

December 21st, 2022

EcoFasten

4141 West Van Buren St.

Phoenix, AZ 85009

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

Re: EcoFasten ClickFit Smart Foot UltraGrip™ Rafter Attachment

This letter certifies the structural capacity of the EcoFasten *ClickFit Smart Foot UltraGrip™* for use with flush mount PV solar systems, when attached to a roof rafter. The EcoFasten ClickFit Smart Foot includes a cast aluminum mount with a 2" long vertical open-end slot for connection of a railed system. The base of the EcoFasten *ClickFit Smart Foot* has 6 holes for roof attachment via No. 14 wood screws. An *UltraGrip™* Flashing Technology is affixed to the underside of the *Smart Foot* base. The *Smart Foot* is secured to a roof rafter using No. 14 x 3" structural wood screws. Screws shall be installed in accordance with the *EcoFasten ClickFit Smart Foot* installation manual. The EcoFasten *ClickFit Smart Foot*, details and component dimensions are shown in Appendix A.

The structural capacities of the *Smart Foot* were determined from mechanical load testing along four respective load directions including uplift, compression, lateral parallel to the rafter, and lateral perpendicular to the rafter for base orientations that represent rail running cross-slope or up slope in relation to roof pitch. The capacity ratings are based on structural load tests performed using a Universal Instron Test Unit according to *ASTM D1761-20 "Standard Test Methods for Mechanical Fasteners in Wood and Wood Based Materials"*. For each load test, a *Smart Foot* was installed on a sample roof deck constructed from 7/16" OSB over 2x4 rafters as shown in Figure 1. 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 between 12% and 14% and the rafter specific gravity was 0.42. For each load test, the point load was placed at the highest position allowed in the open-end slot. The tested *Smart Foot* was installed to the roof rafter using two (2) 3" long #14 stainless steel structural wood screws installed within the middle third of the rafter.

The failure observed during the uplift load testing was splitting of the 2x4 rafter at the peak load of 3011lbs, which is the average of the eight (8) tests provided. For the rafter splitting failure, a safety factor of 3 per ASTM D7147 is applied to the uplift peak load, which provides an **allowable uplift capacity of 1004lbs**. The above allowable capacity is applicable to roof decks with a rafter specific gravity greater than or equal to 0.42, which was the average wood specific gravity recorded in the uplift load tests.

The compression load failure observed was rupture of the OSB deck under the *ClickFit Smart Foot*. The average of peak loads from the five (5) compression tests was 5221lbs. For the deck rupture failure, a safety factor of 2.54 per NDS 2018 is applied to the peak load which provides an **allowable compression capacity of 2056lbs**.

For each lateral load direction, the *ClickFit Smart Foot* was tested in the worst-case condition with the load placed at the highest position allowed in the vertical slot. For lateral load parallel to the rafter, the critical failure mode which results in the lowest allowable capacity was observed to be fastener withdrawal at a peak load of 1103lbs. For the fastener withdrawal failure mode, per ASTM D7147 a safety factor of 3 is applied to the lateral parallel to the rafter peak load, which provides an **allowable capacity of 368lbs**. The critical failure mode for lateral load perpendicular to the rafter is fastener shearing. The average of the shear loads from five (5) tests is 720lbs. and with a safety factor of 3.0 per AISI S100 applied for the screw shearing failure mode, the **allowable capacity is 240lbs**.

Please note the provided test investigation and its associated results described herein were based on the load tests performed on the *ClickFit Smart Foot* as a stand-alone roof attachment. It is not the intention of this letter to rate or certify *ClickFit* system level performance or structural components other than those specifically delineated in this letter. 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 designated system designer or project engineer to verify the structural capacity and adequacy regarding the applied or resultant loads of the chosen array configuration.

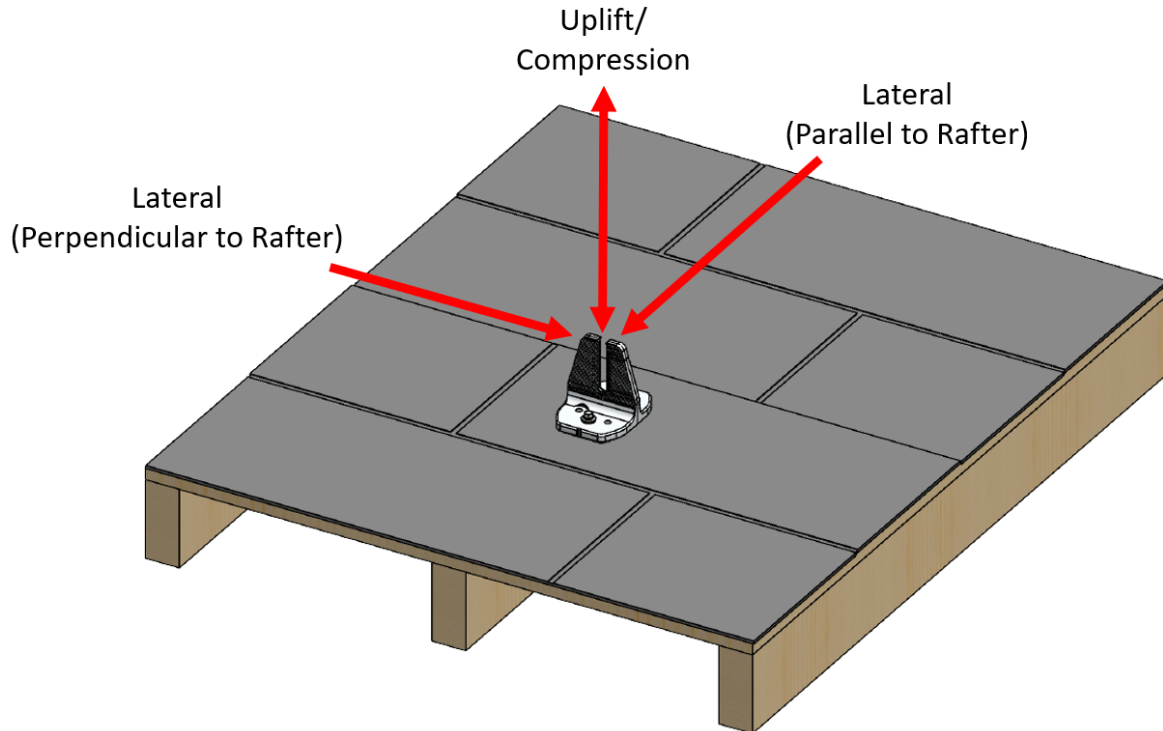


Figure 1: *EcoFasten* ClickFit Smart Foot Assembly and Applied Loading Directions

Table 1: EcoFasten ClickFit Smart Foot Allowable Capacities ⁽¹⁾

Load Direction	Test Quantity	Critical Failure Mode	Safety Factor ⁽⁵⁾	Avg Ultimate Capacity (lbs.)	Max deviation from mean ⁽⁴⁾	Allowable Capacity (lbs.) ⁽⁶⁾
Uplift ⁽²⁾	8	Rafter Splitting	3.0	3011	16.5%	1004
Compression ⁽³⁾	5	OSB Deck Bearing Rupture	2.54	5221	9.2%	2056
Lateral Parallel to Rafter	8	Fastener Withdrawal	3.0	1103	21.8%	368
Lateral Perpendicular to Rafter	5	Screw Shearing	3.0	720	5.1%	240

Table 1 Notes:

- (1) Capacities apply to a roof structure with the minimum component size of a 2x4 rafter, and a roof deck thickness of 7/16" using 3" long #14 wood screws installed per the EcoFasten *ClickFit Installation Guide*. Rafters and roof deck should be in sound structural conditions with no sign of rot, decay, previous installation, or pre-existing damages.
- (2) The uplift direction is upward perpendicular to the roof surface. The uplift capacity shall be used when the direct supporting rafter has a specific gravity of 0.42 or greater
- (3) The compression direction is downward perpendicular to the roof surface.
- (4) Deviation reflects the variance of the highest or the lowest test value from the group mean for the respective load direction. For load directions where deviation was larger than 10% after 5 tests, 3 additional tests are added per *ADM-2020* Appendix 1.
- (5) Safety Factor is associated with the respective failure mode recorded and determined per *NDS 2018*, *ASTM 7147-21*, and *AISI S100-16*
- (6) Allowable capacity is equal to Average Ultimate Capacity divided by its associated Safety Factor.

Sincerely,

Matthew S Kuzila, PE

Structural Engineer

Digitally Signed 12/21/2022

APPENDIX A: ENGINEERING DRAWING

