Perry Precision Products Inc.

Product Testing
CNC Machining

Testing of Fiber Composite Reinforcement Utility Products

PARTS TESTING

Submitted to:

Pole Life Systems, Inc.

Bob Butler

January 17, 2018

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Perry Precision Products, Inc.

a Delaware Company

(727) 232-0868

POLE LIFE SYSTEMS PRODUCT TESTING TO ANSI 05.1-2015

Product Category:	Electrical Utility Industry
Submitted to:	Pole Life Systems, Inc.
Testing Company:	Perry Precision Products, Inc. – (727) 232-0868
Measuring Equipment:	Mark-10 MR01-5000 Force Sensor
	Mark-10 Model M3i Digital Force / Torque Indicator
	Mark-10 Model Plug & Test Software
Start date:	11/1/2017
End date:	12/8/2017

Product Material Data:
Fiber reinforcement type: e-glass Resin matrix type: isothalic polyester resin Compacting force on reinforcement during cure: Resin bath system using Pultrusion process with a minimum of 50% glass reinforcement by volume where at least 90% of the reinforcement is in the form of rovings and the surfaces of the parts are reinforced with continuous filament UV mat.

PRODUCT PARTS LIST –

Machined Products

Item IS20

Front Support 20”

Item VR30

Vertical 30” Reinforcement

Item VR48

Vertical 48” Reinforcement

Item VR72

Vertical 72” Reinforcement

1.10 SCOPE – INDIVIDUAL PART TESTING TO ANSI O5.1-2015

1.11 These test methods cover determination of the break strength of Pultruded Composite Products. Knowledge of these properties are used in providing for reliable and economical design with parts of different sizes, and patterns to accommodate various utility pole configurations.

1.12 Two test methods were used: the cantilever test and the compression test method.

1.13 The procedures specified in this test method applies to Pultruded Composite Parts, after machining.

1.14 The values stated in foot-pound units are to be regarded as the standard.

1.15 Time values are given in 10 sec. intervals during the momentum of break or a pre-determined value deemed sufficient for the application.

A. Pultruded glass fiber composite support products for utility pole applications are tested according to ANSI O5.1-2015 standards.

B. Materials, clamps and fixtures used for securing the product/parts at various anchor points during testing do not touch or impede the true strength of products (are not shown).

NOTATIONS:

i. Not shown, are the various clamping devices, such as C-Clamps, Bolts, and Chains.

ii. Drawings in Views are mainly used for demonstrations and don't always reflect true parts.

iii. Illustrated below are a representation of the major test equipment and fixturing used:

Cantilever and Compression Methods – Applied

2.10 PART TEST FOR IS20 VERTICAL LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 2.10.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item IS20 - IS20 Vertical Load –

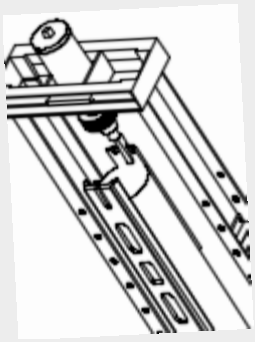


Figure 2.10.1 – Isometric View IS20 & VR30 Part, Ram, and force Block

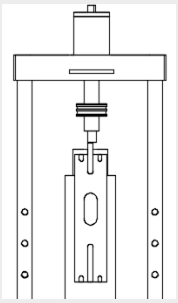


Figure 2.10.2 - Transverse View IS20 Part, Ram and force block

Figure 2.10.3 – Actual load test image

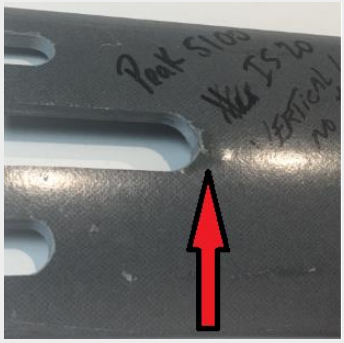
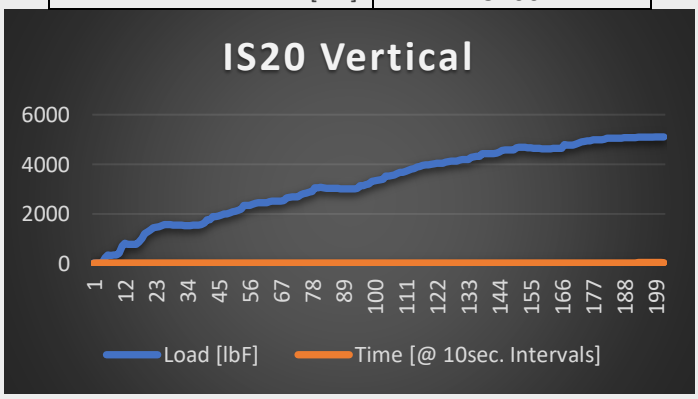


Figure 2.10.4 – Arrow indicated area image no-break

Vertical load fixture of matching shape block	.875" Slot Diameter
Load [lbF]	5100



Test Summary :

IS20 Vertical part - applied force to 5100 [lbf] in noted area as shown in Figure 2.10.4

Load applied, as in Fig. 2.10.3 until max load cell of 5100 [lbf] was reached.

*Notable: No cracks were observed in base composite material. Indenture from force noted with 2 slight laminate cracks.

2.11 PART TEST FOR IS20 LONGITUDINAL LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 2.11.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item IS20 - IS20 Longitudinal Load –

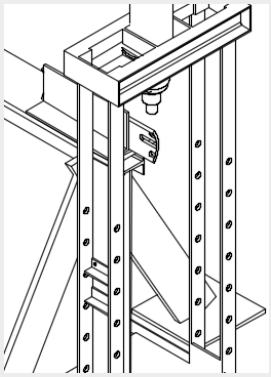


Figure 2.11.1 – Isometric View IS20 Part, anchor, and force Block

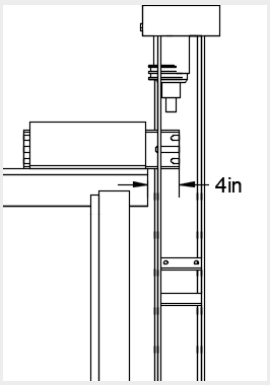
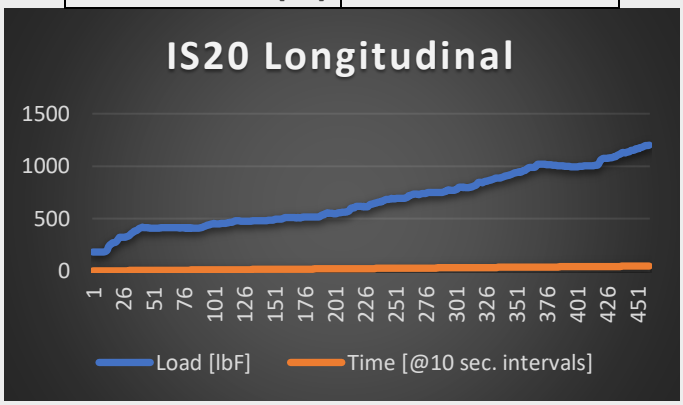


Figure 2.11.2 - Longitudinal View IS20 Part, anchor and force block

Figure 2.11.3 – Actual load test image

Figure 2.11.4 – Marked break point area image

Length from anchor Point	4"
Load [lbF]	1200



Test Summary :

IS20 Longitudinal part - cracked at 1200 [lbf] in marked areas as shown in Figure 2.11.4

Load applied, as in Fig. 2.11.3 until distinct cracks sounded and verified by observation.

2.12 PART TEST FOR IS20 TRANSVERSE INSIDE LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 2.12.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item IS20 - IS20 Transverse Inside Load –

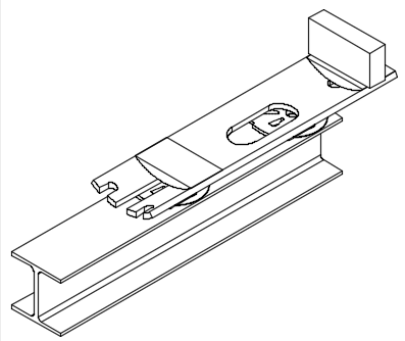


Figure 2.12.1 – Isometric View IS20 Part, anchor, and force Block

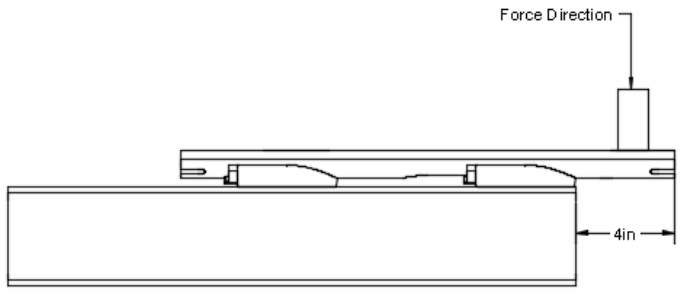


Figure 2.12.2 - Transverse View IS20 Part, anchor and force block

Figure 2.12.3 – Actual load test image

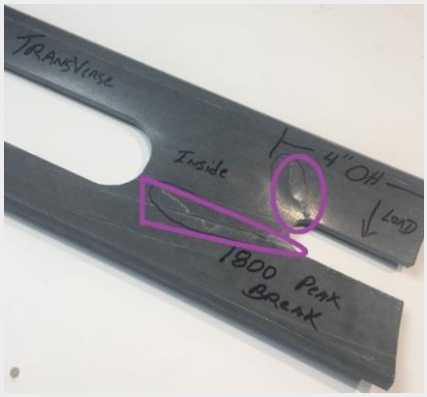
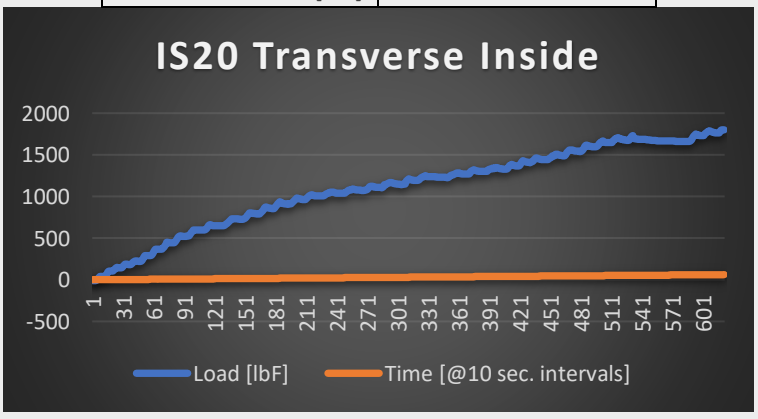


Figure 2.12.4 – Marked break points area image

Length from anchor Point	4"
Load [lbF]	1800



Test Summary :

IS20 Transverse Inside part - cracked at 1800 [lbf] in marked areas as shown in Figure 2.12.4

Load applied, as in Fig. 2.12.3 until distinct cracks sounded and verified by observation.

2.13 PART TEST FOR IS20 TRANSVERSE OUTSIDE LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 2.13.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item IS20 - IS20 Transverse Outside Load –

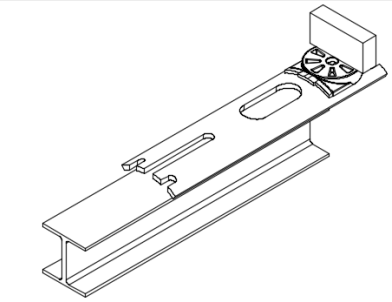


Figure 2.13.1– Isometric View IS20 Part, anchor, and force Block

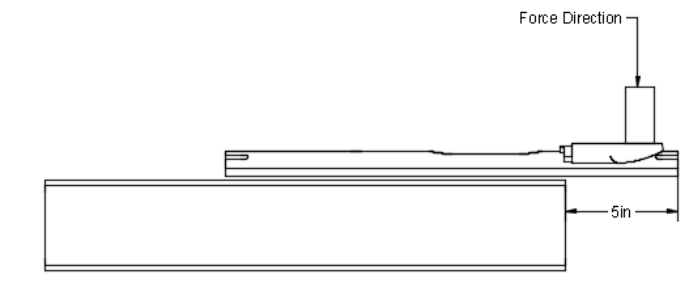
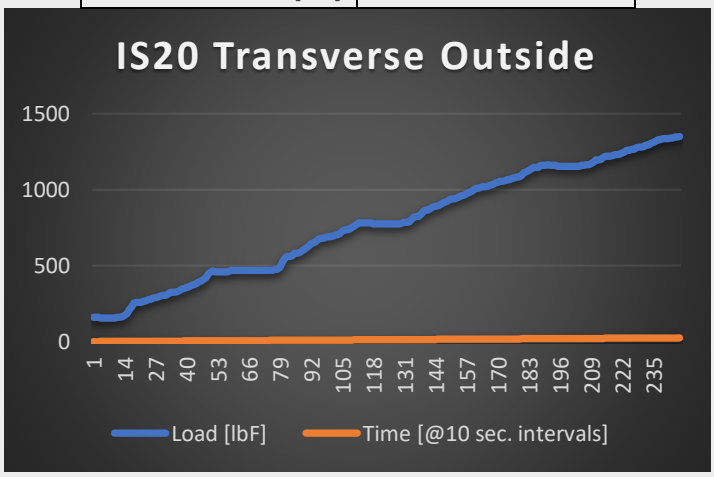


Figure 2.13.2 - Transverse View IS20 Part, anchor and force block

Figure 2.13.3 – Actual load test image

Figure 2.13.4 – Circled break point area image

Length from anchor Point	5"
Load [lbF]	1350



Test Summary :

IS20 Transverse Outside part - cracked at 1350 [lbf] in circled area as shown in Figure 2.13.4

Load applied, as in Fig. 2.13.3 until distinct crack sound was heard and verified by sight.

3.10 PART TEST FOR VR30 VERTICAL LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 3.10.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item VR30 - VR30 Vertical Load –

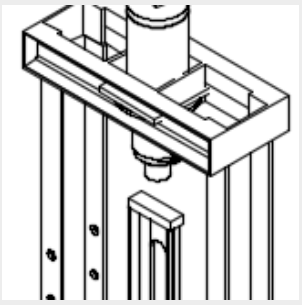


Figure 3.10.1 – Isometric View VR30 Parts, Ram, and force Block

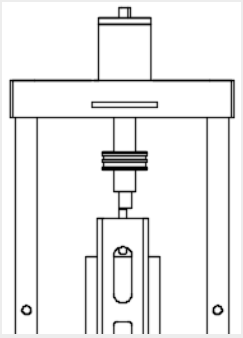


Figure 3.10.2 - Transverse View VR30 Parts, Ram and force block

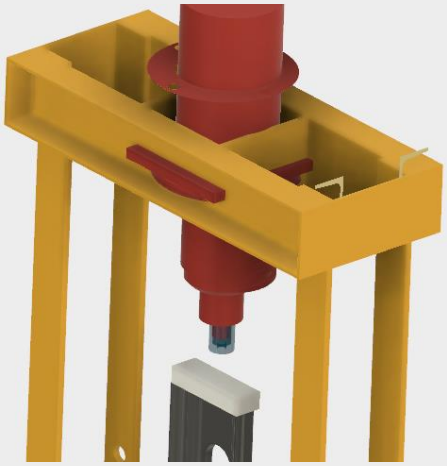
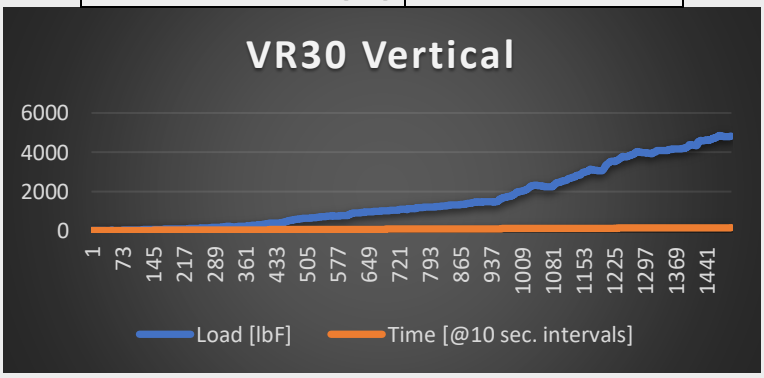


Figure 3.10.3 – Performed Vertical load test Illustration

Figure 3.10.4 – No Observed damage image

Vertical load fixture block	Top
Load [lbF]	5000



Test Summary :

VR30 Vertical part - applied force to 5000 [lbf] No observed damage as shown in Figure 3.10.4

Load applied, as in Fig. 3.10.3 until 5000 [lbf] was reached.

3.11 PART TEST FOR VR30 LONGITUDINAL LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 3.11.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item VR30 - VR30 Longitudinal Load –

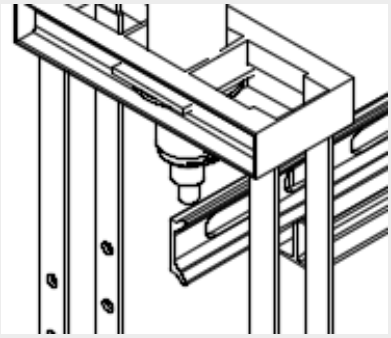


Figure 3.11.1 – Isometric View VR30 Part, anchor, and force Block

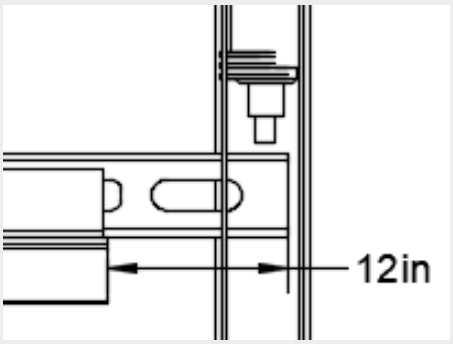


Figure 3.11.2 - Longitudinal View VR30 Part, anchor and force block

Figure 3.11.3 – Actual load test image

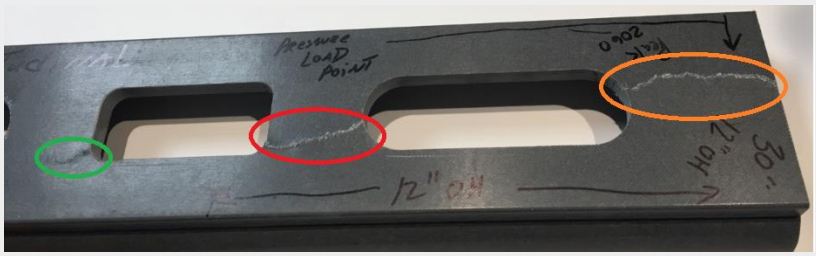
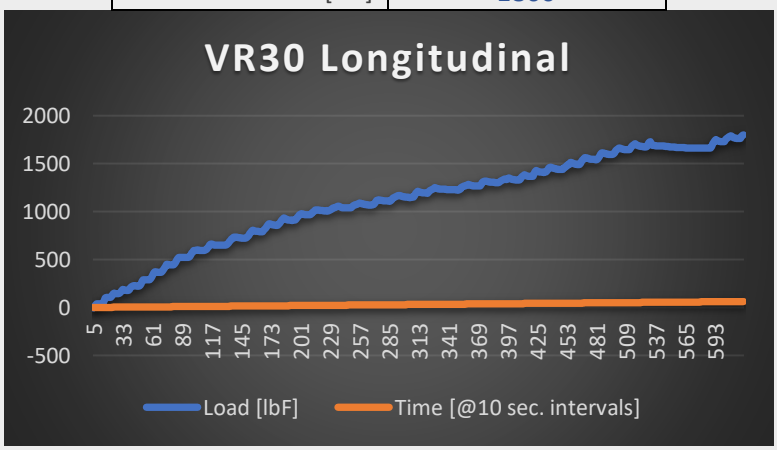


Figure 3.11.4 – Circled break point area image

Length from anchor Point	12"
Load [lbF]	1800



Test Summary :

VR30 Longitudinal part – cracked at 1800 [lbf] in marked areas as shown in Figure 3.11.4

Load applied, as in Fig. 3.11.3 until distinct cracks sounded and verified by observation.

3.12 PART TEST FOR VR30 TRANSVERSE INSIDE LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 3.12.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item VR30 - VR30 Transverse Inside Load –

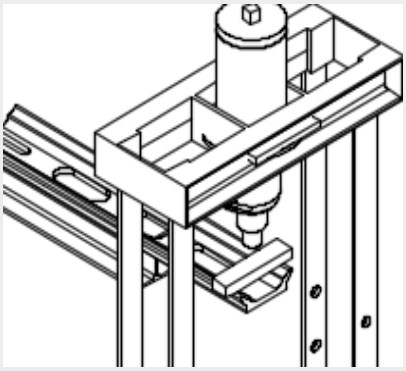


Figure 3.12.1 – Isometric View VR30 Part, anchor, and force Block block

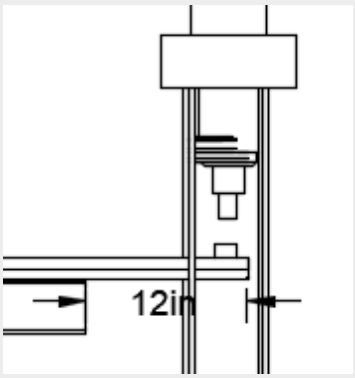
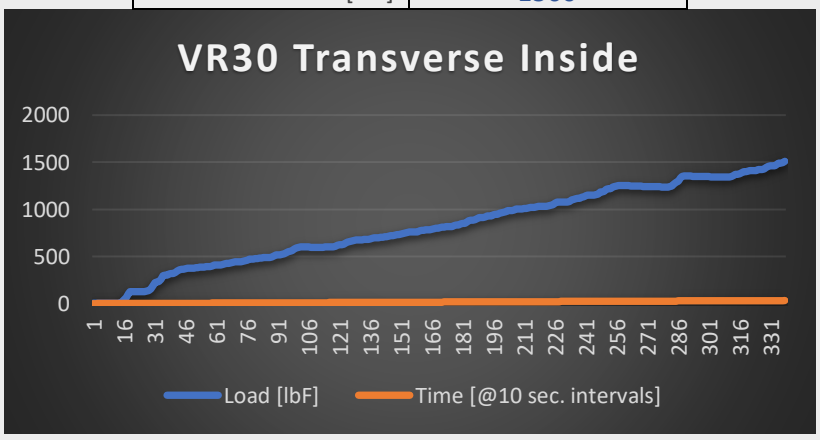


Figure 3.12.2 - Transverse View VR30 Part, anchor and force

Figure 3.12.3 – Actual load test image

Length from anchor Point	12"
Load [lbF]	1500



Test Summary :

VR30 Transverse Inside part – Load applied to 1500 [lbf] , as in Fig. 3.12.3 distinct crack sounded and verified by observation. *Pic not available.

3.13 PART TEST FOR VR30 TRANSVERSE OUTSIDE LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 3.13.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item VR30 - VR30 Transverse Outside Load –

Figure 3.13.1 – Isometric View VR30 Part, anchor, and force Block

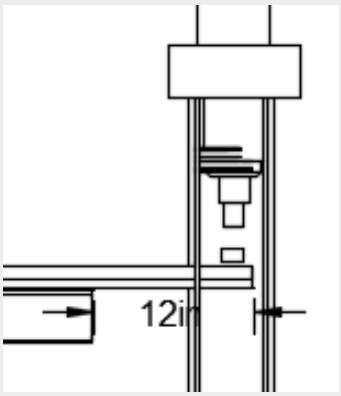
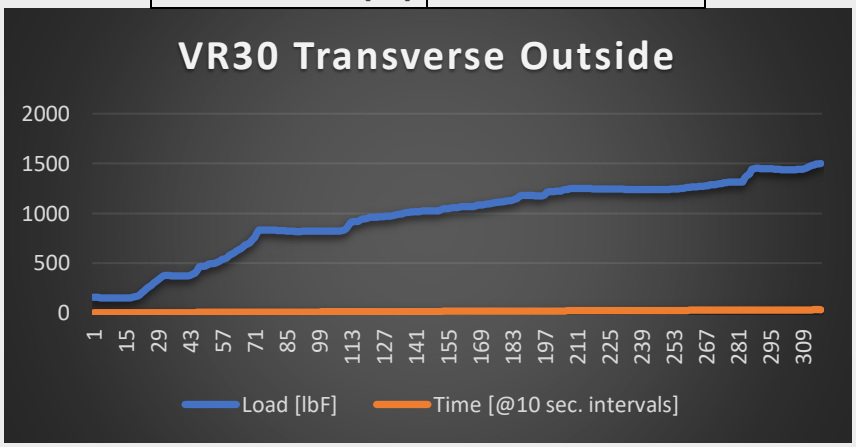


Figure 3.13.2 - Transverse View VR30 Part, anchor and force block

Figure 3.13.3 – Actual load test image

Length from anchor Point	12"
Load [lbF]	1500



Test Summary :

VR30 Transverse outside part – Load applied to 1500 [lbf] , as in Fig. 3.13.3 distinct crack sounded and verified by observation. *Pic not available.

4.10 PART TEST FOR VR48 LONGITUDINAL LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 4.10.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item VR48 - VR48 Longitudinal Load –

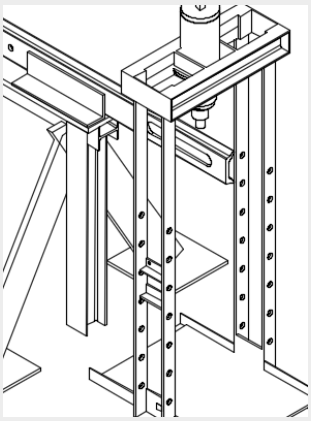


Figure 4.10.1 – Isometric View VR48 Part, anchor, and force Block

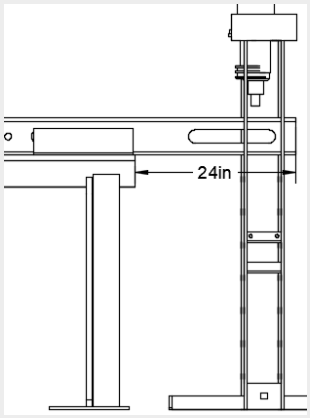


Figure 4.10.2 - Longitudinal View VR48 Part, anchor and force block

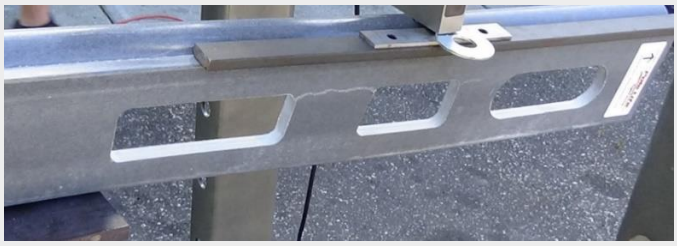
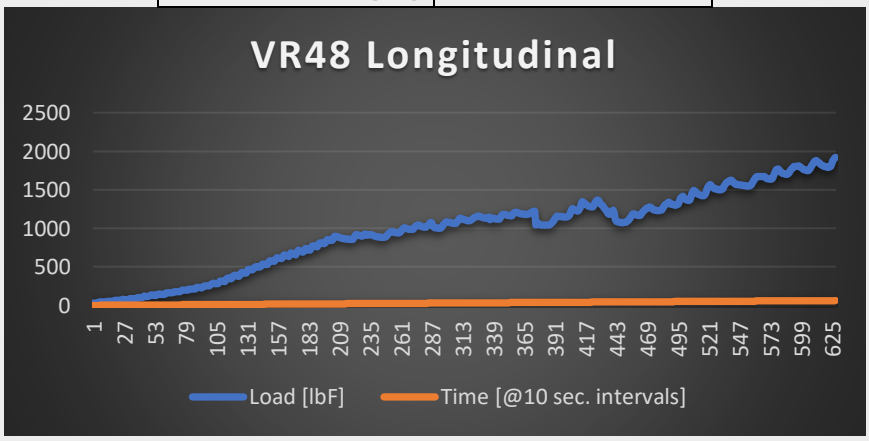


Figure 4.10.3 – Actual load test image

Figure 4.10.4 – Circled break point area image

Length from anchor Point	24"
Load [lbF]	1900



Test Summary :

VR48 Longitudinal part – cracked at 1900 [lbf] in marked areas as shown in Figure 4.10.4

Load applied, as in Fig. 4.10.3 until distinct cracks sounded and verified by observation.

4.11 PART TEST FOR VR48 TRANSVERSE INSIDE LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 4.11.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item VR48 - VR48 Transverse Inside Load –

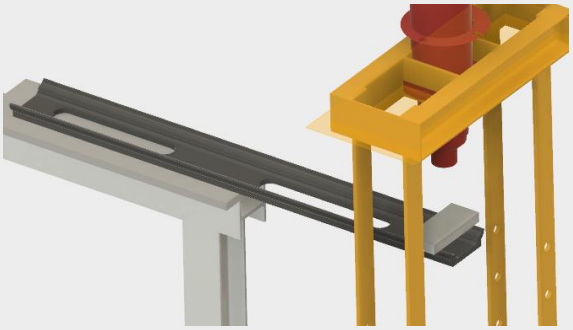


Figure 4.11.1 – Isometric Illustration VR48 Part

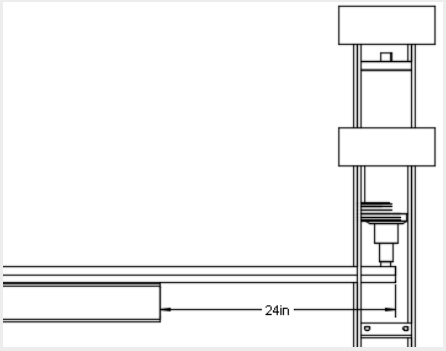
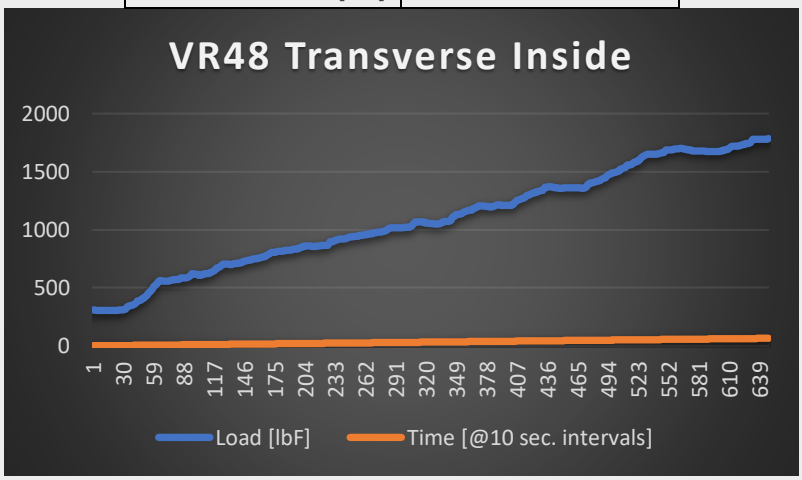


Figure 4.11.2 - Transverse View VR48 Part, anchor and force block

Figure 4.11.3 – Actual load test image

Figure 4.11.4 – No breaks, only indenture line image

Length from anchor Point	24"
Load [lbF]	1785



Test Summary :

VR48 Transverse Inside part – Pressure line in marked areas as shown in Figure 4.11.4

Load applied, as in Fig. 4.11.3 to 1785 [lbf].

4.12 PART TEST FOR VR48 TRANSVERSE OUTSIDE LOAD

This testing was conducted utilizing locked down fixtures as shown in Fig. 4.12.3 and force was applied by a 20 ton Hydraulic Ram with a Mark-10 MR01-5000 Force Sensor Load Cell mounted to fixture load head, with Computer Data output capture software as charted.

Item VR48 - VR48 Transverse Outside Load –

Figure 4.12.1– Isometric Illustration VR48 Part, anchor, and force Block

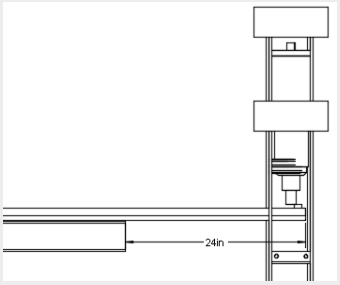


Figure 4.12.2 - Transverse View VR48 Part, anchor and force block

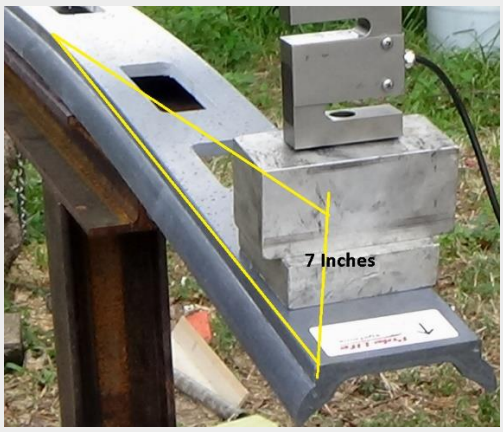
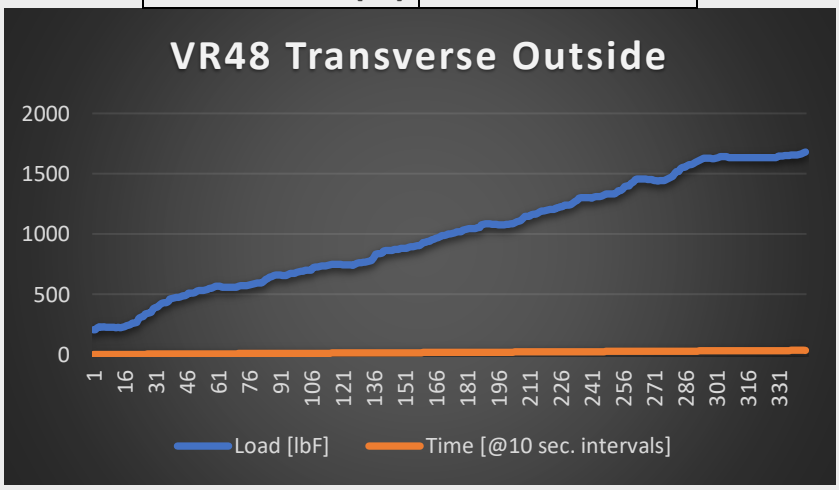


Figure 4.12.3 – Actual load test image

Figure 4.12.4 – Cracks as shown

Length from anchor Point	24"
Load [lbF]	1680



Test Summary :

VR48 Transverse Outside part - cracked at 1680 [lbf] in marked areas as shown in Figure 4.12.4

Load applied, as in Fig. 4.12.3 until distinct crack sound was heard and verified by sight.

5.10 SUMMARY / CONCLUSION – INDIVIDUAL PART TESTING TO ANSI O5.1-2015

5.11 – The following chart in Fig 5.10 will show the overall summary of part loads in highlighted cells.

5.12 Non-highlighted cells indicate test that were not performed due to redundancy, part shape, and no change in composite materials. These numbers are expected to be the same or out-perform the tests that were conducted.

PARTS PERFORMANCE INFORMATION CHART

Part Number	Overall Length inches	Overall Width inches	ANSI Vertical Load Rating	ANSI Longitudinal Load Rating	ANSI Transverse Load Rating	Approx. Shipping Weight Lbs.
IS 20	20	5.0	5100	1200	1350	2.20
VR 30	30	5.5	5000	1800	1500	6.75
VR 48	48	5.5	5000	1900	1680	10.75
VR 72	72	5.5	5000	1900	1700	17.50

Figure 5.10

- OTHER NOTES

- Inside/ Outside Transverse tests were performed, and lowest number has been charted above.
- Vertical load testing suspended when loads reached 5000 [lbf] range.

- INFORMATIVE

- Basic Cantilever and Compression method tests were performed to demonstrate machined part bend/break strengths for Vertical, Longitudinal, and Transverse directions.
- The test hardware, such as clamps, brackets, bolts, and hold down fixtures were carefully placed as to Not impede or alter the true strength of the parts.
- These part loads are thought to be above normal and adverse loads that may be applied in the field.
- Notable – Beyond actual breaks, No Part distortions were observed after the loads released.