US Headquarters | 4141 W. Van Buren St., Ste. 2 | Phoenix, AZ 85009
US Branch | 976 Brady Ave., Ste. 100 | Atlanta, GA 30318

December 20, 2021

EcoFasten

4141 West Van Buren St.

Phoenix, AZ 85009

Attn.: John Hudson, Senior Director of Product, EcoFasten

Re: Structural Certification for EcoFasten *ClickFit Universal Tile Hook* Roof Attachment

This letter addresses the structural capacity of the *ClickFit Universal Tile Hook* for use as a tile roof attachment for flush mounted PV solar systems. The *ClickFit Universal Tile Hook* assembly consists of a cold formed stainless steel base, stainless steel arm and extruded aluminum shelf kit with an optional aluminum flashing. The *ClickFit Universal Tile Hook* base is attached to an underlying roof rafter using two (2) 5/16”x 4” stainless steel lag screws, the arm component is secured to the base by a 5/16" carriage bolt and the shelf kit is secured to the arm with a 5/16” bolt. Assembly of the arm, base, shelf kit and accompanying hardware shall be installed in accordance with EcoFasten’s *ClickFit Universal Tile Hook* installation manual. Full assembly details are shown in Exhibit EX-A-01.

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

ASTM D1761-20, Standard Test Methods for Mechanical Fasteners in Wood and Wood-Based Materials
ASTM A370-21, Standard Test Methods and Definitions for Mechanical Testing of Steel Products
NDS-2018, National Design Specification (NDS) for Wood Construction
ICC-428, Acceptance Criteria for Modular Framing Systems Used to Support Photovoltaic (PV) Modules

The uplift, compression and lateral load testing was performed by installing the *ClickFit Universal Tile Hook* assembly on a sample roof deck composed of 15/32” OSB board over 24” O.C. 2x4 Douglas Fir rafters. The moisture content and the specific gravity of the rafters were measured per ASTM D2395-17 *“Standard Test Methods for Density and Specific Gravity (Relative Gravity) of Wood and Wood-Based Materials”*. The recorded moisture content of the rafters among all sample roof decks was a maximum of 16%. The minimum recorded specific gravity of the rafters among all sample roof decks was 0.37. For each test the arm component was set at the furthest allowable position from the lag screws and loads were directly applied at the highest slot position to perform the tests at the worst configuration.

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The ultimate failure mode for uplift testing was pull-out of the lag screws from the rafters and for compression testing the ultimate failure mode was rupture of the OSB board due to bearing of the arm. The averages of the peak loads of both directions, which were observed concurrent with the respective ultimate failure point, are documented in Table 1 shown below.

The ultimate failure mode for both lateral directions was pull-out of the lag screws from the rafters. Average peak loads of 2315 lbs. and 619 lbs. were recorded for the direction parallel to rafter and direction perpendicular to rafter respectively.

The associated lateral movements at the peak loads were observed to be 7" and 10" respectively. To restrict system deformation under lateral loads, deflection-based serviceability limits where applied, which consequently results in reducing allowable capacities. The loads determined from the serviceability limits are reported as the allowable capacities for both lateral load directions as tabulated in Table 1. Specifically, based on full scale lateral testing, a 1" lateral arm deflection is confirmed compatible with the full-scale system and presented as the serviceability limit for the load direction parallel to rafter. For the lateral load direction perpendicular to rafter, the Instron recorded proportional limit of 0.75" is presented as the serviceability limit which prevents permanent deformation of the assembly.

Observed test results and failure modes along with allowable capacities are summarized in the Table 1. Please note the test investigation and its results described herein were based on the load tests performed on the *ClickFit Universal Tile Hook Assembly* as a stand-alone roof attachment. It is not the intention of the letter to rate or certify other *ClickFit* system components such as *ClickFit* rail or module clamps. This evaluation excludes the structural adequacy of the chosen PV modules, or underlying roof supporting members. For those, it shall be the responsibility of the system designer or engineer to verify the structural capacity and adequacy regarding the applied or resultant loads of the chosen array configuration.

Table 1 EcoFasten ClickFit All Tile Hook Mechanical Load Test Results and Allowable Capacities (1)

Load Direction	Specimen Quantity	Observed Failure Mode	Average Peak Load at Failure (lbs) (2)	Safety Factor (3)	Deviation of Test Results (4)	Allowable Load (lbs)
Uplift	4	Lag Screw Pull-out	1011	3.0	10.6%	337
Compression	4	OSB Deck Rupture	709	2.54	10.3%	279
Lateral Parallel to Rafter	4	Lag Screw Pull-out	2315	3.0	5.4%	154 (5)
Lateral Perpendicular to Rafter	4	Lag Screw Pull-out	619	3.0	8.0%	75 (5)

(1) Capacities apply to rafter size of 2x4 or greater at 24" O.C. or less and deck thickness 15/32 or greater. The Specific Gravity of rafter shall not be less than 0.37. Rafters should be in sound structural condition with no sign of rot, decay, or extant damage due to previous installation.
(2) Values are based on securing the lag screw within center 1/3 of rafter width with a minimum 2.5" end distance.
(3) Safety Factor is associated with respective failure modes per ASTM D7147-21 and NDS-2018.
(4) Deviation refers to the highest or lowest test value to the group average and is based on the ultimate peak load for the tension/compression and serviceability limit load for the lateral directions.
(5) The provided allowable loads are controlled by the specified serviceability limit.

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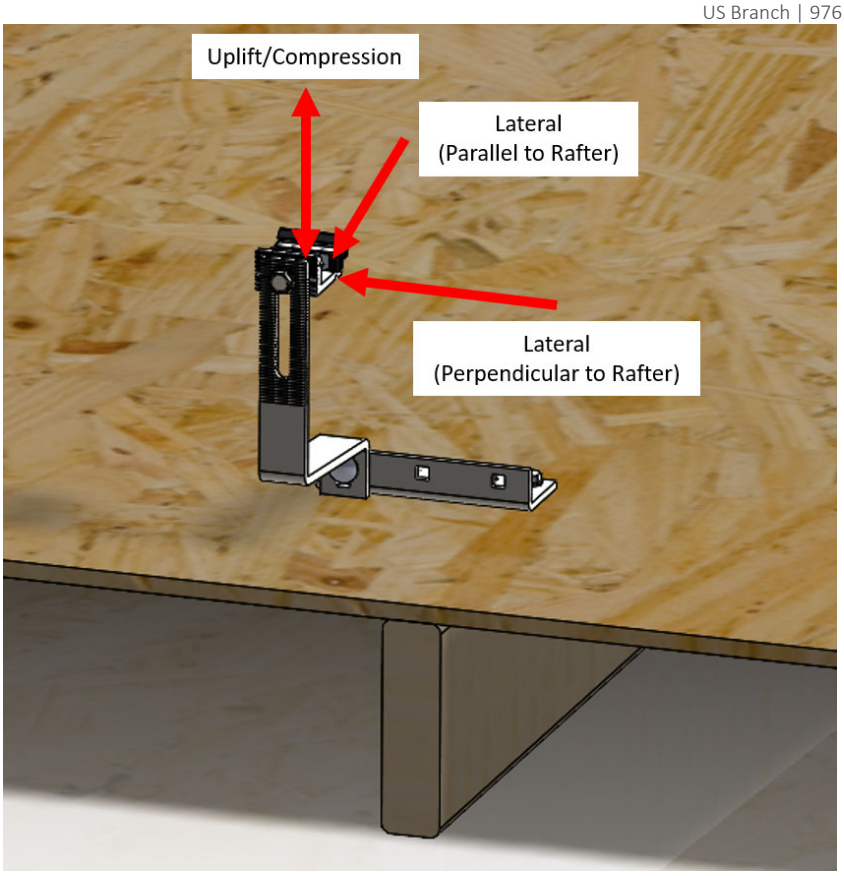


Figure 1

Sincerely,

REGISTERED PROFESSIONAL ENGINEER
GANG XUAN
NO. 6504
STRUCTURAL
STATE OF CALIFORNIA

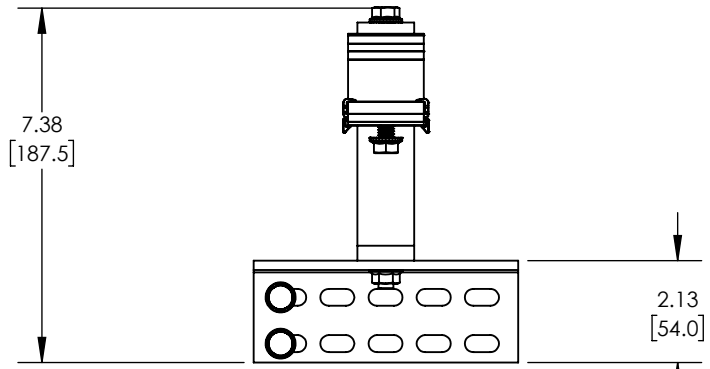
2021.12.20
14:23:41
-08'00'

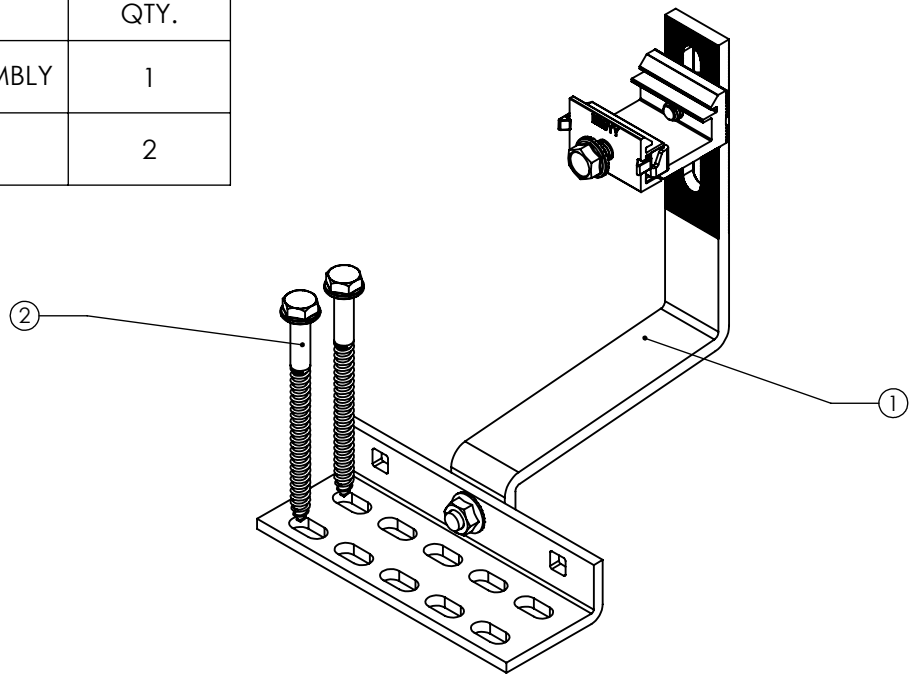
Gang Xuan, SE
Senior Structural Engineer

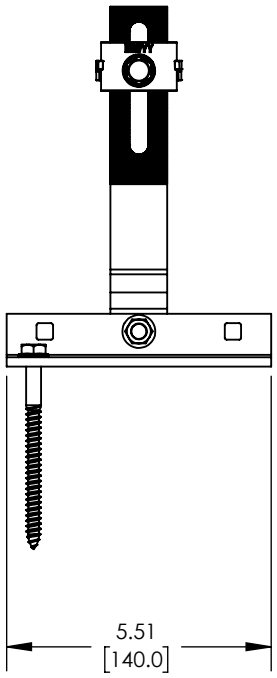
Matthew S Kuzila, PE

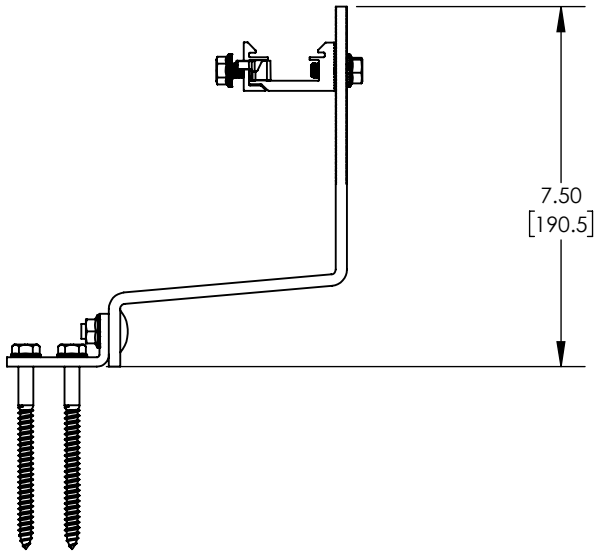
Structural Engineer

ITEM NO.	DESCRIPTION	QTY.
1	CF UNIV TILE HOOK WITH CLICKFIT RAIL ATTACHMENT, ASSEMBLY	1
2	SCREW, LAG, 1/2" HEX, W/ FLANGE, 5/16-9 4"	2









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THIRD ANGLE PROJECTION	DRAWN	T. RAY	12/14/21
	CHECKED	--	--
	ENG APPR.	--	--
	MFG APPR.	--	--
	Q.A.	--	--

DO NOT SCALE DRAWING

INTERPRET DIM AND TOLERANCE PER ASME Y14.5[M]-2009

DIMENSIONS TOLERANCES ARE IN:

INCHES.	[MILLIMETERS]
.XX: +/- .030	.X: +/- .75
.XXX: +/- .010	.XX: +/- .25

ANGLES: +/- 1°

ESDEC
INNOVATIVE MOUNTING SYSTEMS

CF UNIV TILE HOOK

SIZE	DWG. NO.	REV.
A	EX-A01	X01

SCALE:1:4	WEIGHT:	SHEET 1 OF 1