



TECHNICAL DATA SHEET

SUPERWALE®

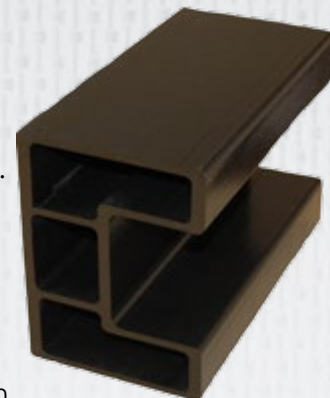
FIBERGLASS REINFORCED POLYMER (FRP) WALE & RETAINING WALL SYSTEM

*Wale & Retaining Wall System
(US Patent #6,893,191 B2/May 17, 2005)



EXTEND THE LIFE OF YOUR BULKHEAD BY SPECIFYING SUPERWALE®

SuperWale®, like the SuperLoc® sheet pile system, is manufactured of state of the art thermoset resins and high strength E-glass, via the pultrusion process, making SuperWale® the product of choice for the test of time. Engineers, architects, home owner associations, and government agencies continue to specify SuperWale® where low maintenance, aesthetics, and a superior design life are crucial to their projects. Your structure is only as strong as the weakest member. Extend the life of your bulkhead by specifying SuperWale®.



The governing design capacity of SuperWale® will be based on either the tie-rod spacing, flexural strength, shear strength, deflection, or washer pull through capacity. In most cases the point load being induced into the SuperWale®, through the tie-rod, governs the tie-rod spacing and wale capacity. The designer is encouraged to pay particular attention to the characteristic tie-rod force permitted on SuperWale® in conjunction with the specified steel washer dimension. The characteristic tie-rod force is dependent on the resin selected for the wale section and the dimensions of the washer specified. The characteristic tie rod force applied into the SuperWale® through the steel washer can be established by referencing the Characteristic Tie-rod Force on SuperWale® with Specified Washers chart. The values are published as characteristic values therefore the appropriate resistance, ϕ , λ or safety factors need to be applied.

Wale splices are made with a galvanized 50 ksi steel section known as the SuperWale® W-splice section. Tie-rods should be used in conjunction with the steel W-splice. Corners are fabricated with a 316 stainless steel fabricated section that is cut and fabricated to fit the angle of the corner. 316 stainless steel is utilized to allow for welding the fabricated section. Oversize steel washers must be utilized with every tie-rod in order for the SuperWale® to perform to its optimal structural capacity.

SUPERWALE® MECHANICAL & PHYSICAL PROPERTIES


The mechanical and physical property charts are provided so that the EOR can determine the allowable tie rod spacing while considering the bending, shear and serviceability requirements of the wale. The properties have been published as characteristic values per ASTM D7290-06.

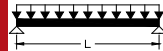
Mechanical Properties of Wale Section Bent about the minor axis	Test Method	Units	Polyester Resin Average Values	Vinyl Ester Resin Average Values
Modulus of Elasticity	Lab	Msi (GPa)	3.16 (21.8)	3.56 (24.5)
Shear Modulus	Lab	Msi (GPa)	0.45 (3.1)	0.45 (3.1)
Shear Capacity	Lab/Calculated	lb (kg)	31,600 (14,300)	44,100 (20,200)
Moment Capacity	Lab/Calculated	ft-lb (N-m)	41,600 (56,400)	42,400 (57,400)
Bending Stiffness EI Value	Calculated	lb-in ² (N-m ²)	1.56E8 (4.46E5)	1.75E8 (5.03E5)
In-Plane Shear Strength	ASTM D5379	ksi (MPa)	9.6 (66.2)	13.4 (92.4)

*Note: All values listed in the above table are characteristic values determined in accordance with ASTM D7290-06.

Physical Properties	Units
Minor Section Modulus	14.40 in ³ (1.97E+07 mm ³)
Minor Moment of Inertia	49.22 in ⁴ (2.05E+07 mm ⁴)
Depth of Section	6.0 in. (152.4 mm)
Width of Section	8.0 in. (203.2 mm)
Weight	9.70 lb/ft. (14.44 kg/m)
Area of the web	4.9 in ² (3,160 mm ²)
Standard Color	Graphite Gray

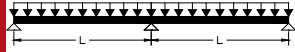
POLYESTER LOAD TABLES

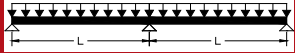
Design Charts for Superwale® Specified with Polyester Resin Simply Supported, Simple Span Load Condition (Imperial Units)							
Tie-rod Spacing (ft.)	Load on the wale that produces 0.25" deflection (lbs./ft)	Load on the wale that produces 0.375" deflection (lbs./ft)	Load on the wale that produces 0.5" deflection (lbs./ft)	Allowable Load per foot of wale (Flexure) (lbs./ft.)	Allowable Load per foot of wale (Shear) (lbs./ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x6.0"x.50" steel washer) (lbs/ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x12"x.75" steel washer) (lbs/ft.)
3	19,233	28,850	38,466	14,802	7,016	8,000	10,578
4	6,085	9,128	12,171	8,326	5,262	6,000	7,933
5	2,493	3,739	4,985	5,329	4,209	4,800	6,347
6	1,202	1,803	2,404	3,701	3,508	4,000	5,289
7	649	973	1,298	2,719	3,007	3,429	4,533
8	380	571	761	2,082	2,631	3,000	3,967
9	237	356	475	1,645	2,339	2,667	3,526
10	156	234	312	1,332	2,105	2,400	3,173

Design Charts for Superwale® Specified with Polyester Resin Simply Supported, Simple Span Load Condition (Metric Units)							
Tie-rod Spacing (m)	Load on the wale that produces 6mm deflection (kN/m)	Load on the wale that produces 10mm deflection (kN/m)	Load on the wale that produces 13mm deflection (kN/m)	Allowable Load per meter of wale (Flexure) (kN/m)	Allowable Load per meter of wale (Shear) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x152x12.7 mm steel washer) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x305x19 mm steel washer) (kN/m)
1.00	185.4	309.0	401.7	180.6	93.6	106.8	141.2
1.25	75.9	126.6	164.5	115.6	74.9	85.4	112.9
1.50	36.6	61.0	79.4	80.3	62.4	71.2	94.1
1.75	19.8	32.9	42.8	59.0	53.5	61.0	80.7
2.00	11.6	19.3	25.1	45.2	46.8	53.4	70.6
2.25	7.2	12.1	15.7	35.7	41.6	47.4	62.7
2.50	4.7	7.9	10.3	28.9	37.4	42.7	56.5
2.75	3.2	5.4	7.0	23.9	34.0	38.8	51.3

NOTES:

1. Safety Factors Include: 2.5 for Flexure, 3 for Shear, and 3 for washer pull through strength.

Design Charts for Superwale® Specified with Polyester Resin Simply Supported, Continuous Span Load Condition (Imperial Units)							
Tie-rod Spacing (ft.)	Load on the wale that produces 0.25" deflection (lbs./ft)	Load on the wale that produces 0.375" deflection (lbs./ft)	Load on the wale that produces 0.5" deflection (lbs./ft)	Allowable Load per foot of wale (Flexure) (lbs./ft.)	Allowable Load per foot of wale (Shear) (lbs./ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x6.0"x.50" steel washer) (lbs/ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x12"x.75" steel washer) (lbs/ft.)
3	36,320	54,481	72,641	14,802	5,613	3,200	4,231
4	11,492	17,238	22,984	8,326	4,209	2,400	3,173
5	4,707	7,061	9,414	5,329	3,368	1,920	2,539
6	2,270	3,405	4,540	3,701	2,806	1,600	2,116
7	1,225	1,838	2,451	2,719	2,405	1,371	1,813
8	718	1,077	1,436	2,082	2,105	1,200	1,587
9	448	673	897	1,645	1,871	1,067	1,410
10	294	441	588	1,332	1,684	960	1,269


Design Charts for Superwale® Specified with Polyester Resin Simply Supported, Continuous Span Load Condition (Metric Units)							
Tie-rod Spacing (m)	Load on the wale that produces 6mm deflection (kN/m)	Load on the wale that produces 10mm deflection (kN/m)	Load on the wale that produces 13mm deflection (kN/m)	Allowable Load per meter of wale (Flexure) (kN/m)	Allowable Load per meter of wale (Shear) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x152x12.7 mm steel washer) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x305x19 mm steel washer) (kN/m)
1.00	350.1	583.6	758.6	180.6	74.9	42.7	56.5
1.25	143.4	239.0	310.7	115.6	59.9	34.2	45.2
1.50	69.2	115.3	149.9	80.3	49.9	28.5	37.6
1.75	37.3	62.2	80.9	59.0	42.8	24.4	32.3
2.00	21.9	36.5	47.4	45.2	37.4	21.4	28.2
2.25	13.7	22.8	29.6	35.7	33.3	19.0	25.1
2.50	9.0	14.9	19.4	28.9	30.0	17.1	22.6
2.75	6.1	10.2	13.3	23.9	27.2	15.5	20.5

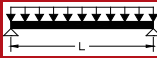
NOTES:

1. Safety Factors Include: 2.5 for Flexure, 3 for Shear, and 3 for washer pull through strength.

2. To ensure conservative values, 3 spans used for deflection calculations, and 2 spans used for strength calculations.

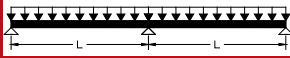
VINYL ESTER LOAD TABLES

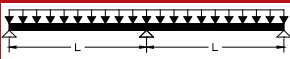
Design Charts for Superwale® Specified with Vinylester Resin Simply Supported, Simple Span Load Condition (Imperial Units)							
Tie-rod Spacing (ft.)	Load on the wale that produces 0.25" deflection (lbs./ft)	Load on the wale that produces 0.375" deflection (lbs./ft)	Load on the wale that produces 0.5" deflection (lbs./ft)	Allowable Load per foot of wale (Flexure) (lbs./ft.)	Allowable Load per foot of wale (Shear) (lbs./ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x6.0"x.50" steel washer) (lbs./ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x12"x.75" steel washer) (lbs./ft.)
3	21,668	32,501	43,335	15,058	9,793	10,000	10,578
4	6,856	10,284	13,712	8,470	7,345	7,500	7,933
5	2,808	4,212	5,616	5,421	5,876	6,000	6,347
6	1,354	2,031	2,708	3,765	4,896	5,000	5,289
7	731	1,096	1,462	2,766	4,197	4,286	4,533
8	428	643	857	2,118	3,672	3,750	3,967
9	268	401	535	1,673	3,264	3,333	3,526
10	176	263	351	1,355	2,938	3,000	3,173

Design Charts for Superwale® Specified with Vinylester Resin Simply Supported, Simple Span Load Condition (Metric Units)							
Tie-rod Spacing (m)	Load on the wale that produces 6mm deflection (kN/m)	Load on the wale that produces 10mm deflection (kN/m)	Load on the wale that produces 13mm deflection (kN/m)	Allowable Load per meter of wale (Flexure) (kN/m)	Allowable Load per meter of wale (Shear) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x152x12.7 mm steel washer) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x305x19 mm steel washer) (kN/m)
1.00	208.9	348.1	452.6	183.7	130.7	133.4	141.2
1.25	85.6	142.6	185.4	117.6	104.5	106.8	112.9
1.50	41.3	68.8	89.4	81.7	87.1	89.0	94.1
1.75	22.3	37.1	48.3	60.0	74.7	76.3	80.7
2.00	13.1	21.8	28.3	45.9	65.3	66.7	70.6
2.25	8.2	13.6	17.7	36.3	58.1	59.3	62.7
2.50	5.3	8.9	11.6	29.4	52.3	53.4	56.5
2.75	3.7	6.1	7.9	24.3	47.5	48.5	51.3

NOTES:

1. Safety Factors Include: 2.5 for Flexure, 3 for Shear, and 3 for washer pull through strength.

Design Charts for Superwale® Specified with Vinylester Resin Simply Supported, Continuous Span Load Condition (Imperial Units)							
Tie-rod Spacing (ft.)	Load on the wale that produces 0.25" deflection (lbs./ft)	Load on the wale that produces 0.375" deflection (lbs./ft)	Load on the wale that produces 0.5" deflection (lbs./ft)	Allowable Load per foot of wale (Flexure) (lbs./ft.)	Allowable Load per foot of wale (Shear) (lbs./ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x6.0"x.50" steel washer) (lbs./ft.)	Allowable Load per foot of wale (Tie-rod Pull Force utilizing a 3.25"x12"x.75" steel washer) (lbs./ft.)
3	40,918	61,377	81,836	15,058	7,834	4,000	4,231
4	12,947	19,420	25,893	8,470	5,876	3,000	3,173
5	5,303	7,954	10,606	5,421	4,701	2,400	2,539
6	2,557	3,836	5,115	3,765	3,917	2,000	2,116
7	1,380	2,071	2,761	2,766	3,358	1,714	1,813
8	809	1,214	1,618	2,118	2,938	1,500	1,587
9	505	758	1,010	1,673	2,611	1,333	1,410
10	331	497	663	1,355	2,350	1,200	1,269

Design Charts for Superwale® Specified with Vinylester Resin Simply Supported, Continuous Span Load Condition (Metric Units)							
Tie-rod Spacing (m)	Load on the wale that produces 6mm deflection (kN/m)	Load on the wale that produces 10mm deflection (kN/m)	Load on the wale that produces 13mm deflection (kN/m)	Allowable Load per meter of wale (Flexure) (kN/m)	Allowable Load per meter of wale (Shear) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x152x12.7 mm steel washer) (kN/m)	Allowable Load per meter of wale (Tie-rod Pull Force utilizing a 83x305x19 mm steel washer) (kN/m)
1.00	394.5	657.4	854.7	183.7	104.5	53.4	56.5
1.25	161.6	269.3	350.1	117.6	83.6	42.7	45.2
1.50	77.9	129.9	168.8	81.7	69.7	35.6	37.6
1.75	42.1	70.1	91.1	60.0	59.7	30.5	32.3
2.00	24.7	41.1	53.4	45.9	52.3	26.7	28.2
2.25	15.4	25.7	33.3	36.3	46.5	23.7	25.1
2.50	10.1	16.8	21.9	29.4	41.8	21.4	22.6
2.75	6.9	11.5	14.9	24.3	38.0	19.4	20.5

NOTES:

1. Safety Factors Include: 2.5 for Flexure, 3 for Shear, and 3 for washer pull through strength.

2. To ensure conservative values, 3 spans used for deflection calculations, and 2 spans used for strength calculations.

DATA AND TESTING INFORMATION

The SuperWale® was tested in a full section scenario, in independent labs, to determine the full section modulus of elasticity, moment capacity, shear capacity and tie rod punch through strength.

MOMENT CAPACITY

The moment capacity was determined by several full section tests configured in a three-point bend scenario. Sufficient data was collected to calculate the characteristic value via ASTM D7290, which provides an 80% lower confidence bound on the 5th percentile value. These values should be used in conjunction with the load combinations, adjustment factors, and phi factors set forth in the Pre-Standard for Load and Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures developed by ASCE.



The wale sections were loaded until failure in a 3-point bend configuration utilizing an 8' span. The average failure load was recorded to be 24,135 lbs. The corresponding moment was determined to be 48,271 ft-lbs. When analyzed in accordance with ASTM D7290 the characteristic moment capacity is calculated to be 41,600 ft-lbs.

SHEAR CAPACITY OF THE SUPERWALE®

The ultimate shear capacity was determined by the utilization of the following shear equation:

Where,

$$\tau_{xy} = \frac{3 V}{2 A_w}$$

τ_{xy} = 9,600 psi, Shear Stress (psi)

V = Shear Load (lbs.)

A_w = 4.9 in², Area of the web (in²)

The ultimate shear load V was calculated to be 31,571 lbs.

The shear values shown in the load tables are calculated using the characteristic shear strength of the webs when tested with ASTM D5379. The resulting data was then analyzed, as specified, by ASTM D7290 to determine the characteristic value of Shear Stress

τ_{xy}

TIE-ROD CAPACITY

The tie-rod capacity is subject to the tie-rod connection detail. The washer size greatly influences the capacity of the SuperWale® system. Punch through tests have been conducted on the SuperWale® section with various washer configurations.

The test involved drilling a 1.25" diameter hole in the middle of the wale section and inserting an FRP nut and stud through the hole in the washer as depicted in Figure 1. Various washer sizes were tested to determine the appropriate washer dimensions.

A load was then induced onto the nut utilizing an INSTRON testing machine. The load and deflection was recorded until a failure occurred. Failure was defined as permanent distortion or when audible/visual cracking was detected.

The following chart reflects the allowable tie-rod force with various washers. CPI only recommends the washer dimensions specified below. Alternative washer dimensions are only to be used at the discretion of the practicing engineer.

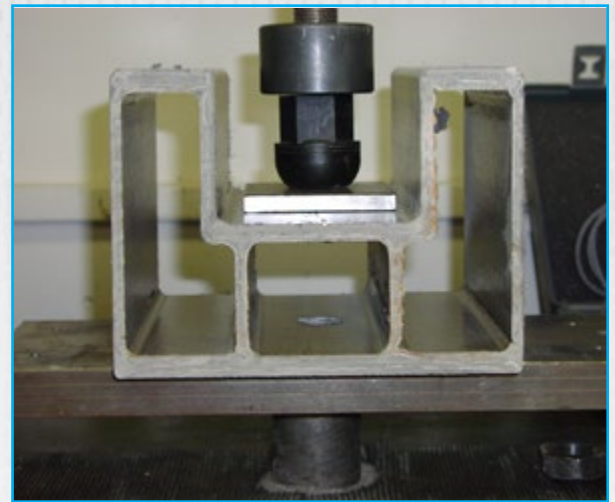


Figure 1. Photo of the Tie-rod push through test conducted in CPI Lab.

Characteristic Tie-rod Force on SuperWale® with Specified Washers (Safety Factor Required)

Vinylester Resin Specified in SuperWale® lbs (kg)	Polyester Resin Specified in SuperWale® lbs (kg)	Steel Washer Dimensions inches (mm)
45,000 (20,400)	36,000 (16,300)	3.25x6x.5 (82x152x12.7)
47,600 (21,600)	47,600 (21,600)	3.25x12x.75 (82x152x19)

FABRICATION

The SuperWale® can be cut and drilled with standard construction tools. Specifically, a concrete saw should be utilized to field cut the wale section. A standard carbide steel drill bit should be used to drill holes in the SuperWale®. A wood bit is not recommended!

GENERAL SAFETY

It is recommended to wear a dust mask and safety glasses when cutting the composite materials. Fiberglass dust can be irritating to the eyes and the skin. The dust and drops are inert and can be land filled. For a complete MSDS please consult Creative Pultrusions, Inc.

Example of Wale Installation



SUPERWALE® ACCESSORIES

Part drawings can be viewed at <http://www.creativepultrusions.com>.

W-SPLICE



SuperWale® W-Splice

Part Number	Material	Dimension	Weight
FAB383	50 ksi structural steel galvanized per ASTM A123	12L x 8.4W (305x213) in(mm) Hole diameter 1.125 (28.58) in(mm)	11 lbs. (5 kg)

Engineering Notes:

1. Tie-rod must be backed with a 3x3x.25 (83x83x6) in(mm) galvanized per ASTM A123 steel washer.
2. A tie rod should be utilized with each splice.
3. The working load capacity of the wale splice is 20,000 lbs., which includes a service factor.

W-CORNER CONNECTOR



SuperWale® W-Corner Connector

Part Number ¹	Material	Dimension	Weight
FAB093 - 90° FAB094 - 45°	316 Stainless Steel ²	Both sides 12L x 8.4W (304.8x 213.4) in(mm) Hole Diameter drilled at 13/16" (20.64) for a .75x4.5 (19.05x114.3) in(mm) bolt	23 lbs. (10 kg)

Engineering Notes:

1. Special angles are available upon request.
2. Parts can be factory or field welded.

STEEL WASHERS



SuperWale® Steel Washers

Part Number	Material	Dimension	Weight
FAB384	50 ksi steel galvanized per ASTM A123	3.25x6x.5 (82x152x12.7) in(mm) Hole diameter 1.125 (28.58) in(mm)	2.75 lbs. (1.25 kg)
FAB385	50 ksi steel galvanized per ASTM A123	3.25x12x.75 (82x305x19) in(mm) Hole diameter 1.125 (28.58) in(mm)	8.35 lbs. (3.79 kg)

**FOR MORE DETAILS ON THE SUPERLOC™ SHEET PILE SYSTEM
AND SUPERWALE® CONTACT:**

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**Wale & Retaining Wall System
(US Patent #6,893,191 B2/May 17, 2005)**



PLEASE SCAN WITH PHONE