

# Structural Analysis TNH Development

September 21, 2023

Project Name	8ft x 12ft x 2ft FRP Wall Enclosure
Site Location	1990 Olivera Rd. Concord, CA 94520 37.997685 N NAD83 122.048607 W NAD83
Structure Type	Rooftop
Structural Usage Ratio	<b>66%</b>
Overall Result	<b>Pass</b>

Upon reviewing the results of this analysis, it is our opinion that the structure does meet the specified IBC/ASCE/TIA code requirements. The proposed structure will be deemed adequate to support the proposed loading once the recommendations have been added as listed in this report.



## **Summary of Contents**

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### Introduction

- Opening Statement
- Project Description
- Criteria
- Conclusion

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### Appendix A

- Design Tables & Resources Used
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## **Assumptions and Limitations**

For the purposes of calculations, we assume an overall structure condition of “like new” and all members and connections to be free of corrosion and/or structural defects. The structure owner and/or contractor shall verify the structure’s condition prior to installation of any proposed equipment. If actual conditions differ from those described in this report TNH should be notified immediately to complete a revised evaluation.

Our evaluation is completed using standard TIA, AISC, ACI, and ASCE methods and procedures. Our structural results are proprietary and should not be used by others as their own. TNH is not responsible for decisions made by others that are or are not based on our supplied assumptions and conclusions.

**INTRODUCTION**

TNH has performed a structural design for only the referenced 8’x12’x2’ FRP enclosure. Connection to other structures is not part of this scope and is the responsibility of the customer to determine the size and frequency of anchors.

**Supporting Documentation**

<b>Design Drawings</b>	Shop Drawings by TNH, Dated: 09/13/2023
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**Analysis Code Requirements**

Wind Speed	92 mph (Vult)
Wind Speed w/ ice	30 mph (3-Second Gust) w/ 0” ice
TIA Revision	ANSI/TIA-222-H
Adopted IBC	2021 IBC / 2022 CBC
Structure Class	II
Exposure Category	C
Topographic Category	1
Calculated Crest Height	0
Spectral Response	S <sub>s</sub> : 1.625g S <sub>1</sub> : 0.6g S <sub>Ds</sub> : 1.301g

**CONCLUSION**

Upon reviewing the results of this analysis, it is our opinion that the structure does meet the specified IBC/ASCE/TIA code requirements. The proposed structure will be deemed adequate to support the proposed loading once the recommendations have been added as listed in this report.

**Recommendations:**

- Refer to the latest structural drawings for details.
- Use ½” Ø FRP bolts with ASI MP55310 methacrylate adhesive. Applied to a minimum of 3”x3” area.
- Connection to other structures is beyond the scope of this analysis.



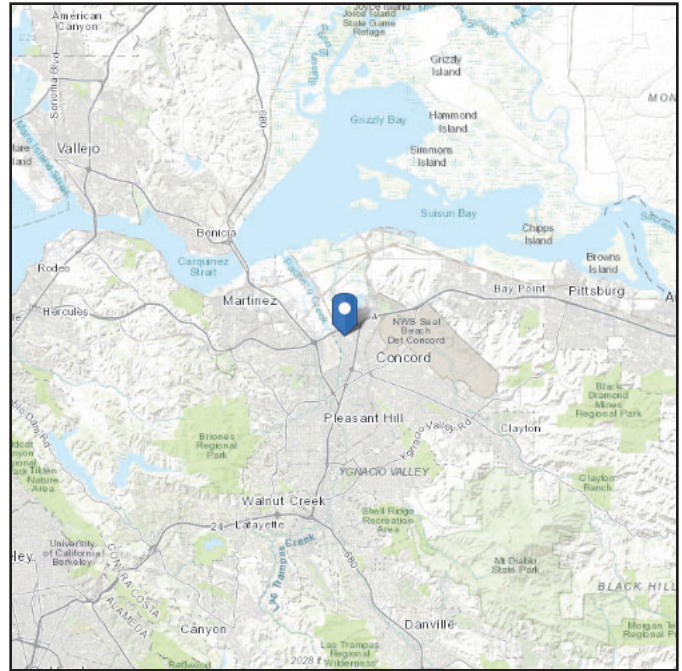
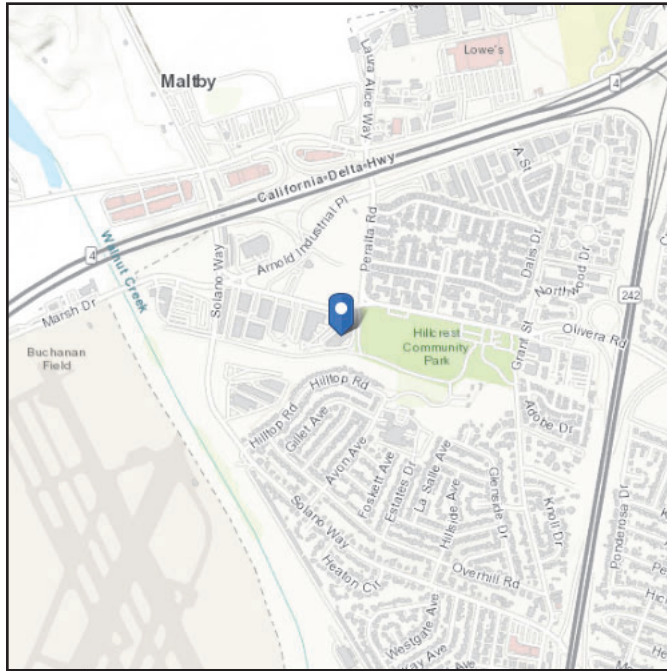
**APPENDIX A**  
Design Tables & Resources

# ASCE 7 Hazards Report

**Address:**  
1990 Olivera Rd  
Concord, California  
94520

**Standard:** ASCE/SEI 7-16  
**Risk Category:** II  
**Soil Class:** D - Default (see Section 11.4.3)

**Latitude:** 37.997685  
**Longitude:** -122.048607  
**Elevation:** 24.768770375933958 ft (NAVD 88)



## Wind

### Results:

Wind Speed	92 Vmph
10-year MRI	64 Vmph
25-year MRI	70 Vmph
50-year MRI	75 Vmph
100-year MRI	79 Vmph

Data Source: ASCE/SEI 7-16, Fig. 26.5-1B and Figs. CC.2-1–CC.2-4, and Section 26.5.2  
Date Accessed: Sat Aug 12 2023

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

**Site Soil Class:** D - Default (see Section 11.4.3)

**Results:**

$S_s$ :	1.626	$S_{D1}$ :	N/A
$S_1$ :	0.6	$T_L$ :	8
$F_a$ :	1.2	PGA :	0.659
$F_v$ :	N/A	PGA <sub>M</sub> :	0.791
$S_{MS}$ :	1.951	$F_{PGA}$ :	1.2
$S_{M1}$ :	N/A	$I_e$ :	1
$S_{DS}$ :	1.301	$C_v$ :	1.425

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

**Data Accessed:** Sat Aug 12 2023

**Date Source:** [USGS Seismic Design Maps](#)

## Ice

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**Results:**

Ice Thickness: 0 in.  
Concurrent Temperature: 25 F  
Gust Speed 30 mph

**Data Source:** Standard ASCE/SEI 7-16, Figs. 10-2 through 10-8

**Date Accessed:** Sat Aug 12 2023

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Values provided are equivalent radial ice thicknesses due to freezing rain with concurrent 3-second gust speeds, for a 500-year mean recurrence interval, and temperatures concurrent with ice thicknesses due to freezing rain. Thicknesses for ice accretions caused by other sources shall be obtained from local meteorological studies. Ice thicknesses in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

## Snow

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**Results:**

Ground Snow Load,  $p_g$  : 0 lb/ft<sup>2</sup>  
Mapped Elevation: 24.8 ft

**Data Source:** ASCE/SEI 7-16, Table 7.2-8

**Date Accessed:** Sat Aug 12 2023

Values provided are ground snow loads. In areas designated "case study required," extreme local variations in ground snow loads preclude mapping at this scale. Site-specific case studies are required to establish ground snow loads at elevations not covered.

Snow load values are mapped to a 0.5 mile resolution. This resolution can create a mismatch between the mapped elevation and the site-specific elevation in topographically complex areas. Engineers should consult the local authority having jurisdiction in locations where the reported 'elevation' and 'mapped elevation' differ significantly from each other.

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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**DEVELOPMENT**

Site Name: 2ftx2ft Wall Mount FRP Box

Client: TNH

Carrier: TNH

Date: 8/16/2023

Design Wind Velocity: 92.0

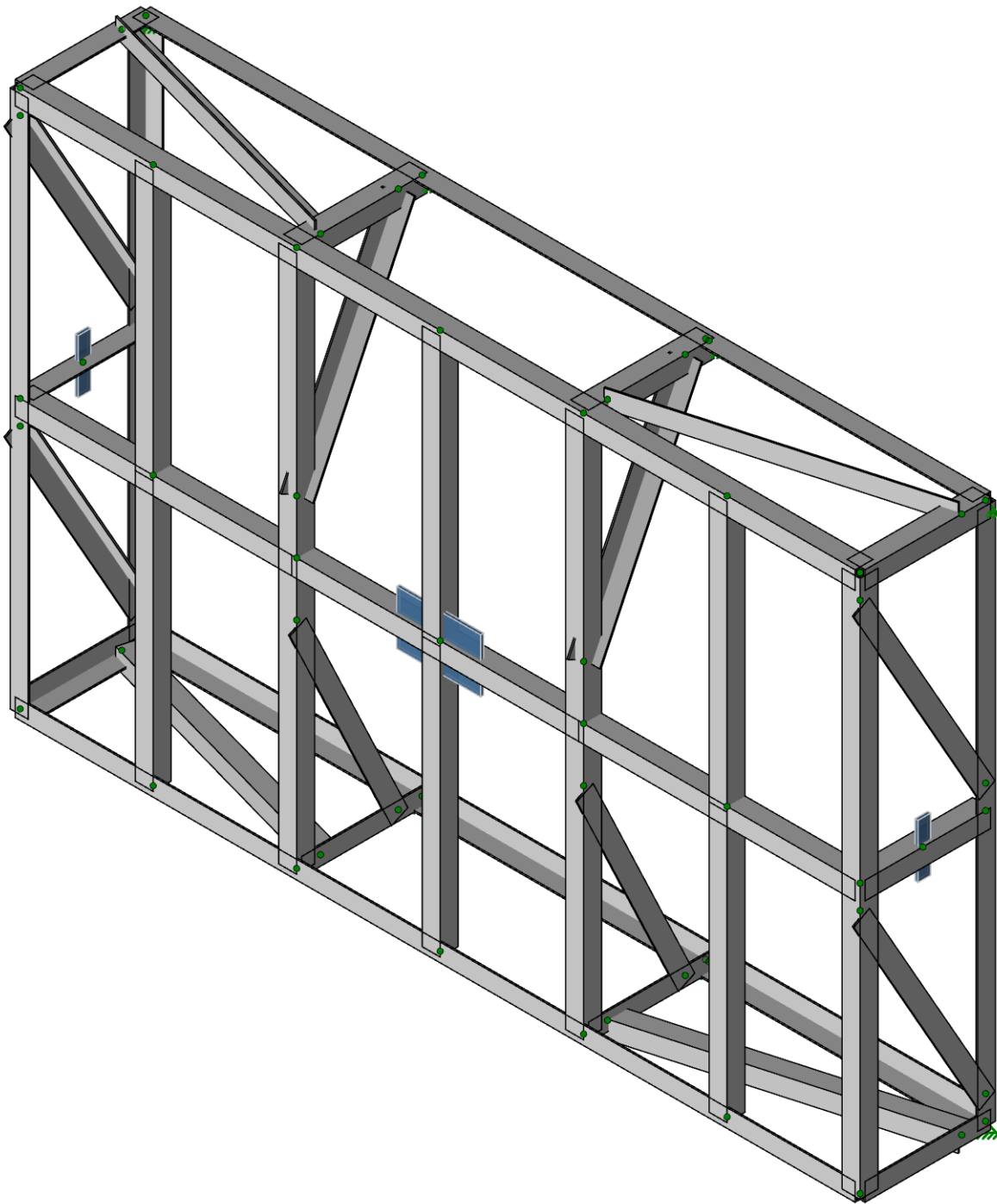
Wind Centerline: 28.0

Exposure Category: C

Code TIA-222-H

qz = 30.3 Fp = 0.78

Appurtenance Name	Quantity	Wind Force		Seismic Force	
		F-norm (lbs)	F-perp (lbs)	F-norm (lbs)	F-perp (lbs)
8ftx12ftx2ft Wall Mount	1.0	1745.9	307.2	780.6	780.6



Envelope Only Solution



TNH

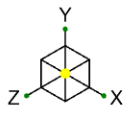
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8ftx12ftx2ft FRP Wall Mount Box

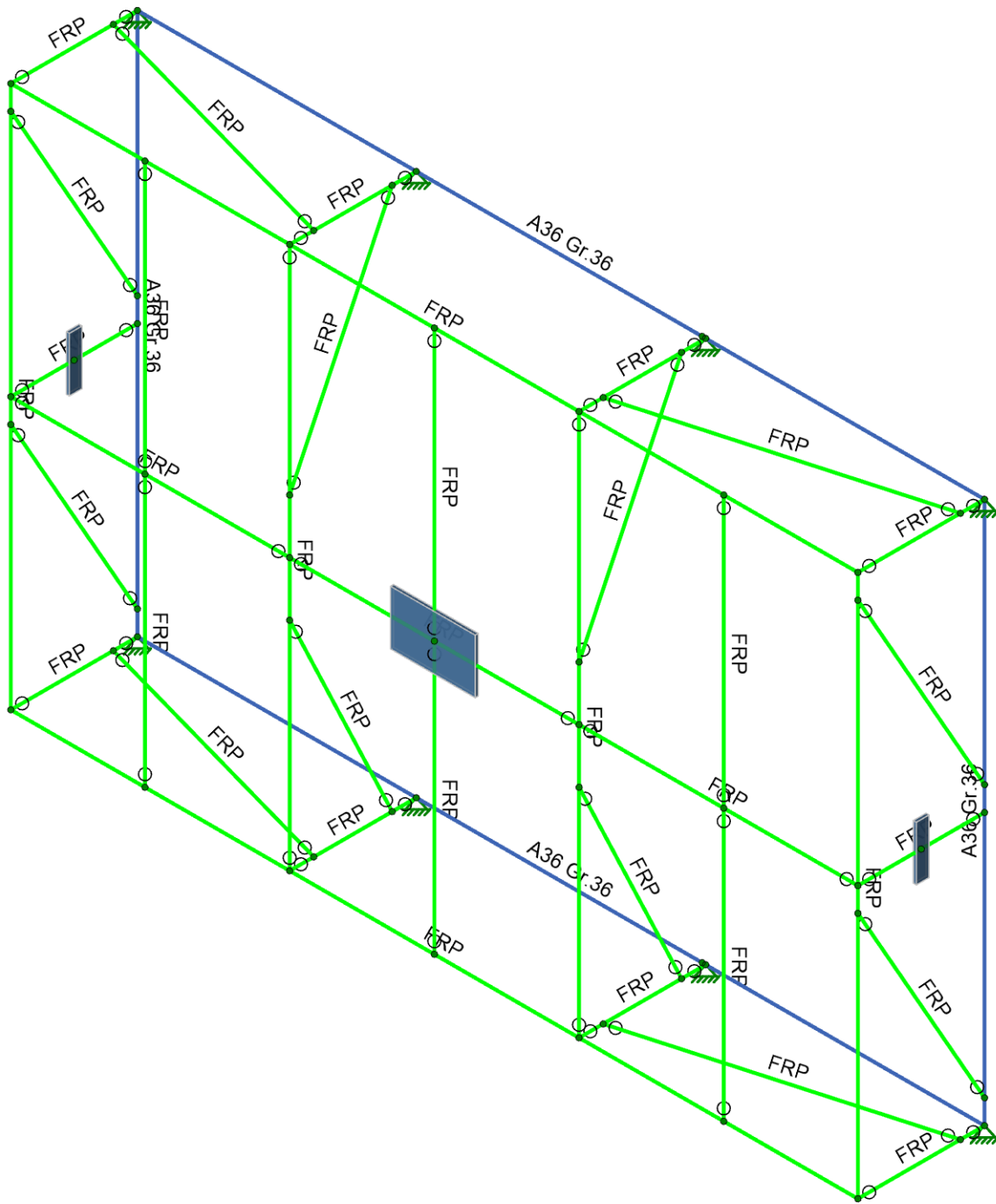
SK-1

Aug 31, 2023 at 12:56 PM

8ftx12ftx2ft FRP Wall Enclos...



Member Material Sets	
<span style="color: blue;">█</span>	A36 Gr.36
<span style="color: green;">█</span>	FRP



Envelope Only Solution



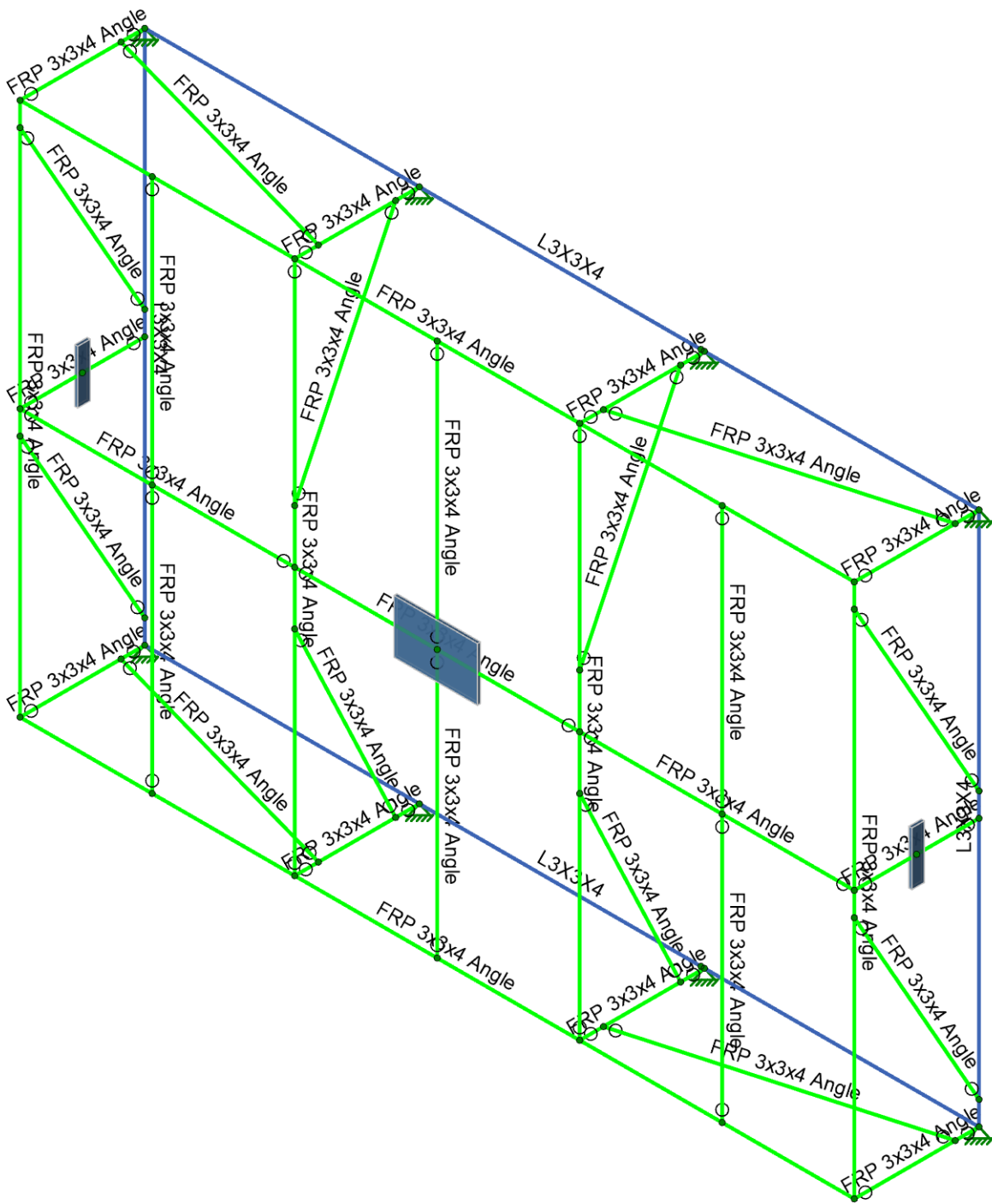
TNH  
2023-05-95

8ftx12ftx2ft FRP Wall Mount Box

SK-2  
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8ftx12ftx2ft FRP Wall Enclos...



Section Sets	
<span style="color: blue;">■</span>	L3X3X4
<span style="color: green;">■</span>	FRP 3x3x4 Angle



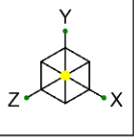
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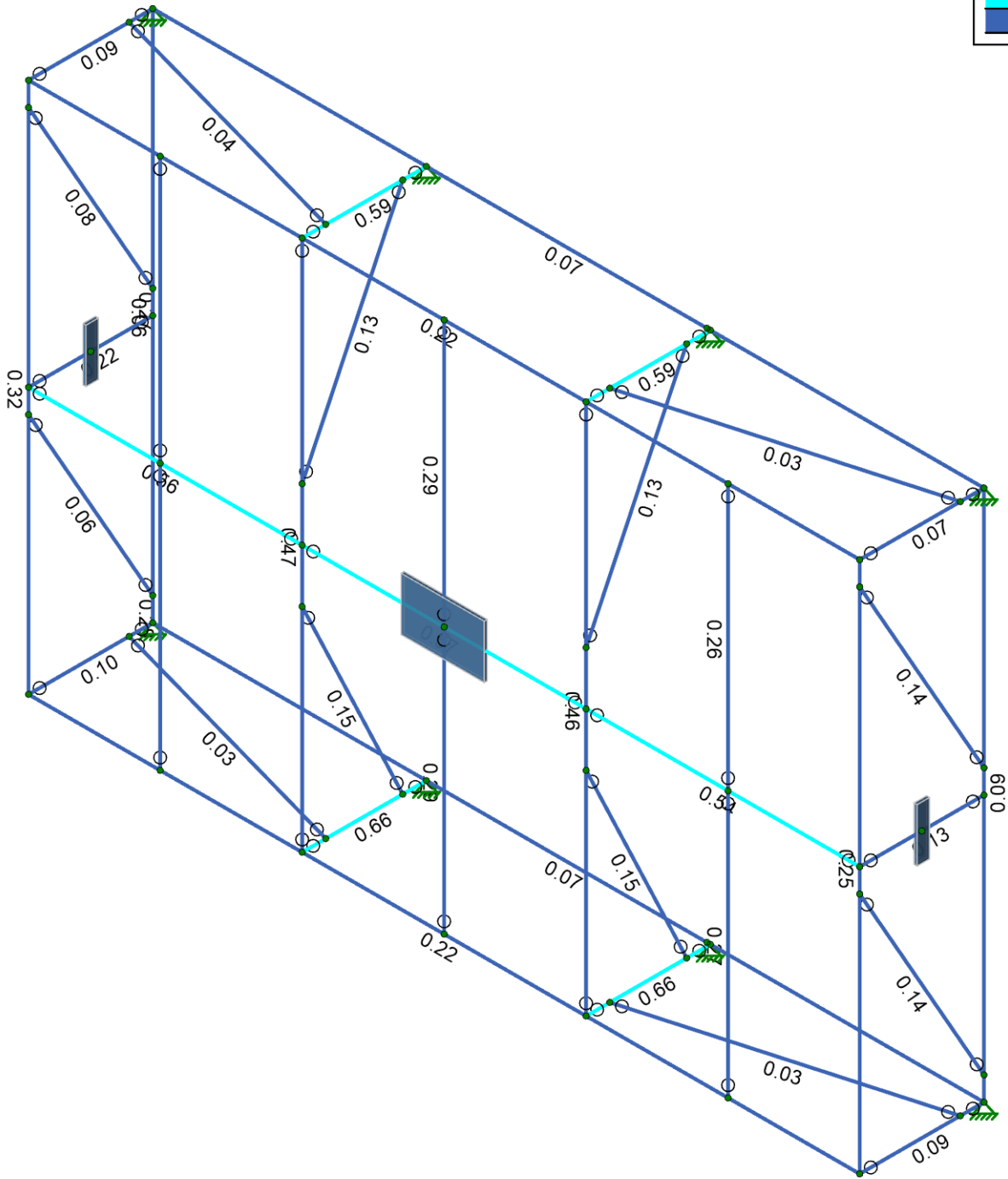
TNH  
2023-05-95

8ftx12ftx2ft FRP Wall Mount Box

SK-3  
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8ftx12ftx2ft FRP Wall Enclos...



Code Check (Env)	
Black	No Calc
Red	> 1.0
Magenta	.90-1.0
Green	.75-.90
Cyan	.50-.75
Blue	0-.50



Member Code Checks Displayed (Enveloped)  
Envelope Only Solution



TNH  
2023-05-95

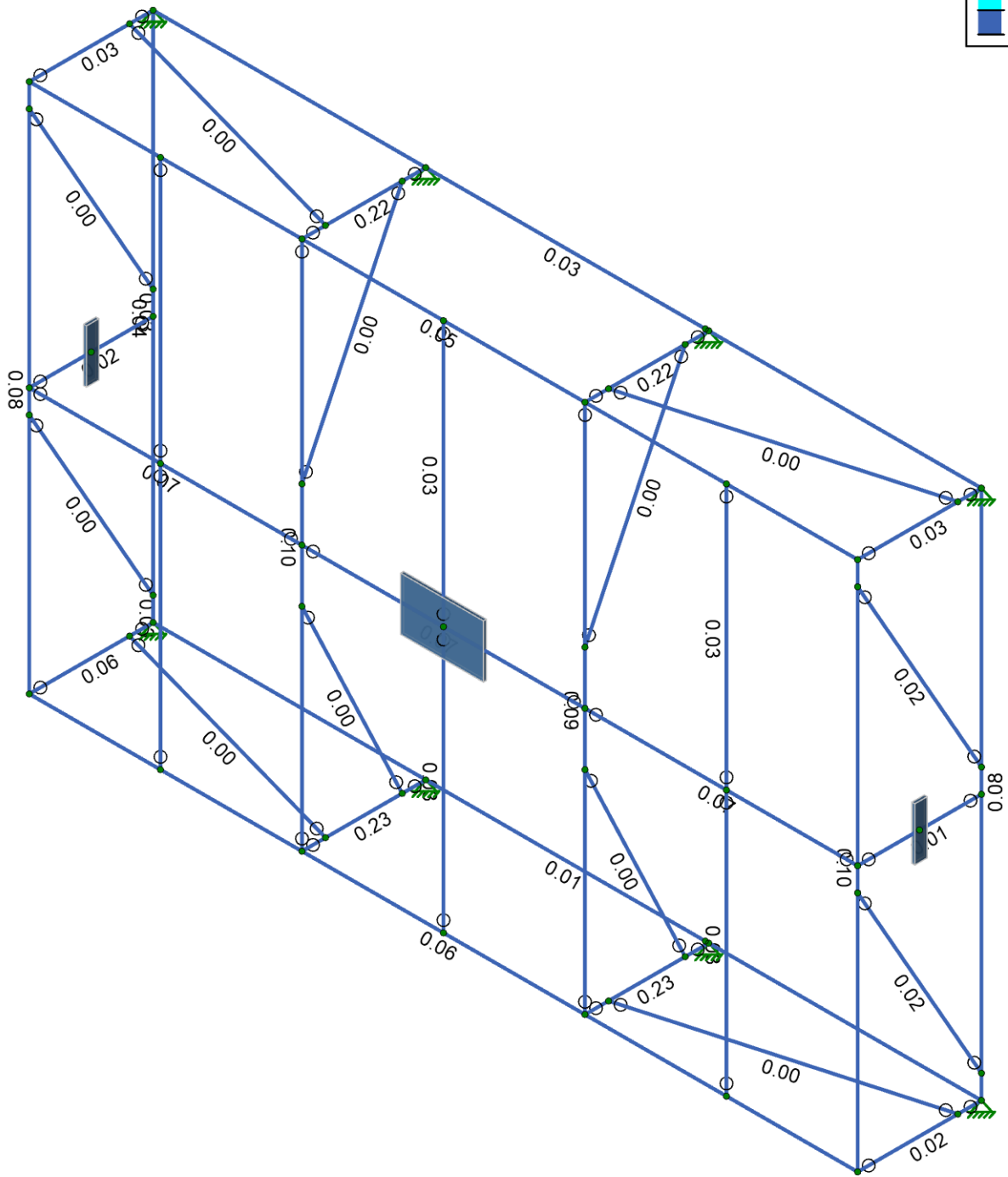
8ftx12ftx2ft FRP Wall Mount Box

SK-4  
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8ftx12ftx2ft FRP Wall Enclos...



Shear Check (Env)

- No Calc
- > 1.0
- .90-1.0
- .75-.90
- .50-.75
- 0-.50



Member Shear Checks Displayed (Enveloped)  
Envelope Only Solution



TNH  
2023-05-95

8ftx12ftx2ft FRP Wall Mount Box

SK-5  
Aug 31, 2023 at 12:57 PM  
8ftx12ftx2ft FRP Wall Enclos...



**Basic Load Cases**

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Distributed	Area(Member)
1	Self Weight	DL		-1.1			
2	Wind Load AZI 000	WLZ					1
3	Wind Load AZI 090	WLX					1
4	Seismic Load AZI 000	ELZ			-0.62		
5	Seismic Load AZI 090	ELX	-0.62				
6	BLC 2 Transient Area Loads	None				25	
7	BLC 3 Transient Area Loads	None				31	

**Load Combinations**

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	1.0D	Yes	Y	DL	1				
2	1D + 0.6W AZI 000	Yes	Y	DL	1	WLZ	0.6		
3	1D + 0.6W AZI 030	Yes	Y	DL	1	WLZ	0.52	WLX	0.3
4	1D + 0.6W AZI 060	Yes	Y	DL	1	WLZ	0.3	WLX	0.52
5	1D + 0.6W AZI 090	Yes	Y	DL	1			WLX	0.6
6	1D + 0.6W AZI 120	Yes	Y	DL	1	WLZ	-0.3	WLX	0.52
7	1D + 0.6W AZI 150	Yes	Y	DL	1	WLZ	-0.52	WLX	0.3
8	1D + 0.6W AZI 180	Yes	Y	DL	1	WLZ	-0.6		
9	1D + 0.6W AZI 210	Yes	Y	DL	1	WLZ	-0.52	WLX	-0.3
10	1D + 0.6W AZI 240	Yes	Y	DL	1	WLZ	-0.3	WLX	-0.52
11	1D + 0.6W AZI 270	Yes	Y	DL	1			WLX	-0.6
12	1D + 0.6W AZI 300	Yes	Y	DL	1	WLZ	0.3	WLX	-0.52
13	1D + 0.6W AZI 330	Yes	Y	DL	1	WLZ	0.52	WLX	-0.3
14	0.6D + 0.6W AZI 000	Yes	Y	DL	0.6	WLZ	0.6		
15	0.6D + 0.6W AZI 030	Yes	Y	DL	0.6	WLZ	0.52	WLX	0.3
16	0.6D + 0.6W AZI 060	Yes	Y	DL	0.6	WLZ	0.3	WLX	0.52
17	0.6D + 0.6W AZI 090	Yes	Y	DL	0.6			WLX	0.6
18	0.6D + 0.6W AZI 120	Yes	Y	DL	0.6	WLZ	-0.3	WLX	0.52
19	0.6D + 0.6W AZI 150	Yes	Y	DL	0.6	WLZ	-0.52	WLX	0.3
20	0.6D + 0.6W AZI 180	Yes	Y	DL	0.6	WLZ	-0.6		
21	0.6D + 0.6W AZI 210	Yes	Y	DL	0.6	WLZ	-0.52	WLX	-0.3
22	0.6D + 0.6W AZI 240	Yes	Y	DL	0.6	WLZ	-0.3	WLX	-0.52
23	0.6D + 0.6W AZI 270	Yes	Y	DL	0.6			WLX	-0.6
24	0.6D + 0.6W AZI 300	Yes	Y	DL	0.6	WLZ	0.3	WLX	-0.52
25	0.6D + 0.6W AZI 330	Yes	Y	DL	0.6	WLZ	0.52	WLX	-0.3
26	(1.0+0.14Sds)D + 0.7E AZI 000	Yes	Y	DL	1.182	ELZ	0.7		
27	(1.0+0.14Sds)D + 0.7E AZI 030	Yes	Y	DL	1.182	ELZ	0.606	ELX	0.35
28	(1.0+0.14Sds)D + 0.7E AZI 060	Yes	Y	DL	1.182	ELZ	0.35	ELX	0.606
29	(1.0+0.14Sds)D + 0.7E AZI 090	Yes	Y	DL	1.182			ELX	0.7
30	(1.0+0.14Sds)D + 0.7E AZI 120	Yes	Y	DL	1.182	ELZ	-0.35	ELX	0.606
31	(1.0+0.14Sds)D + 0.7E AZI 150	Yes	Y	DL	1.182	ELZ	-0.606	ELX	0.35
32	(1.0+0.14Sds)D + 0.7E AZI 180	Yes	Y	DL	1.182	ELZ	-0.7		
33	(1.0+0.14Sds)D + 0.7E AZI 210	Yes	Y	DL	1.182	ELZ	-0.606	ELX	-0.35
34	(1.0+0.14Sds)D + 0.7E AZI 240	Yes	Y	DL	1.182	ELZ	-0.35	ELX	-0.606
35	(1.0+0.14Sds)D + 0.7E AZI 270	Yes	Y	DL	1.182			ELX	-0.7
36	(1.0+0.14Sds)D + 0.7E AZI 300	Yes	Y	DL	1.182	ELZ	0.35	ELX	-0.606
37	(1.0+0.14Sds)D + 0.7E AZI 330	Yes	Y	DL	1.182	ELZ	0.606	ELX	-0.35
38	(0.6-0.2Sds)D + 0.7E AZI 000	Yes	Y	DL	0.418	ELZ	0.7		
39	(0.6-0.2Sds)D + 0.7E AZI 030	Yes	Y	DL	0.418	ELZ	0.606	ELX	0.35
40	(0.6-0.2Sds)D + 0.7E AZI 060	Yes	Y	DL	0.418	ELZ	0.35	ELX	0.606
41	(0.6-0.2Sds)D + 0.7E AZI 090	Yes	Y	DL	0.418			ELX	0.7
42	(0.6-0.2Sds)D + 0.7E AZI 120	Yes	Y	DL	0.418	ELZ	-0.35	ELX	0.606
43	(0.6-0.2Sds)D + 0.7E AZI 150	Yes	Y	DL	0.418	ELZ	-0.606	ELX	0.35
44	(0.6-0.2Sds)D + 0.7E AZI 180	Yes	Y	DL	0.418	ELZ	-0.7		



**Load Combinations (Continued)**

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
45	(0.6-0.2Sds)D + 0.7E AZI 210	Yes	Y	DL	0.418	ELZ	-0.606	ELX	-0.35
46	(0.6-0.2Sds)D + 0.7E AZI 240	Yes	Y	DL	0.418	ELZ	-0.35	ELX	-0.606
47	(0.6-0.2Sds)D + 0.7E AZI 270	Yes	Y	DL	0.418			ELX	-0.7
48	(0.6-0.2Sds)D + 0.7E AZI 300	Yes	Y	DL	0.418	ELZ	0.35	ELX	-0.606
49	(0.6-0.2Sds)D + 0.7E AZI 330	Yes	Y	DL	0.418	ELZ	0.606	ELX	-0.35

**Node Boundary Conditions**

	Node Label	X [k/in]	Y [k/in]	Z [k/in]
1	N29	Reaction	Reaction	Reaction
2	N30	Reaction	Reaction	Reaction
3	N27	Reaction	Reaction	Reaction
4	N26	Reaction	Reaction	Reaction
5	N23	Reaction	Reaction	Reaction
6	N32	Reaction	Reaction	Reaction
7	N24	Reaction	Reaction	Reaction
8	N33	Reaction	Reaction	Reaction

**Hot Rolled Steel Section Sets**

	Label	Shape	Type	Design List	Material	Design Rule	Area [in <sup>2</sup> ]	I <sub>yy</sub> [in <sup>4</sup> ]	I <sub>zz</sub> [in <sup>4</sup> ]	J [in <sup>4</sup> ]
1	FRP 3X3X3/16 Tube	FRPHSS3X3X3/16	Beam	None	FRP	Typical	2.109	2.793	2.793	4.171
2	HSS3X3X3/16	HSS3X3X3/16	Beam	None	A500 Gr.B Rect	Typical	2.109	2.793	2.793	4.171
3	FRP 4X4X4 Tube	FRPHSS4X4X4	Beam	None	FRP	Typical	3.75	8.828	8.828	13.184
4	HSS4X4X4	HSS4X4X4	Beam	None	A500 Gr.B Rect	Typical	3.37	7.8	7.8	12.8
5	L3X3X4	L3X3X4	Beam	None	A36 Gr.36	Typical	1.44	1.23	1.23	0.031
6	FRP 3x3x4 Angle	L3X3X4	Beam	Single Angle	FRP	Typical	1.44	1.23	1.23	0.031
7	FRP 4X4X4 Angle	FRPL4X4X4	Beam	None	FRP	Typical	1.938	3.039	3.039	0.039
8	FRP 4X4X6 Angle	L4X4X6	Beam	None	FRP	Typical	2.86	4.32	4.32	0.141
9	PIPE 2.0	PIPE 2.0	Beam	None	A36 Gr.36	Typical	1.02	0.627	0.627	1.25

**Nodal Loads and Enforced Displacements**

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**Member Point Loads**

No Data to Print..										
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**Member Distributed Loads (BLC 6 : BLC 2 Transient Area Loads)**

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, lb-ft/ft]	End Magnitude [k/ft, F, ksf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Z	-0.02	-0.036	0	2.342
2	M1	Z	-0.036	-0.038	2.342	4.683
3	M1	Z	-0.038	-0.038	4.683	7.025
4	M1	Z	-0.038	-0.036	7.025	9.367
5	M1	Z	-0.036	-0.02	9.367	11.708
6	M5	Z	-0.02	-0.036	0	2.342
7	M5	Z	-0.036	-0.038	2.342	4.683
8	M5	Z	-0.038	-0.038	4.683	7.025
9	M5	Z	-0.038	-0.036	7.025	9.367
10	M5	Z	-0.036	-0.02	9.367	11.708
11	M7	Z	-0.069	-0.069	0.927	2.823
12	M8	Z	-0.048	-0.048	0.937	6.563
13	M9	Z	-0.072	-0.072	0.938	2.812
14	M10	Z	-0.048	-0.048	0.937	6.563





**Member Distributed Loads (BLC 6 : BLC 2 Transient Area Loads) (Continued)**

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, lb-ft/ft]	End Magnitude [k/ft, F, ksf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
15	M11	Z	-0.069	-0.069	0.927	2.823
16	M12	Z	-0.022	-0.022	0.926	6.574
17	M13	Z	-0.022	-0.022	0.926	6.574
18	M40	Z	-0.061	-0.067	0	1.927
19	M40	Z	-0.067	-0.072	1.927	3.854
20	M41	Z	-0.067	-0.067	0	4
21	M42	Z	-0.072	-0.067	0	1.927
22	M42	Z	-0.067	-0.061	1.927	3.854
23	M43	Z	-0.069	-0.069	0.927	2.822
24	M44	Z	-0.072	-0.072	0.938	2.812
25	M45	Z	-0.069	-0.069	0.928	2.823

**Member Distributed Loads (BLC 7 : BLC 3 Transient Area Loads)**

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, lb-ft/ft]	End Magnitude [k/ft, F, ksf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M3	X	-0.0006896	-0.012	0	0.583
2	M3	X	-0.012	-0.019	0.583	1.167
3	M3	X	-0.019	-0.011	1.167	1.75
4	M4	X	-0.011	-0.019	0	0.583
5	M4	X	-0.019	-0.012	0.583	1.167
6	M4	X	-0.012	-0.0006898	1.167	1.75
7	M12	X	-0.0002676	-0.013	0	1.5
8	M12	X	-0.013	-0.015	1.5	3
9	M12	X	-0.015	-0.011	3	4.5
10	M12	X	-0.011	-0.017	4.5	6
11	M12	X	-0.017	-0.023	6	7.5
12	M17	X	-0.0002676	-0.013	0	1.5
13	M17	X	-0.013	-0.015	1.5	3
14	M17	X	-0.015	-0.011	3	4.5
15	M17	X	-0.011	-0.017	4.5	6
16	M17	X	-0.017	-0.023	6	7.5
17	M18	X	-0.006	-0.026	0	0.35
18	M18	X	-0.026	-0.037	0.35	0.7
19	M18	X	-0.037	-0.037	0.7	1.05
20	M18	X	-0.037	-0.026	1.05	1.4
21	M18	X	-0.026	-0.005	1.4	1.75
22	M26	X	-0.006	-0.021	0	0.709
23	M26	X	-0.021	-0.037	0.709	1.418
24	M26	X	-0.037	-0.035	1.418	2.127
25	M26	X	-0.035	-0.022	2.127	2.836
26	M26	X	-0.022	-0.018	2.836	3.545
27	M27	X	-0.018	-0.022	0	0.709
28	M27	X	-0.022	-0.035	0.709	1.418
29	M27	X	-0.035	-0.037	1.418	2.127
30	M27	X	-0.037	-0.021	2.127	2.836
31	M27	X	-0.021	-0.006	2.836	3.545

**Member Area Loads (BLC 2 : Wind Load AZI 000)**

Node A	Node B	Node C	Node D	Direction	Load Direction	Magnitude [ksf]	
1	N17	N20	N21	N18	Z	Two Way	-0.036



Company : TNH  
 Designer :  
 Job Number : 2023-05-95  
 Model Name : 8ftx12ftx2ft FRP Wall Mount Box

8/31/2023  
 12:58:07 PM  
 Checked By : Trelos

**Member Area Loads (BLC 3 : Wind Load AZI 090)**

Node A	Node B	Node C	Node D	Direction	Load Direction	Magnitude [ksf]
1 N20	N32	N33	N21	X	Two Way	-0.036

**Envelope AISC 15TH (360-16): ASD Member Steel Code Checks**

Member	Shape	Code Check	Loc [ft]	LC Shear	Check Loc [ft]	Dir	LC Pnc/om [k]	Pnt/om [k]	Mnyy/om [lb-ft]	Mnzz/om [lb-ft]	Cb	Eqn		
0 M1	L3X3X4	0.217	3.903	2	0.051	3.903	y	14	4.516	6.036	215.669	438.27	1	H2-1
1 M2	L3X3X4	0.095	0	8	0.034	1.75	y	7	4.276	6.036	218.396	477.478	1.414	H2-1
2 M3	L3X3X4	0.068	0	8	0.035	0.328	y	8	4.276	6.036	218.396	452.845	1.453	H2-1
3 M4	L3X3X4	0.094	0.328	13	0.02	0	z	13	4.276	6.036	218.396	452.845	1.5	H2-1
4 M5	L3X3X4	0.217	3.781	8	0.056	7.806	z	2	4.516	6.036	218.396	438.27	1	H2-1
5 M6	L3X3X4	0.096	1.75	2	0.056	1.75	z	2	4.276	6.036	218.396	481.658	1.5	H2-1
6 M7	L3X3X4	0.271	1.563	14	0.027	3.75	z	8	4.516	6.036	218.396	438.27	1	H2-1
7 M8	L3X3X4	0.47	3.75	14	0.099	4.453	z	2	4.516	6.036	218.396	438.27	1	H2-1
8 M9	L3X3X4	0.285	1.602	14	0.027	3.75	z	20	4.516	6.036	218.396	438.27	1	H2-1
9 M10	L3X3X4	0.464	3.75	14	0.092	4.453	z	2	4.516	6.036	218.396	438.27	1	H2-1
10 M11	L3X3X4	0.265	1.563	14	0.027	3.75	z	8	4.516	6.036	218.396	438.27	1	H2-1
11 M12	L3X3X4	0.245	3.75	20	0.096	0.313	z	6	4.516	6.036	215.669	266.273	1	H2-1
12 M13	L3X3X4	0.317	3.75	21	0.077	0.313	y	8	4.516	6.036	218.396	266.273	1	H2-1
13 M14	L3X3X4	0.068	0	5	0.03	11.708	y	8	3.752	31.042	1123.179	1883.609	1.5	H2-1
14 M15	L3X3X4	0.055	3.75	8	0.037	3.75	z	15	9.145	31.042	1123.179	2146.12	1.5	H2-1
15 M16	L3X3X4	0.069	11.708	11	0.015	3.781	z	2	3.752	31.042	1123.179	1883.609	1.5	H2-1
16 M17	L3X3X4	0.085	4.141	23	0.079	0.313	z	4	9.145	31.042	1123.179	2103.351	1.385	H2-1
17 M18	L3X3X4	0.126	0	2	0.013	1.75	z	13	4.276	6.036	218.396	481.658	1.5	H2-1
18 M19	L3X3X4	0.222	0	2	0.015	0	z	2	4.276	6.036	218.396	452.845	1.105	H2-1
19 M20	L3X3X4	0.591	1.422	8	0.22	1.75	y	8	4.276	6.036	218.396	472.487	1.322	H2-1
20 M21	L3X3X4	0.587	1.422	8	0.221	1.75	y	8	4.276	6.036	218.396	472.687	1.325	H2-1
21 M22	L3X3X4	0.663	1.422	2	0.227	1.75	z	2	4.276	6.036	218.396	452.845	1.215	H2-1
22 M23	L3X3X4	0.655	1.422	2	0.226	1.75	z	2	4.276	6.036	218.396	452.845	1.231	H2-1
23 M24	L3X3X4	0.148	1.763	2	0.002	3.318	y	4	3.567	6.036	218.396	400.03	1.136	H2-1
24 M26	L3X3X4	0.144	1.514	6	0.024	3.545	z	11	3.425	6.036	218.396	395	1.161	H2-1
25 M25	L3X3X4	0.147	2.385	2	0.002	3.318	y	4	3.567	6.036	218.396	400.03	1.136	H2-1
26 M27	L3X3X4	0.138	1.477	12	0.022	3.545	z	5	3.425	6.036	218.396	394.816	1.159	H2-1
27 M28	L3X3X4	0.078	3.545	8	0.002	3.545	z	3	3.425	6.036	218.396	392.54	1.136	H2-1
28 M29	L3X3X4	0.059	0	2	0.002	0	z	4	3.425	6.036	218.396	392.54	1.136	H2-1
29 M30	L3X3X4	0.04	2.043	8	0.004	4.004	y	2	2.953	6.036	215.669	373.962	1.098	H2-1
30 M31	L3X3X4	0.031	1.585	2	0.004	0	z	2	2.953	6.036	215.669	409.764	1.5	H2-1
31 M32	L3X3X4	0.03	2.169	7	0.004	0	z	8	2.953	6.036	218.396	378.169	1.136	H2-1
32 M33	L3X3X4	0.034	1.835	2	0.004	0	y	8	2.953	6.036	218.396	372.062	1.081	H2-1
33 M40	L3X3X4	0.563	1.847	14	0.07	3.854	z	2	3.111	6.036	218.396	393.598	1.247	H2-1
34 M41	L3X3X4	0.566	2	2	0.068	0	z	2	2.956	6.036	218.396	387.087	1.223	H2-1
35 M42	L3X3X4	0.541	2.007	8	0.068	0	z	2	3.111	6.036	218.396	393.111	1.241	H2-1
36 M43	L3X3X4	0.276	2.188	2	0.027	0.898	z	8	4.516	6.036	218.396	438.27	1	H2-1
37 M44	L3X3X4	0.286	2.148	2	0.027	0.938	z	8	4.516	6.036	218.396	438.27	1	H2-1
38 M45	L3X3X4	0.269	2.188	2	0.027	0.898	z	20	4.516	6.036	218.396	438.27	1	H2-1
39 M46	L3X3X4	0.13	2.799	14	0.003	3.318	y	10	3.567	6.036	218.396	428.79	1.5	H2-1
40 M47	L3X3X4	0.13	1.59	14	0.003	3.318	y	10	3.567	6.036	218.396	409.221	1.237	H2-1

**TECHNICAL DATA SHEET**  
**TDS #: MP55310**  
**METHACRYLATE ADHESIVE**

**MAXIMUM PERFORMANCE SERIES**  
**MP55310 METHACRYLATE ADHESIVE**

**DESCRIPTION:**

MP55310 is a high performance two part methacrylate adhesive engineered to bond a wide range of plastics, metals, and composite assemblies. It offers outstanding bond strength, is extremely durable, with excellent impact and weathering properties. MP55310 greatly increases the reliability of finished assemblies with exceptional flexibility, it's ability to with stand extreme temperature fluctuation and thermal cycling, and resistance to a wide range of chemicals and environmental conditions.

**PHYSICAL PROPERTIES (UNCURED):**

VISCOSITY @ 25°C (cps):	RESIN	60,000
	ACTIVATOR	60,000
COLOR:	OFF WHITE	AMBER, GREY, OR BLACK
MIXED DENSITY:	8.20	
MIX RATIO:	VOLUME	1 TO 1
	WEIGHT	1 TO 1
THIX INDEX:	5	
FLASH POINT:	51°F	

**PHYSICAL PROPERTIES (CURED):**

STRENGTH (PSI):	SHEAR	3000-3500
	TENSILE	3000-3500
WORK TIME:	10 MINUTES	
HANDLING STRENGTH:	30 MINUTES	
GAP FILL:	.125 INCHES	
TEMPERATURE RANGE:	-67°F - +250°F	

**PACKAGING:**

The MP 55310 Series is conveniently packaged in 50 mil, 400 mil, pail, and drum kits. Special packaging is available upon request.

**EFFECTS OF TEMPERATURE:**

The product is best used at temperatures between 65° F and 80° F. Temperatures below 65° F will slow the cure speed of the material and viscosities will be higher. Temperatures above 80° F will cause the material to cure faster and viscosities will be lower. For consistent dispensing maintain temperature in the above mentioned range.

**WHAT THE MP SERIES BONDS:**

**METALS**

- \*ALUMINUM
- \*STEEL
- \*STAINLESS
- \*COATED METALS

**THERMO SETS**

- \*FIBERGLASS
- \*PHENOLICS
- \*GEL COATS
- \*EPOXY
- \*RIM URETHANE
- \*POLYURETHANE
- \*LIQUID MOLDING RESINS

**THERMO PLASTICS**

- \*ACRYLICS
- \*ABS
- \*POLYCARBONATES
- \*NYLONS
- \*PPO's
- \*VINYL'S
- \*PVC's
- \*STYRENE'S
- \*PEEK's
- \*PBT BLENDS
- \*PET BLENDS

**BENEFITS:**

- >NO SURFACE PREP
- >EXCELLENT STRENGTH
- >IMPACT RESISTANT
- >100% REACTIVE
- >ROOM TEMPERATURE CURE
- >EASILY APPLIED

**STORAGE AND SHELF LIFE:**

The shelf life of the MP55300 Series for most products is one year from date of shipment (check with ASI). Shelf life is based on the products being stored properly at temperatures between 55°F and 75° F. Exposure to temperatures above 75° F will reduce the shelf life of these materials.

**PRECAUTIONS:**

ASI's MP55300 Series products are *flammable*. Keep away from heat, spark, and open flames.

**KEEP OUT OF REACH OF CHILDREN. THE PRODUCT IS FOR INDUSTRIAL USE ONLY.** Keep containers closed when not in use. Avoid contact with skin and eyes. Harmful if swallowed. Refer to Material Safety Data Sheet for complete safety information.

**HANDLING AND CLEAN-UP:**

For optimum bond strength and to insure maximum performance in the finished assembly mate parts together within the specified work time of the adhesive. Make sure the bond joint has uniform coverage and that a sufficient amount of adhesive is in the bond area. It is important to have the adhesive applied, parts aligned and positioned, within the established work times for the product. To ensure maximum performance in the finished assembly parts should remain undisturbed until the fixture time is reached.

Clean up is best before the adhesive has cured. Cleaners containing NMP (N-methyl pyrrolidone) or Citrus terpene provide the best results. On cured adhesive repeat use may be required.

Revised 2/20/2014

**NON WARRANTY:**

Information contained herein is based on tests we believe to be reliable and accurate. It is offered in good faith for the benefit of the consumer. The Company shall not be liable for any injury, loss, or damage in the use of its chemical products since conditions or use are beyond our control. In every case we urge and recommend the user conduct tests to determine to their own satisfaction that the product is of acceptable quality and suitable for their particular purpose under their own operating conditions. Statements concerning the possible use of our products are not intended as recommendations to use our products in the infringement of any patent. These products are for industrial use only.

**PROPERTIES OF EXTREN®**

**INTRODUCTION**

The properties in this manual are for product as produced by Strongwell and the data sheets in this section present the **minimum** ultimate values from testing in conformance to ASTM procedures. These values are obtained from coupons machined from **EXTREN®** structural shapes and function as a proof test for the **EXTREN®** composite. Descriptions of the ASTM test procedures are found at the end of this section.

Strongwell verifies the full section bending Modulus of Elasticity using a simple beam concept at the start of each production run. The empirically determined **EXTREN®** structural design equations presented in later sections will be a function of the Modulus of Elasticity.

The designer must consider environmental factors in designing for the actual application. These factors include elevated temperature and corrosive chemicals.

**TEMPERATURE EFFECTS**

The approximate retention of mechanical properties at elevated temperatures are:

		<b>EXTREN®</b>	
		<b>Series 500/525</b>	<b>Series 625</b>
Ultimate Stress	100°F	85%	90%
	125°F	70%	85%
	150°F	50%	80%
	175°F	not recommended	75%
	200°F	not recommended	50%
	>200°F	not recommended	not recommended
Modulus of Elasticity	100°F	100%	100%
	125°F	90%	95%
	150°F	85%	90%
	175°F	not recommended	88%
	200°F	not recommended	85%
	>200°F	not recommended	not recommended

These recommendations are based on the normal **EXTREN®** proprietary resin system. Strongwell routinely processes other resin systems to achieve higher temperature ratings for specific applications. Independent test data confirms that **EXTREN®** structural shapes and plate maintain their mechanical and physical properties for temperatures down to at least -60°F.

**CORROSION EFFECTS**

As a general rule, the isophthalic polyester resin used in **EXTREN®** Series 500/525 is resistant to most acidic attacks while the vinyl ester resin in **EXTREN®** Series 625 is resistant to acids and bases. The effect of corrosive chemicals is temperature dependent with elevated temperature increasing the corrosion activity. A corrosion guide has been included in this manual and a Strongwell salesperson can respond to chemicals not listed in this guide. Strongwell incorporates a synthetic veil on the surface of all **EXTREN®** structural shapes which causes a resin rich layer which enhances corrosion protection.

**UV (ULTRAVIOLET RADIATION) EFFECTS**

UV is a sunlight produced environmental attack on FRP composites. The synthetic surfacing veil also aids in protecting the composite from UV degradation, the effect of which is sometimes referred to as “fiber blooming”. **EXTREN®** also contains a UV inhibitor.

There is a large variation in the degree of fading from UV degradation based on the color selected. It should be noted that the surfacing veil, while not preventing color fading, serves to protect the composite from any mechanical property degradation potentially caused by UV. Coating with materials such as UV stabilized polyurethane based paints are very effective in maintaining the color and offer the optimum long-term protection from UV attack.

**SERIES 500/525/625 STRUCTURAL SHAPES ULTIMATE COUPON PROPERTIES**

Below are the test results for the **minimum** ultimate **coupon** properties of **EXTREN®** structural shapes as per the referenced ASTM procedures. The properties of plate as well as thermal cure rod and bar are found elsewhere in this section. Designers should refer to Section 8 — **FLEXURAL MEMBERS** and Section 9 — **COMPRESSION MEMBERS** for the recommended design equations for **EXTREN®**. The actual geometry and application of the structural shape will determine its ultimate usability. Additionally, WF / I-Beam ASTM properties may vary due to location in the part but the modulus of elasticity will not be affected.

PROPERTY	ASTM TEST	UNITS	SERIES 500/525	SERIES 625
<b>MECHANICAL</b>				
Tensile Stress, LW	D638	psi	30,000	30,000
Tensile Stress, CW	D638	psi	7,000	7,000
Tensile Modulus, LW	D638	10 <sup>6</sup> psi	2.5	2.6
Tensile Modulus, CW	D638	10 <sup>6</sup> psi	0.8	0.8
Compressive Stress, LW <sup>①</sup>	D695	psi	30,000	30,000
Compressive Stress, CW	D695	psi	15,000	16,000
Compressive Modulus, LW	D695	10 <sup>6</sup> psi	2.5	2.6
Compressive Modulus CW	D695	10 <sup>6</sup> psi	0.8	0.8
Flexural Stress, LW <sup>②</sup>	D790	psi	30,000	30,000
Flexural Stress, CW	D790	psi	10,000	10,000
Flexural Modulus, LW <sup>②</sup>	D790	10 <sup>6</sup> psi	1.6	1.6
Flexural Modulus, CW	D790	10 <sup>6</sup> psi	0.8	0.8
Modulus of Elasticity <sup>③</sup>	full section	10 <sup>6</sup> psi	2.6	2.8
Modulus of Elasticity (W and I Shapes > 4") <sup>③</sup>	full section	10 <sup>6</sup> psi	2.5	2.5
Shear Modulus, LW <sup>④⑧</sup>	—	10 <sup>6</sup> psi	0.425	0.425
Short Beam Shear, LW <sup>⑦⑧</sup>	D2344	psi	4,500	4,500
Ultimate Bearing Stress, LW	D953	psi	30,000	30,000
Poisson's Ratio, LW <sup>⑧</sup>	D3039	in/in	0.33	0.33
Notched Izod Impact, LW	D256	ft-lbs/in	25	25
Notched Izod Impact, CW	D256	ft-lbs/in	4	4
<b>PHYSICAL</b>				
Barcol Hardness <sup>⑤</sup>	D2583	—	45	45
24 hr. Water Absorption <sup>⑥</sup>	D570	% Max	0.6	0.6
Density	D792	lbs/in <sup>3</sup>	.062-.070	.062-.070
Coefficient of Thermal Expansion, LW <sup>⑧</sup>	D696	10 <sup>-6</sup> in/in/°F	7	7
Coefficient of Thermal Expansion, CW <sup>⑧</sup>	D696	10 <sup>-6</sup> in/in/°F	16	16
Thermal Conductivity <sup>⑧</sup>	C177	BTU-in/ft <sup>2</sup> /hr/°F	4	4
<b>ELECTRICAL</b>				
Arc Resistance, LW <sup>⑧</sup>	D495	seconds	120	120
Dielectric Strength, LW <sup>⑧</sup>	D149	KV/in	35	35
Dielectric Strength, PF <sup>⑨</sup>	D149	volts/mil	200	200

PROPERTY	TEST	VALUE
<b>FLAMMABILITY</b>		
<b>(Only Series 525 and 625)</b>		
Flammability Classification (1/8")	UL 94	VO
Tunnel Test	ASTM E84	25 Max
NBS Smoke Chamber	ASTM E662	650-700 (Typical)
Flammability	ASTM D635	Self Extinguishing
UL Thermal Index	Generic	266°F
British Fire Test	BS 476-7	Class 1

LW — lengthwise  
 CW — crosswise  
 PF — perpendicular to laminate face

**NOTES:**

- ① Refer to Section 9 — **COMPRESSION MEMBERS** for the recommended allowable stresses for **EXTREN®** columns.
- ② Refer to Section 8 — **FLEXURAL MEMBERS** for the recommended allowable stresses for **EXTREN®** beams. LW results are for the flange only.
- ③ This value is determined from full section simple beam bending of **EXTREN®** structural shapes and will be used in Sections 8 and 9 for design.
- ④ The Shear Modulus value has been determined from tests with full sections of **EXTREN®** structural shapes. Less precise values are occasionally estimated for pultrusion by using an equation for isotropic materials,  $G=E/[2(1 + \nu)]$ . For example, if **EXTREN®** pultrusions are assumed to be isotropic with a Poisson's Ratio ( $\nu$ ) of 0.33 and a Modulus of Elasticity of  $2.6 \times 10^6$  psi, then  $G = 977,000$  psi, which exceeds the listed tested value. **EXTREN®** shapes are mat/roving composites and anisotropic.
- ⑤ Strongwell incorporates a synthetic surfacing veil routinely on the surface of all **EXTREN®** structural shapes. This has the effect of lowering the measured Barcol Hardness and does not reflect an absence of cure. Other additives incorporated into the composite for corrosion protection and surface improvements may also reduce Barcol Hardness to a typical value of 45. A surface unprotected by a surfacing veil without additives would have a minimum value of 50.
- ⑥ Measured as a percentage maximum by weight.
- ⑦ Span to depth ratio of 3:1; **EXTREN®** angles will have a minimum value of 4000 psi and the I/W shapes are tested in the web.
- ⑧ Typical values.
- ⑨ This is a typical value which varies with composite thickness.

**THERMAL CURE ROD AND BAR ULTIMATE COUPON PROPERTIES**

Below are the test results for the **minimum** ultimate **coupon** properties of thermal cure rod and bar as per the referenced ASTM procedures. Rod and bar stock contain longitudinal reinforcements only – no mat. Coupon testing provides a proof test for the composite, but the actual geometry and application of the structural shape will determine its ultimate usability.

PROPERTY	ASTM TEST	UNITS	THERMAL CURE CLEAR
<b>MECHANICAL</b>			
Tensile Stress, LW	D3916	psi	100,000
Tensile Modulus, LW	D3916	10 <sup>6</sup> psi	6.0
Compressive Stress, Axial, LW	D695	psi	60,000
Flexural Stress, LW	D790	psi	100,000
Flexural Modulus, LW	D790	10 <sup>6</sup> psi	6.0
Notched Izod Impact, LW	D256	ft-lbs/in	40
Short Beam Shear, LW	D4475	psi	5,500
<b>PHYSICAL</b>			
Barcol Hardness	D2583	—	50
24 hr. Water Absorption ①	D570	% Max	0.25
Density	D792	lbs/in <sup>3</sup>	.072-0.76
Coefficient of Thermal Expansion ②	D696	10 <sup>-6</sup> in/in/°F	5
<b>ELECTRICAL</b>			
Dielectric Strength, LW ②	D149	KV/in	35

LW — lengthwise or parallel to the roving

**NOTE:** All thermal cure rod and bar are not normally produced with a fire retardant resin. Thermal cure rod and bar were not designed to be machined. Machining may cause splintering or other issues due to the lack of off-axis reinforcements.

- ① Measured as a percentage maximum by weight.
- ② Typical values.





**SERIES 500/525 PLATE ULTIMATE COUPON PROPERTIES**

Below are the test results for the minimum ultimate coupon properties of **EXTREN®** Series 500/525 plate as per the referenced ASTM procedures. Designers should refer to Section 10 — **PLATE** for the recommended design equations for **EXTREN®**. The actual geometry and application of the plate will determine its ultimate usability.

PROPERTY	ASTM TEST	UNITS	THICKNESS		
			1/8"	3/16"-3/8"	1/2"-1"
<b>MECHANICAL</b>					
Tensile Stress, LW	D638	psi	20,000	20,000	20,000
Tensile Stress, CW	D638	psi	7,500	10,000	10,000
Tensile Modulus, LW	D638	10 <sup>6</sup> psi	1.8	1.8	1.8
Tensile Modulus, CW	D638	10 <sup>6</sup> psi	0.7	0.9	1.0
Compressive Stress, Edgewise, LW	D695	psi	24,000	24,000	24,000
Compressive Stress, Edgewise, CW	D695	psi	15,500	16,500	20,000
Compressive Modulus, Edgewise, LW	D695	10 <sup>6</sup> psi	1.8	1.8	1.8
Compressive Modulus, Edgewise, CW	D695	10 <sup>6</sup> psi	0.7	0.9	1.0
Flexural Stress, Flatwise, LW	D790	psi	24,000	24,000	24,000
Flexural Stress, Flatwise, CW	D790	psi	10,000	13,000	17,000
Flexural Modulus, Flatwise, LW	D790	10 <sup>6</sup> psi	1.1	1.1	1.4
Flexural Modulus, Flatwise, CW	D790	10 <sup>6</sup> psi	0.8	0.8	1.3
Ultimate Bearing Stress, LW	D953	psi	32,000	32,000	32,000
Poisson's Ratio, LW ②	D3039	in/in	0.31	0.31	0.31
Poisson's Ratio, CW ②	D3039	in/in	0.29	0.29	0.29
Notched Izod Impact, LW	D256	ft-lbs/in	15	10	10
Notched Izod Impact, CW	D256	ft-lbs/in	5	5	5
<b>PHYSICAL</b>					
Barcol Hardness	D2583	—	40	40	40
24 hr. Water Absorption ①	D570	% Max	0.6	0.6	0.6
Density	D792	lbs/in <sup>3</sup>	.060-0.68	.060-0.68	.060-0.68
Coefficient of Thermal Expansion ②	D696	10 <sup>-6</sup> in/in/°F	8	8	8
<b>ELECTRICAL</b>					
Dielectric Strength, LW ②	D149	KV/in	35	35	35
Dielectric Strength, PF ②	D149	volts/mil	200	N.T.	N.T.

LW — lengthwise  
 CW — crosswise  
 PF — perpendicular to the laminate face  
 N.T. — not tested

**NOTES:**

- ① Measured as a percentage maximum by weight.
- ② This is a typical value which varies with composite thickness.

**SERIES 625 PLATE ULTIMATE COUPON PROPERTIES**

Below are the test results for the minimum ultimate coupon properties of **EXTREN®** Series 625 plate as per the referenced ASTM procedures. Designers should refer to Section 10 — **PLATE** for the recommended design equations for **EXTREN®**. The actual geometry and application of the plate will determine its ultimate usability.


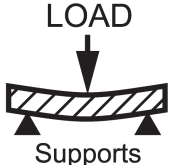

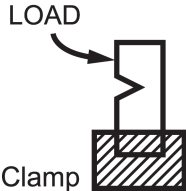
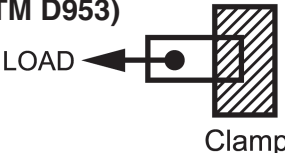

PROPERTY	ASTM TEST	UNITS	THICKNESS		
			1/8"	3/16"-1/4"	3/8"-1"
<b>MECHANICAL</b>					
Tensile Stress, LW	D638	psi	20,000	20,000	20,000
Tensile Stress, CW	D638	psi	7,500	10,000	10,000
Tensile Modulus, LW	D638	10 <sup>6</sup> psi	1.8	1.8	1.8
Tensile Modulus, CW	D638	10 <sup>6</sup> psi	1.0	1.0	1.0
Compressive Stress, Edgewise, LW	D695	psi	24,000	24,000	24,000
Compressive Stress, Edgewise, CW	D695	psi	16,500	17,500	17,500
Compressive Modulus, Edgewise, LW	D695	10 <sup>6</sup> psi	1.8	1.8	1.8
Compressive Modulus, Edgewise, CW	D695	10 <sup>6</sup> psi	1.0	1.0	1.0
Flexural Stress, Flatwise, LW	D790	psi	24,000	24,000	24,000
Flexural Stress, Flatwise, CW	D790	psi	10,000	13,000	17,000
Flexural Modulus, Flatwise, LW	D790	10 <sup>6</sup> psi	1.1	1.1	1.4
Flexural Modulus, Flatwise, CW	D790	10 <sup>6</sup> psi	0.8	0.9	1.3
Ultimate Bearing Stress, LW	D953	psi	32,000	32,000	32,000
Poisson's Ratio, LW ②	D3039	in/in	0.32	0.32	0.32
Poisson's Ratio, CW ②	D3039	in/in	0.24	0.24	0.24
Notched Izod Impact, LW	D256	ft-lbs/in	15	10	10
Notched Izod Impact, CW	D256	ft-lbs/in	5	5	5
<b>PHYSICAL</b>					
Barcol Hardness	D2583	—	40	40	40
24 hr. Water Absorption ①	D570	% Max	0.6	0.6	0.6
Density	D792	lbs/in <sup>3</sup>	.060-0.68	.060-0.68	.060-0.68
Coefficient of Thermal Expansion ②	D696	10 <sup>-6</sup> in/in/°F	8	8	8
<b>ELECTRICAL</b>					
Dielectric Strength, LW ②	D149	KV/in	35	35	35
Dielectric Strength, PF ②	D149	volts/mil	250	N.T.	N.T.

LW — lengthwise  
 CW — crosswise  
 PF — perpendicular to the laminate face  
 N.T. — not tested

**NOTES:**

- ① Measured as a percentage maximum by weight.
- ② This is a typical value which varies with composite thickness.

**DESCRIPTION OF TESTS FOR EXTREN®**

TEST	DESCRIPTION
<p><b>TENSILE STRENGTH</b> (ASTM D638)</p> 	<p>The tensile strength is determined by pulling ends of a test specimen until failure. The tensile modulus can be calculated by measuring the ratio of stress and strain. When the tensile strength is measured in the longitudinal direction, as a first approximation, it is an indication of relative roving content. For example, an all roving thermal cure rod has a higher tensile strength than the <b>EXTREN®</b> structural shapes which are a combination of roving and continuous strand mat.</p>
<p><b>FLEXURAL PROPERTIES</b> (ASTM D790)</p> 	<p>The flexural strength is determined by placing a test specimen between two supports and applying a load to the center. ASTM D790 specifies required span to depth ratios for the test specimen. Flexural tests on coupon samples are often used to determine the effects of environmental conditions such as temperature and corrosive agents.</p>
<p><b>COMPRESSIVE STRENGTH</b> (ASTM D695)</p> 	<p>The ultimate compressive strength of a composite is a force required to rupture the composite when a load is applied such that the specimen is crushed. The compressive test is an excellent indication of the resin matrix to reinforcement bond and has been adopted by the ANSI A14.5 specification for fiberglass rail as the primary physical property audit.</p>
<p><b>IZOD IMPACT</b> (ASTM D256)</p> 	<p>The Izod impact is determined by subjecting a specimen to a pendulum-type collision; the specimen can be notched or unnotched. The energy required to rupture the specimen due to the collision caused by the swinging pendulum is used to calculate the Izod impact strength.</p>
<p><b>BEARING STRESS</b> (ASTM D953)</p> 	<p>This test specimen consists of a flat strip with a hole machined in one end as specified by the ASTM procedure. The testing consists of clamping the end without the hole and attempting to tear or rupture the hole in the specimen. The load required to rupture the hole is used to determine the bearing stress.</p>
<p><b>MODULUS OF ELASTICITY</b></p> 	<p>This parameter is determined by loading a prescribed length of the full shape (not a coupon) with a support at each end and applying a center load. From the measured deflection and the known load and span, the bending modulus of elasticity can be determined once the shear deflection effects are identified. This is a more reliable estimate of the field performance in beam bending situation than the coupon properties.</p>

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**DESCRIPTION OF TESTS FOR EXTREN®**

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**BARCOL HARDNESS  
(ASTM D2583)**

The barcol hardness is a measure of the resistance of the surface of a test specimen to penetration by a needle probe which is spring driven. The barcol hardness value is generally an average of multiple measurements on the same part and is an approximate measure of the composite's completeness of cure.

**WATER ABSORPTION  
(ASTM D570)**

In this test, the specimens are immersed in water for a period of 24 hours and the change in weight is measured. This test has utility in electrical and corrosive applications.

**DENSITY  
(ASTM D792)**

The density is the ratio of the mass (weight) of a specimen to the volume of the specimen. This parameter is important in determining the ultimate weight of the finished product.

**SPECIFIC GRAVITY  
(ASTM D792)**

The ratio of the density of a composite to the density of water.

**ARC RESISTANCE  
(ASTM D495)**

This test is performed by placing two probes on a test specimen at a distance of 1/4". A high voltage, low current, arc is passed between the probes with a specified on/off cycle for this arc. The time taken for the arc to completely burn a path through the composite is measured.

**DIELECTRIC STRENGTH  
(ASTM D149)**

In this electrical test, the sample is placed between electrodes with the electrodes and the sample immersed in non-conducting oil to prevent a false failure signal. Failure occurs when the voltage is sufficient to cause the current to discharge through the composite. This test is occasionally performed after conditioning the test specimen with water at elevated temperatures.

**WEATHERING  
QUV WEATHEROMETER  
(ASTM G53)**

The QUV Weatherometer applies alternating cycles of water, high temperature, humidity and ultraviolet exposure to measure the weatherability of a given composite and/or additive. This test is primarily comparative in nature between composites and/or formulations. The geographic location of the composite will determine its actual weatherability.

**UL 94**

**EXTREN®** Series 525 and Series 625 conform to UL 94 testing with a VO Rating. In the UL 94 test, a vertically clamped sample is subjected to a flame from a Bunsen burner.

**TUNNEL TEST  
(ASTM E84)**

In the 25 foot tunnel test, a smoke generation value and the rate of flame spread are determined. This test has been the standard for years in measuring flammability and smoke generation.

**NBS SMOKE CHAMBER  
(ASTM E662)**

This test requires a much smaller test specimen and essentially places this specimen in the bottom of a chamber and measures the smoke that is generated to an optical detector at the top of the chamber.

**FLAMMABILITY  
(ASTM D635)**

This is a less severe flammability test in which the specimen is held horizontally with one end subjected to a flame for 30 seconds.

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## **SPECIFICATION FOR EXTREN® FIBERGLASS REINFORCED POLYMER (FRP)**

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### **SCOPE**

This specification covers **EXTREN®** fiberglass reinforced polymer (FRP) wide flange shapes, I-shapes, channels, angles, tubing, rod, bar, flat sheet and special shapes produced by Strongwell, Bristol, Virginia, and its locations.

### **PRODUCT DESCRIPTION**

All structural shapes shall be **EXTREN®** FRP Series (select one: 500, 525 or 625) produced using the pultrusion process.

All rod and bar shall be Strongwell FRP thermal cure rod and bar produced using the pultrusion process.

### **DESIGN**

Selection of structural shapes for use under compressive or flexural load to be in accordance with load tables provided in the Strongwell *Design Manual*.

### **TOLERANCES**

The tolerance for a structural shape supplied to this specification shall be within the limits given in Section 5 - **TOLERANCES** of the Strongwell *Design Manual*.

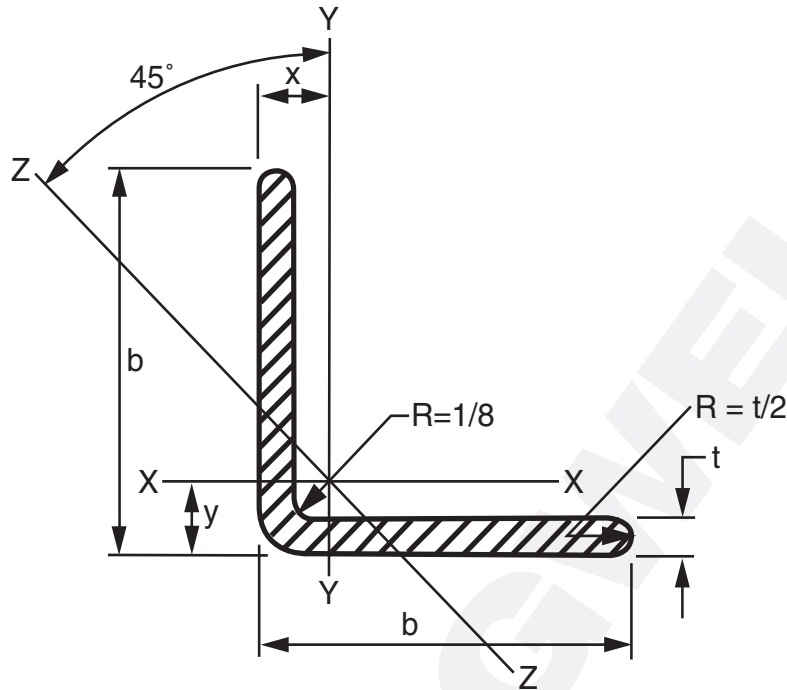
### **FABRICATION AND HANDLING**

- 1) Cut edges and holes can be sealed with a resin compatible with the resin matrix used in the structural shape if there is concern about the environment in which the shape will be used.
- 2) The fabricator and contractor shall exercise precautions necessary to protect the fiberglass pultruded structural shapes from abuse to prevent breakage, nicks, gouges, etc. during fabrication, handling and installation.
- 3) Structural shapes shall be fabricated and assembled as indicated on the design drawings and in accordance with Strongwell's **EXTREN®** *Fabrication & Repair Manual*.

### **NOTE:**

See Section 20 — **Specifications for Fiberglass Reinforced Polymer Products and Fabrications**.





**EXTREN® EQUAL LEG ANGLES**

PHYSICAL PROPERTIES				SECTION PROPERTIES						DESIGN PROPERTIES	
SIZE		A	NOM. Wt/ft	AXIS X—X OR Y—Y				AXIS Z—Z		b — t	J
b	t			I	S	r	x or y	I	r		
in	in	in <sup>2</sup>	lbs	in <sup>4</sup>	in <sup>3</sup>	in	in	in <sup>4</sup>	in	in <sup>4</sup>	
1	1/8	0.22	0.18	0.02	0.03	0.30	0.29	0.01	0.19	8.00	0.001
1-1/4	1/8	0.29	0.24	0.04	0.05	0.37	0.35	0.02	0.24	10.00	0.002
1-1/4	3/16	0.42	0.35	0.06	0.07	0.37	0.37	0.03	0.24	6.67	0.005
1-1/2	1/8	0.35	0.29	0.07	0.07	0.45	0.41	0.03	0.29	12.00	0.002
1-1/2	3/16	0.51	0.43	0.11	0.10	0.45	0.44	0.04	0.29	8.00	0.006
1-1/2	1/4	0.67	0.56	0.13	0.13	0.44	0.46	0.06	0.29	6.00	0.007
2	1/8	0.48	0.40	0.19	0.13	0.63	0.55	0.08	0.46	16.00	0.002
2	3/16	0.70	0.59	0.27	0.19	0.61	0.56	0.11	0.39	10.67	0.008
2	1/4	0.92	0.77	0.34	0.24	0.60	0.58	0.14	0.39	8.00	0.020
3	1/4	1.42	1.19	1.18	0.54	0.91	0.82	0.49	0.58	12.00	0.030
3	3/8	2.09	1.76	1.70	0.80	0.90	0.87	0.70	0.58	8.00	0.090
4	1/4	1.92	1.61	2.94	1.00	1.23	1.07	1.21	0.79	16.00	0.040
4	3/8	2.84	2.39	4.26	1.48	1.22	1.12	1.75	0.78	10.67	0.134
4	1/2	3.75	3.15	5.56	1.97	1.22	1.18	2.29	0.78	8.00	0.312
5	1/2	4.71	3.96	11.34	3.35	1.55	1.61	4.87	1.02	10.00	0.390
6	1/4	2.94	2.47	10.70	2.43	1.91	1.59	4.36	1.22	24.00	0.061
6	3/8	4.34	3.65	14.85	3.38	1.85	1.60	6.07	1.18	16.00	0.204
6	1/2	5.72	4.80	19.38	4.46	1.84	1.66	7.92	1.17	12.00	0.480