screw with a minimum thread length of 3" and the L-foot is secured to the pedestal by a 5/16" stainless steel threaded stud and nut. Assembly of *Knockout Tile* and accompanying hardware shall be installed in accordance with IronRidge *Knockout Tile* Installation Manual. Full assembly details are shown in Exhibit EX-0018.

The referenced uplift, compression and lateral capacities of *Knockout Tile* tabulated below are based on mechanical load tests conducted along the four load directions as shown in Figure 1, using a Universal Instron Test Unit, conforming to the following listed standards.

- ASTM D1761-20, Standard Test Methods for Mechanical Fasteners in Wood and Wood Based Material
- ASTM B 557-15, Standard Test Method for Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products
- NDS-2018, National Design Specification (NDS) for Wood Construction
- ADM-2015 Aluminum Design Manual
- ICC-428, Acceptance Criteria for Modular Framing Systems Used to Support Photovoltaic (PV) Modules

For each load test, a *Knockout Tile* assembly was installed onto a preconditioned sample roof deck composed of 7/16" OSB board and 2x4 Douglas Fir rafters. The measured moisture contents of the conditioned roof decks ranged from 10% to 15%, with the average specific gravity of rafters of 0.42. For each test, loads were applied at the highest slot position on the L-foot as shown in Figure 1 and testing was performed to consider the different orientations of L-foot and pedestal base as allowed per the *Knockout Tile* Installation Manual. Table 1 below summarizes the average peak load, its associated failure mode, and the calculated allowable capacity for the respective load direction. The listed average peak failure load reflects the orientation of L-foot and pedestal which results in the lowest capacity and therefore shall be applied to other orientation configurations.

Table 1: IronRidge Knockout Tile with Open-End Slot L-foot Roof Assembly Allowable Capacities ⁽¹⁾						
Load Direction	Specimen Quantity	Average Peak Failure Load (lbs)	Deviation of Test Results ⁽²⁾	Critical Failure Mode	Safety Factor ⁽³⁾	Allowable Capacity (lbs) ⁽⁴⁾
Uplift	4	1620	3.8%	Pedestal Rupture	1.95	831
Compression	4	2385	6.8%	OSB Deck Rupture	2.54	939 ⁽⁵⁾
Lateral Parallel to Rafter	4	461	2.1%	Pedestal Rupture	1.95	222 ⁽⁶⁾
Lateral Perpendicular to Rafter	6	347	4.1%	Pedestal Rupture	1.95	168 ⁽⁶⁾

Notes:

- (1) Capacities apply to a rafter size of 2x4 or greater, and deck board thickness 7/16" or greater. The specific density of rafter shall not be less than 0.42. The Lag screw shall be secured within the center 1/3 of rafter width with a minimum 2.5" end distance. Rafters should be in sound structural condition with no sign of rot, decay, or extant damage due to previous installation.
- (2) Deviation reflects the variance of the highest or the lowest test value from the group mean for the respective load direction.
- (3) Safety Factor is associated with the respective failure mode recorded and determined per ADM-2015, and NDS-2018.
- (4) Allowable capacity is equal to Average Peak Failure Load divided by the listed Safety Factor.
- (5) The compression allowable capacity is based on the load test for *Knockout Tile* with Closed End Slot. The dimensional revision applied to the *Knockout Tile* with Open End Slot was reviewed and deemed not to change the compression direction capacity.
- (6) The lateral allowable capacities are based on load tests for *Knockout Tile* with Closed End Slot. The capacities are decreased to account for the dimensional revision applied to the *Knockout Tile* with Open End Slot which increased the lag hole diameter on the pedestal.

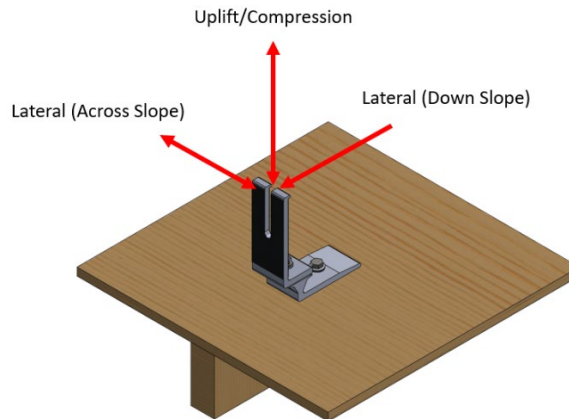


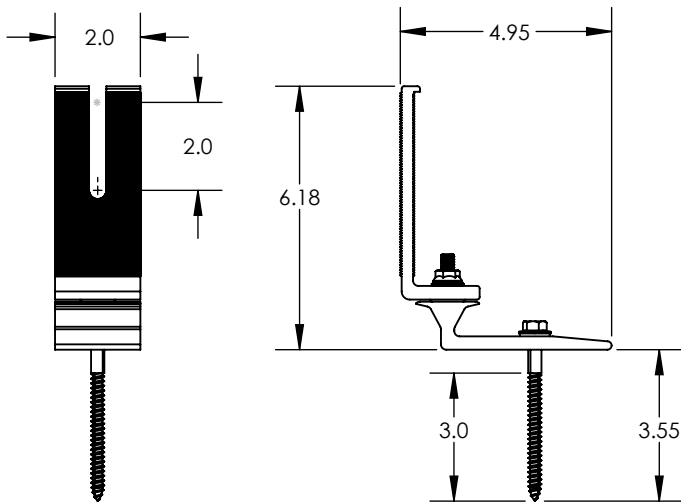
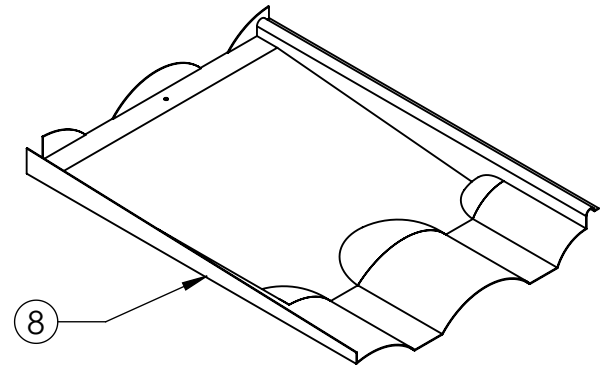
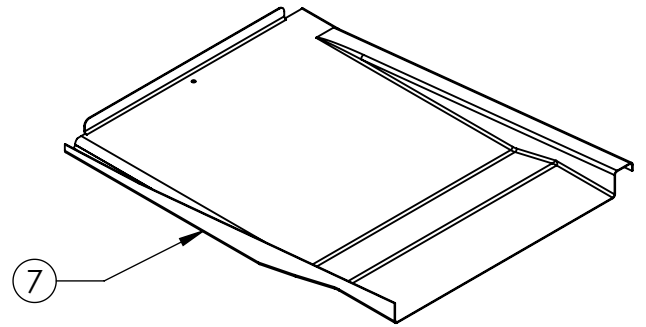
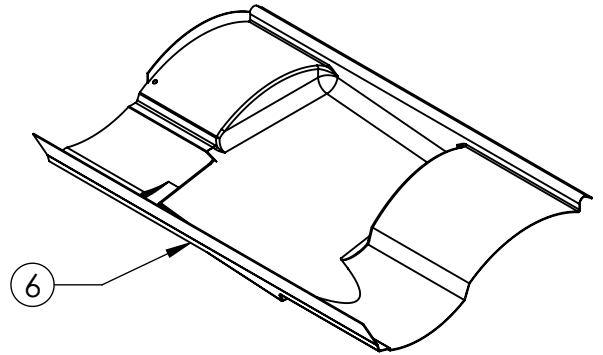
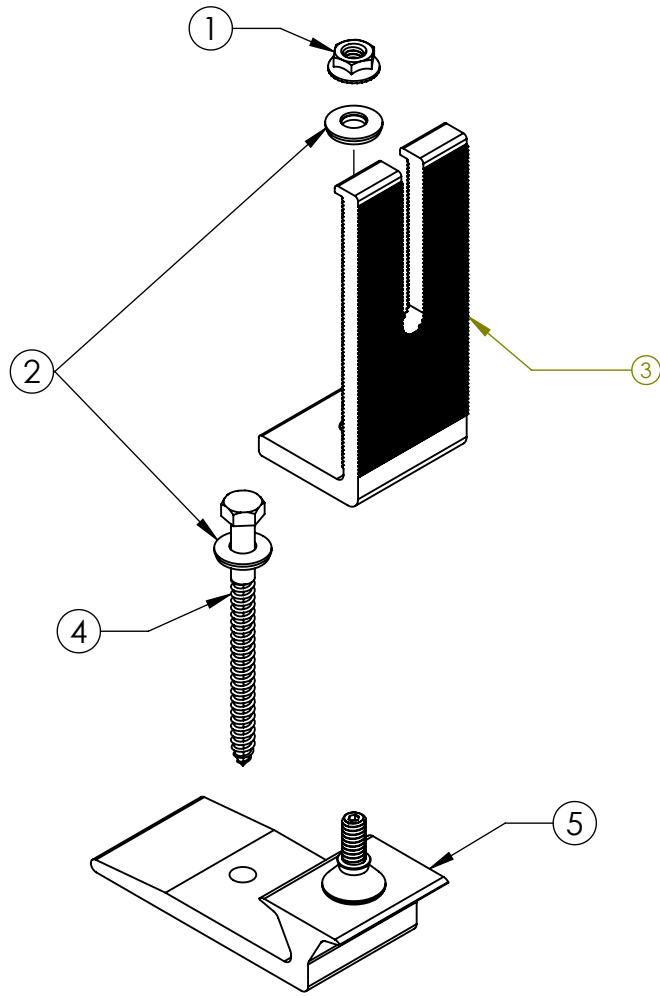
Figure 1

Sincerely,

Gang Xuan, SE
Senior Structural Engineer



EXHIBIT: EX-0018



ITEM NO.	DESCRIPTION
1	NUT, FLANGE, HEX, 5/16-18 SS
2	WASHER, EPDM BACKED
3	L-FOOT, OPEN SLOT L-FOOT
4	BOLT, LAG 5/16 X 4"
5	ASSY, BASE
6	FLASHING, TILE REPLACEMENT, S-TILE
7	FLASHING, TILE REPLACEMENT, FLAT TILE
8	FLASHING, TILE REPLACEMENT, W-TILE



IRONRIDGE

Assy, Knockout Tile
DWG. NO. EX-0018