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CREATIVE PULTRUSIONS

PRODUCT BROCHURE

SUPERLOC™

FIBERGLASS REINFORCED POLYMER (FRP) SHEET PILING AND ACCESSORIES

PROVIDING LEADERSHIP IN FRP SHEET PILE TECHNOLOGY

THE PERFECT SOLUTION FOR SHORELINE PROTECTION

Creative Pultrusions, Inc. (CPI) is the world leader in pultrusion manufacturing. Our commitment to continuous process and product improvement has transformed CPI into a world-renowned pultruder specializing in custom profiles while utilizing high-performance resins and our proprietary high-pressure injection pultrusion technology.

As the world's most innovative leader in the FRP pultrusion industry, over the last two decades, we've developed structural systems that out perform and outlast structures built with traditional materials of construction. CPI has continued to build upon their reputation by offering a complete line of quality composite products to the marine industry, including the SuperLoc™ Sheet Pile System. Developed to provide a solution for deteriorated waterfront structures subjected to the harsh marine environment, SuperLoc™ is the perfect solution for shoreline protection.

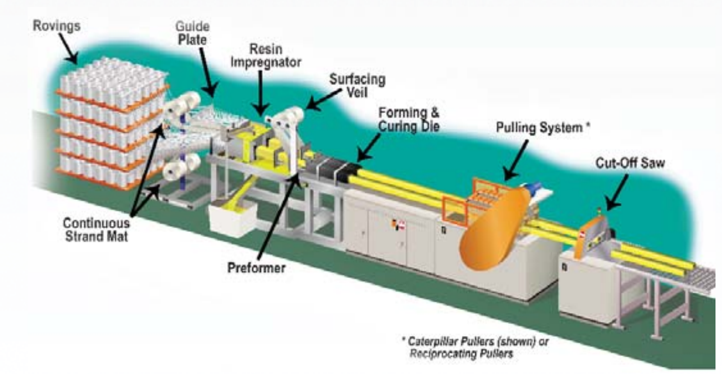
SUPERLOC™ SHEET PILING

SuperLoc™ Composite Sheet Pile System, a FRP composite system, is manufactured by the pultrusion process and is designed and manufactured to provide a solution for deteriorated waterfront structures subjected to the harsh marine environment.

The patented SuperLoc™ product line offers cost effective, long-term and low-maintenance solutions, and has been vetted for two decades as the premier solution for long-term shoreline and asset protection.

WHAT IS PULTRUSION?

Pultrusion is a continuous manufacturing process utilized to make composite profiles with constant cross-sections whereby reinforcements, in the form of roving and mats, are saturated with resin and guided into a heated die. The resin undergoes a curing process known as polymerization. The once resin saturated reinforcements exit the die in a solid state and in the form of the cross section of the die. The pultrusion process requires little labor and is ideal for mass production of constant cross section profiles.



Full section test of a 1580 sheet pile wall at CPI by WVU. Note the strain gauge instrumentation.

SUPERLOC™ CONSTRUCTION

SuperLoc™ Sheet Piling is manufactured with electrical grade fiberglass and high strength resins. The combination of the advanced resin and high strength glass produces a superior, highly corrosion resistant sheet pile that has been engineered to stand the test of time.

ADVANCED UV PROTECTION

UV rays and heat from solar radiation degrade the molecular structure of most materials. The extent of degradation ranges from mere fading to reduction in strength. Additives in the form of ultraviolet light absorbers and inhibitors greatly increase the performance in long term sunlight exposure. Polyester synthetic veils are applied to the SuperLoc™ in order to encapsulate the E-glass fibers and provide a resin rich surface.

Results have shown that UV degradation does not affect the modulus of elasticity. Fading of the polymerized resin will occur at various rates over time. Typically, within three years the gloss is eliminated and a visual whitening or yellowing can be observed on the surface. In general, the amount of sunlight and intensity will depend on the geographical location. Therefore, the rate at which composite materials will lighten is variable. The SuperLoc™ system utilizes the most advanced resin technology and pigmentation to ensure the best possible aesthetics over time.

CPI's composite sheetpiles are shipped standard with two layers of Ultra Violet (UV) protection. First, CPI adds UV light absorbers to each sheetpile. The UV light absorbers are mixed into the thermoset resin, prior to production, and function as long term thermal and light stability promoters. Second, the composite sheetpiles are encompassed with a 10 mil polyester surfacing veil. The 10 mil veil creates a resin rich surface and protects the glass reinforcements from fiber blooming.

FIBERGLASS REINFORCEMENTS

All composite sheet piles are manufactured with electrical grade E-glass reinforcements in the form of unidirectional roving, Continuous Filament Mat (CFM) and stitched fabric mats. The combination of fiber reinforcements has been engineered for optimal bending strength, as well as superior stiffness. All E-glass reinforcements meet a minimum tensile strength of 290 ksi per ASTM D2343.

RESIN/MATRIX

CPI manufactures the SuperLoc™ sheet piles and accessories in both vinyl ester (VE) and isophthalic polyester (I) resin formulations. Proper resin selection should be based on the environmental aspects of the site conditions including the soil and water pH and chemical exposure.

VE Resins are based on bisphenol- A epoxy resin. VE resins provide resistance to a wide range of acids, alkalis, bleaches and solvents for use in many chemical environments. They also offer excellent toughness and fatigue resistance. The mechanical properties are typically 10% to 15% higher than polyester properties. A long service life can be expected for waterfront environments in salt and fresh water.

I pultrusions are manufactured for corrosion related applications. I resins display excellent structural properties and are resistant to acids, salts, and many dilute chemicals at moderate temperatures. They perform well in acidic environments; however, I pultrusions are not recommended for caustic or alkaline environments. The pH should be kept below 10.5. Oxidizing environments usually present limitations. A long service life can be expected for waterfront environments in salt and fresh water.

Coupon level tensile testing utilizing CPI calibrated 56 Kip Instron

COLOR

SuperLoc™ and its accessories come standard in graphite gray, the color that has been selected for both its aesthetics and UV performance. Custom colors are available upon request. Minimum quantities and color match charges apply.

Standard Graphite Gray Color

SYSTEM TESTING

SuperLoc™ has undergone extensive testing at Pennsylvania State University, West Virginia University (WVU) and the University of Akron. Testing ranged from full section to coupon to internationally recognized ASTM standards when applicable.

TYPICAL WALL APPLICATIONS

SuperLoc™ is an alternative construction material without many of the performance disadvantages of conventional materials such as aluminum, concrete, steel and wood. SuperLoc™ will not corrode, decay, or spall thereby reducing maintenance costs and future replacements. The FRP composite system resists impact, creep, UV and weathering effects better than vinyl (PVC) materials and is easier to install in harder soils than vinyl sheet piling.

Typical applications are highlighted below.

1. WAVE BREAKS
2. RETAINING WALLS
3. WATER CONTROL
4. LAND STABILIZATION
5. BRIDGE ABUTMENTS
6. EROSION CONTROL
7. STAY-IN-PLACE FORMS
8. STORM SURGE/FLOOD PROTECTION
9. CONTAINMENT/CUT-OFF WALLS

WHY SHOULD YOU SPECIFY AND PROCURE CPI'S SUPERLOC™ SHEET PILE SYSTEM?

SuperLoc™ Composite Sheet Pile System is patented (Wale and Retaining Wall System US Patent #6,893,191 B2/May 17, 2005) and proven to provide a structural solution to waterfront protection while maintaining an aesthetically pleasing look. It's pound for pound stronger than steel, concrete or wood, and is manufactured in an environmentally controlled complex to stringent quality assurance standards.

SuperLoc™ can be driven with standard pile driving equipment and is field drillable, making fabrication easier and faster than traditional materials.

The Glenridge on Palmer Ranch
Sarasota, Florida

LIGHT WEIGHT

Transported and installed with lighter equipment.

EASE OF FABRICATION

Drilled and cut with traditional tools in seconds.

ENGINEERED SOLUTION

Designed for bulkhead applications and manufacturing plant is environmentally controlled.

HIGHLY CORROSION RESISTANT

Predicted to have a 75+ year service life.

INERT TO MARINE BORERS

Unaffected by marine life.

ENVIRONMENTALLY FRIENDLY

SuperLoc™ is inert and will not leach dangerous chemicals into the environment.

Full Section Test Set Up, CPI

MECHANICAL & PHYSICAL PROPERTIES

MOMENT CAPACITY ANALYSIS AND VERIFICATION

The published moment capacities were derived by utilizing the local buckling equations depicted in the "Pre-Standard for Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures" that has been developed by The American Composites Manufacturing Association (ACMA) in conjunction with the American Society of Civil Engineers (ASCE).

The moment capacity of the sheet pile sections have been validated with Finite Element Analysis (FEA) and full section testing. The analysis and results for the 1580 seawall profile can be scrutinized in the white paper titled Development of Design Properties for the Series 1580 Seawall Profile. The paper describes the equations used to predict the local compression buckling capacity, which is the normal mode of failure for thin walled slender FRP profiles. The predicted results were compared against a FEA and a full section cantilever wall test that was conducted by WVU. CPI's engineering team predicted results that were within ± 4% of the full section test conducted on the 1580 cantilever wall.

SUPERLOC™ SHEET PILES

The mechanical and physical data detailed herein is provided for the structural engineer. The mechanical data is published in terms of average and characteristic values. The characteristic values were derived per the requirements as set forth in ASTM D7290-06 "Standard Practice for Evaluating Material Property Characteristic Values for Polymeric Composites for Civil Engineering Structural Applications". The characteristic value is defined as a statistically based material property representing the 80% lower confidence bound on the 5th-percentile value of a specified population. The characteristic value accounts for statistical uncertainty due to a finite sample size. The characteristic value is the reference strength.

In September of 2006, ASTM D7290-06 "Standard Practice for Evaluating Material Property Characteristic Values for Polymeric Composites for Civil Engineering Structural Applications" was published. Until the development of the ASTM D7290-06 Standard, manufacturers of pultruded members, could present their data, in the format of their choice. The standard protects both manufacturers and engineers, as it provides statistical based data that rewards tight process control. It also gives engineers the comfort that the data was derived per a world-recognized standard. The adoption of the ASTM D7290-06 Standard dictates that every manufacturer must present their data based on a characteristic value. The characteristic values determined using the ASTM D7290-06 Standard can be used to calculate structural member resistance values in design codes for composite civil engineering structures and for establishing limits upon which qualification and acceptance criteria can be based. The data presented in the SuperLoc™ Data Sheets was developed per the ASTM D7290-06 Standard.

ENGINEERING YOUR BULKHEAD

CPI provides both coupon level and full section properties so that you can properly design your bulkhead. There are two accepted methodologies for designing structures with pultruded profiles. They include Allowable Stress Design (ASD) and LRFD. In terms of LRFD design, the reference strength shall be adjusted for end use conditions by applying the applicable adjustment factors to establish the nominal resistance strength. The design strength shall include the nominal resistance, adjusted for end use conditions, a resistance factor and time effect factor. The capacities labeled as LRFD in the mechanical and physical property charts are based on the following:

The LRFD design strengths published in the property charts were calculated as the product of the nominal resistance, Rn, adjusted for end-use conditions, a resistance factor, Ø, and a time effect factor, λ.

The reference strength of the FRP sheet pile materials has been adjusted in accordance to the LRFD pre-standard factors for long term performance in water based on the resin types. For example, A resistance factor (Ø), in accordance to the LRFD pre-standard, has been applied to the nominal resistance value based on the governing mode of failure. The resistance factors for material rupture in shear and flexural members with local instability of the flanges are taken as Ø= .65 and .80, respectively.

THE POLYESTER RESIN STRENGTH AND STIFFNESS REDUCTION FACTORS ARE AS FOLLOWS:

- **Moisture Condition Strength Reduction Factor = 0.80**
- **Moisture Condition Modulus of Elasticity Reduction Factor = 0.85**

THE VINYL ESTER RESIN STRENGTH AND STIFFNESS REDUCTION FACTORS ARE AS FOLLOWS:

- **Moisture Condition Strength Reduction Factor = 0.85**
- **Moisture Condition Modulus of Elasticity Reduction Factor = 0.95**

When the full design load acts during the entire service life equal to or exceeding 50 years, the time effect factor shall be taken equal to 0.4. A time effect factor λ of 0.4 has been applied to the design strengths.

Serviceability should be checked using realistic loads for the serviceability limit state of concern. The adjusted mean values of the longitudinal elastic modulus should be used in determining the stiffness for calculating deflections of the sheet pile wall system and components. The average full section modulus of elasticity has been published based on the lesser value of the average compression or tensile modulus of elasticity derived from coupons extracted from the flange and web sections of the sheet pile. Note that the modulus should be adjusted for long term performance in water by utilizing the modulus reduction factors provided.

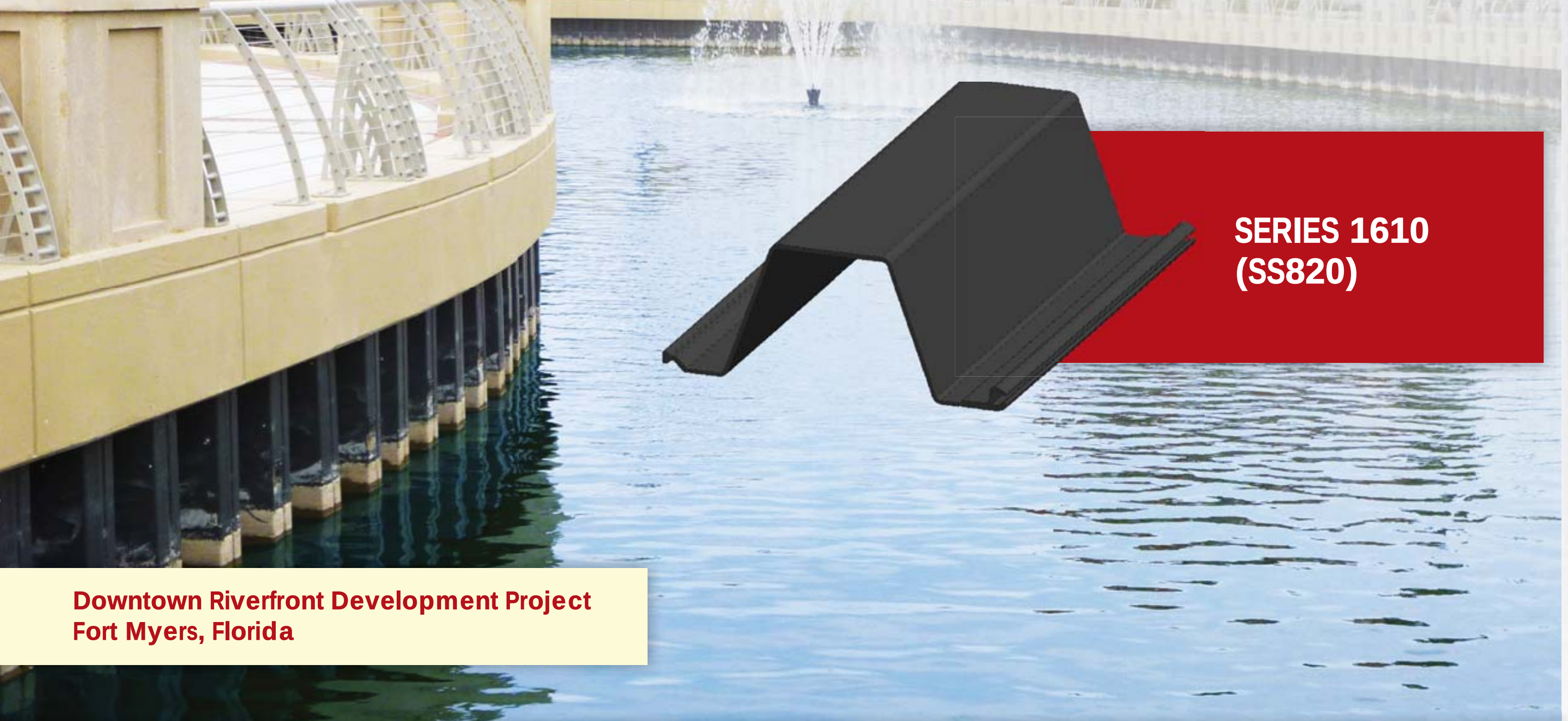
Industry standards for ASD include a 2.5 safety factor for flexural members, and a 3.0 for shear and connections. The ASD moment capacities were derived by utilizing the local compression flange buckling capacity equation in the LRFD pre-standard. The modulus of elasticity for serviceability calculations is the average full section modulus of elasticity published in the property charts.

HIGHLY CONCENTRATED LOADS ON YOUR BULKHEAD

Concentrated loads, applied to composite materials, need to be scrutinized. Specifically, although FRP materials exhibit very high strengths, the modulus of elasticity is relatively low compared to steel. Therefore, the engineer of record is encouraged to analyze the stresses induced into the sheet pile sections from concentrated loads. A prime example is the stress induced into a FRP bulkhead from the wale. The wale section is essentially concentrating a large amount of the total wall load into the sheet. A highly concentrated wale load could cause the webs to fracture or buckle. CPI publishes the characteristic web buckling capacity for each sheet for the engineer to consider. Appropriate factors must be applied to derive the design capacity.

Coupon Testing, CPI

PHYSICAL & MECHANICAL PROPERTIES



Downtown Riverfront Development Project
Fort Myers, Florida

Part drawings and physical property sheets can be viewed at http://www.assetint.co.uk.

Series 1610 (SS820) 24" (609.6mm) W x 10" (254mm) H Physical Properties	Imperial Value	Units	Metric Value	Units
Section Modulus	18.40	in^3/ft	989.24	cm^3/m
Moment of Inertia	101.43	in^4/ft	13851.12	cm^4/m
Typical Thickness	0.30	in	7.62	mm
Depth of Sheet	10.00	in	254.00	mm
Width of Sheet	24.00	in	609.60	mm
Weight (single pile)	5.47	lbs/ft^2	26.71	kg/m^2
Angle of the web	20	°	20	°
Cross Sectional Area of Sheet	13.47	in^2	86.90	cm^2
Standard Color	Graphite Gray			

PHYSICAL & MECHANICAL PROPERTIES

SUPERLOC™ SHEET PILES - SERIES 1610 (SS820)

Series 1610 (SS820) 24" (609.6mm) W x 10" (254mm) H Mechanical Properties	Test Method	ASTM D7290-06 Characteristic Values				Units
		Polyester Resin		Vinyl Ester Resin		
		Imperial	Metric	Imperial	Metric	
Tensile Modulus (LW)	ASTM D638	3.74	25.79	3.91	26.96	Msi / GPa
Tensile Modulus (CW)	ASTM D638	1.84	12.69	1.85	12.76	Msi / GPa
Compression Modulus (LW)	ASTM D6641	3.25	22.41	3.67	25.30	Msi / GPa
Compression Modulus (CW)	ASTM D6641	1.37	9.45	1.75	12.07	Msi / GPa
Tensile Strength (LW)	ASTM D638	58.82	405.55	70.88	488.70	ksi / MPa
Tensile Strength (CW)	ASTM D638	12.43	85.70	16.50	113.76	ksi / MPa
Compression Strength (LW)	ASTM D6641	49.62	342.12	49.74	342.95	ksi / MPa
Compression Strength (CW)	ASTM D6641	14.47	99.77	19.70	135.83	ksi / MPa
Inplane Shear Strength	ASTM D5379	8.70	59.98	12.51	86.25	ksi / MPa
Inplane Shear Modulus	ASTM D5379	0.50	3.45	0.50	3.45	Msi / GPa
Short Beam Shear Strength	ASTM D2344	1.48	10.20	4.33	29.85	ksi / MPa

Series 1610 (SS820) 24" (609.6mm) W x 10" (254mm) H Mechanical Properties		
Moment Capacity	**Imperial**	**Metric**
Moment Capacity Polyester ASD*	47,053 lb-ft/ft. of wall	209.3 kN-m/meter of wall
Moment Capacity Vinyl Ester ASD*	54,677 lb-ft/ft. of wall	243.2 kN-m/meter of wall
Moment Capacity Polyester LRFD[1]	13,551 lb-ft/ft. of wall	60.3 kN-m/meter of wall
Moment Capacity Vinyl Ester LRFD[1]	16,622 lb-ft/ft. of wall	73.9 kN-m/meter of wall
Shear Strength	**Imperial**	**Metric**
Shear Strength Polyester ASD*	39,300 lbs per ft. of wall	573.5 kN/meter of wall
Shear Strength Vinyl Ester ASD*	47,250 lbs per ft. of wall	689.6 kN/meter of wall
Shear Strength Polyester LRFD[2]	11,319 lbs per ft. of wall	165.2 kN/meter of wall
Shear Strength Vinyl Ester LRFD[2]	14,365 lbs per ft. of wall	209.6 kN/meter of wall
Full Section Modulus of Elasticity	**Imperial**	**Metric**
Characteristic Value ASTM D7290-06 Full Section Modulus of Elasticity	3.25 Msi (Polyester) 3.67 Msi (Vinyl Ester)	22.41 GPa (Polyester) 25.30 GPa (Vinyl Ester)
Average Full Section Modulus of Elasticity	4.25 Msi (Polyester) 4.39 Msi (Vinyl Ester)	29.34 GPa (Polyester) 30.27 GPa (Vinyl Ester)
Web Buckling Capacity from Wale Force based on ASTM D7290-06 Testing (based on 8" wale section)	10,600 lbs/ft of wall	155 kN/m of wall

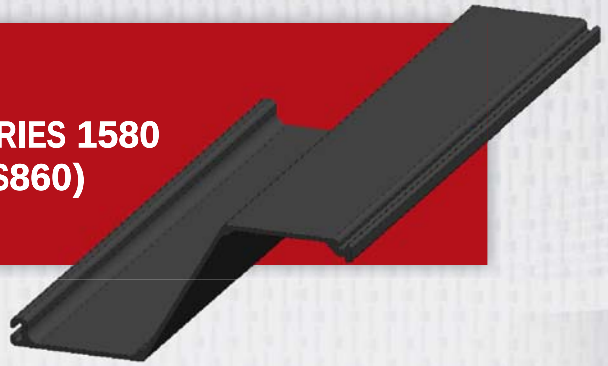
Notes: All capacities have been developed based on equations and design methodologies described in the Pre-Standard Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures.

*Ultimate Capacity based on ASTM D7290-06 Characteristic Values.
[1]LRFD Factored for long term water exposure; Time effect factor λ of .4 applied; ϕ factor of .80 applied.
[2]LRFD Factored for long term water exposure; Time effect factor λ of .4 applied; ϕ factor of .80 applied.
[3]Average based on 30 data points; lesser of the flange or web modulus.

PHYSICAL & MECHANICAL PROPERTIES

Long Beach Boardwalk Replacement, Long Beach, New York

SERIES 1580 (SS860)



"The Long Beach Boardwalk repair project was a fast paced project, with a lot of scrutiny from the public in anticipation of completion. Creative Pultrusions provided the 1580 SuperLoc™ sheets to spec and on time. The staff of Creative Pultrusions were able to stay ahead of Peter Scalamandre & Sons, Inc. Even as our production increased beyond the original projected commitments. CP was always accessible and provided clear and accurate information. One of the best material suppliers that I have been involved with in my career. The ability of CP to provide the material in a timely and balanced manner set the pace for Peter Scalamandre & Sons, Inc. and all those that followed behind on this project."

~Robert Hutzler
Peter Scalamandre & Sons

Part drawings and physical property sheets can be viewed at **http://www.assetint.co.uk**

Series 1580 (SS860) 18" (457.2mm) W x 8" (203.2mm) H Physical Properties	Imperial Value	Units	Metric Value	Units
Section Modulus	13.08	in^3/ft	703.22	cm^3/m
Moment of Inertia	54.01	in^4/ft	7375.52	cm^4/m
Typical Thickness	0.265	in	6.731	mm
Depth of Sheet	8.00	in	203.20	mm
Width of Sheet	18.00	in	457.20	mm
Weight (single pile)	4.05	lbs/ft^2	19.77	kg/m^2
Angle of the web	30	°	30	°
Cross Sectional Area of Sheet	7.43	in^2	47.94	cm^2
Standard Color	Graphite Gray			

PHYSICAL & MECHANICAL PROPERTIES

SUPERLOC™ SHEET PILES - SERIES 1580 (SS860)

Series 1580 (SS860) 18" (457.2mm) W x 8" (203.2mm) H Mechanical Properties	Test Method	ASTM D7290-06 Characteristic Values				Units
		Polyester Resin		Vinyl Ester Resin		
		Imperial	Metric	Imperial	Metric	
Tensile Modulus (LW)	ASTM D638	3.46	23.86	3.41	23.51	Msi / GPa
Tensile Modulus (CW)	ASTM D638	1.31	9.03	1.45	10.00	Msi / GPa
Compression Modulus (LW)	ASTM D6641	3.74	25.79	3.27	22.55	Msi / GPa
Compression Modulus (CW)	ASTM D6641	0.93	6.41	1.23	8.48	Msi / GPa
Tensile Strength (LW)	ASTM D638	67.85	467.81	73.42	506.21	ksi / MPa
Tensile Strength (CW)	ASTM D638	6.06	41.78	8.81	60.74	ksi / MPa
Compression Strength (LW)	ASTM D6641	49.17	339.02	54.92	378.66	ksi / MPa
Compression Strength (CW)	ASTM D6641	10.77	74.26	15.05	103.77	ksi / MPa
Inplane Shear Strength	ASTM D5379	5.39	37.16	5.72	39.44	ksi / MPa
Inplane Shear Modulus	ASTM D5379	0.50	3.45	0.50	3.45	Msi / GPa
Short Beam Shear Strength	ASTM D2344	3.51	24.20	4.18	28.82	ksi / MPa

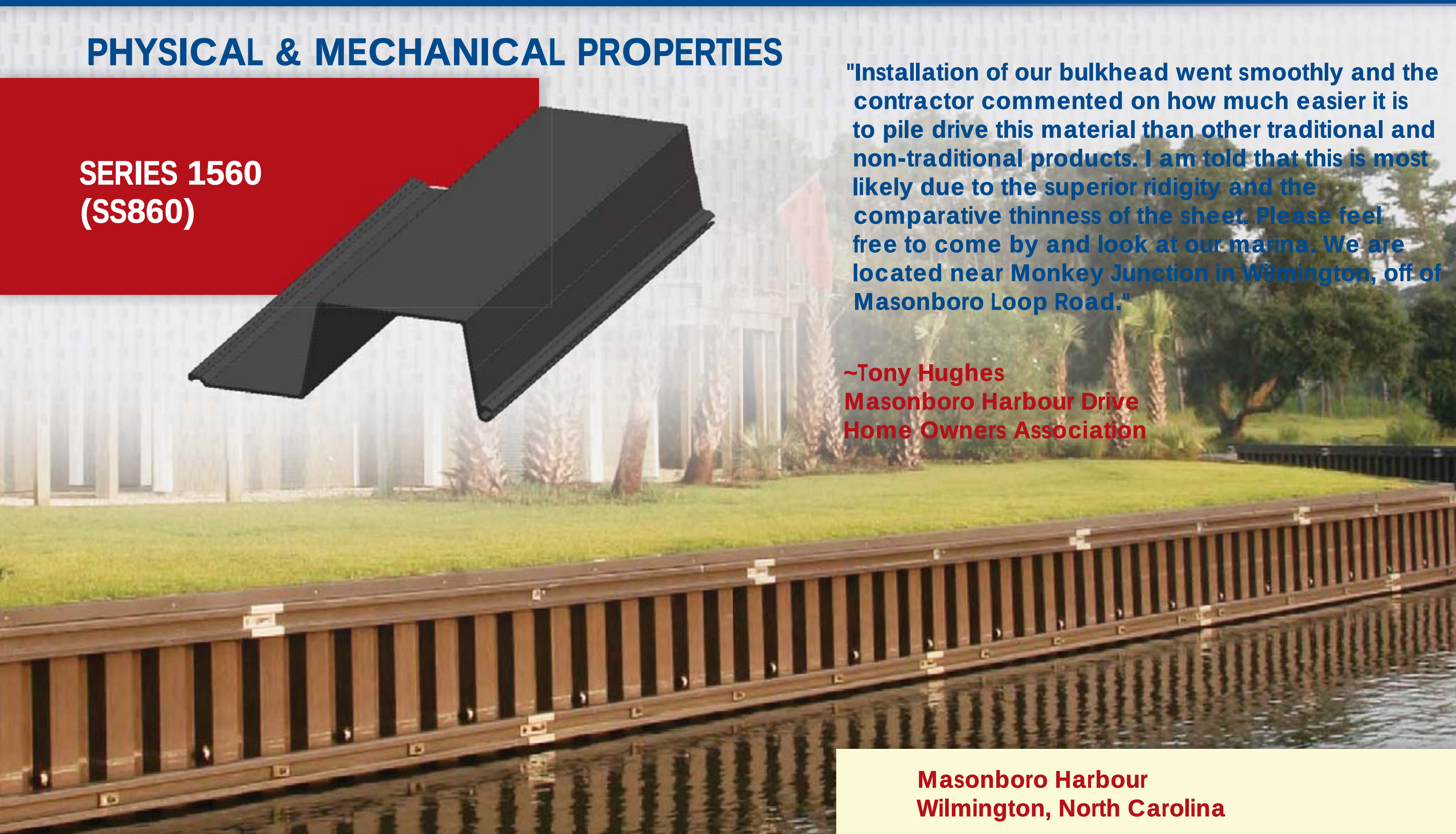
Series 1580 (SS860) 18" (457.2mm) W x 8" (203.2mm) H Mechanical Properties		
Moment Capacity	**Imperial**	**Metric**
Moment Capacity Polyester ASD*	11,671 lb-ft/ft. of wall	51.9 kN-m/meter of wall
Moment Capacity Vinyl Ester ASD*	12,873 lb-ft/ft. of wall	57.3 kN-m/meter of wall
Moment Capacity Polyester LRFD[1]	3,361 lb-ft/ft. of wall	15.0 kN-m/meter of wall
Moment Capacity Vinyl Ester LRFD[1]	3,913 lb-ft/ft. of wall	17.4 kN-m/meter of wall
Shear Strength	**Imperial**	**Metric**
Shear Strength Polyester ASD*	26,700 lbs per ft. of wall	389.7 kN/meter of wall
Shear Strength Vinyl Ester ASD*	31,200 lbs per ft. of wall	455.3 kN/meter of wall
Shear Strength Polyester LRFD[2]	5,553 lbs per ft. of wall	81.0 kN/meter of wall
Shear Strength Vinyl Ester LRFD[2]	6,896 lbs per ft. of wall	100.6 kN/meter of wall
Full Section Modulus of Elasticity	**Imperial**	**Metric**
Characteristic Value ASTM D7290-06 Full Section Modulus of Elasticity	3.46 Msi (Polyester) 3.27 Msi (Vinyl Ester)	23.85 GPa (Polyester) 22.54 GPa (Vinyl Ester)
Average Full Section Modulus of Elasticity	4.25 Msi (Polyester) 4.56 Msi (Vinyl Ester)	29.30 GPa (Polyester) 31.44 GPa (Vinyl Ester)
Web Buckling Capacity from Wale Force based on ASTM D7290-06 Testing (based on 8" wale section)	2,376 lbs/ft of wall	34.7 kN/m of wall

Notes: All capacities have been developed based on equations and design methodologies described in the Pre-Standard Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures.

*Ultimate Capacity based on ASTM D7290-06 Characteristic Values.
[1]LRFD Factored for long term water exposure; Time effect factor λ of .4 applied; ϕ factor of .80 applied.
[2]LRFD Factored for long term water exposure; Time effect factor λ of .4 applied; ϕ factor of .65 applied.
[3]Average based on 30 data points; lesser of the flange or web modulus.

PHYSICAL & MECHANICAL PROPERTIES

SERIES 1560 (SS860)



"Installation of our bulkhead went smoothly and the contractor commented on how much easier it is to pile drive this material than other traditional and non-traditional products. I am told that this is most likely due to the superior ridigity and the comparative thinness of the sheet. Please feel free to come by and look at our marina. We are located near Monkey Junction in Wilmington, off of Masonboro Loop Road."

~Tony Hughes
Masonboro Harbour Drive
Home Owners Association

Masonboro Harbour
Wilmington, North Carolina

Part drawings and physical property sheets can be viewed at http://www.assetint.co.uk

Series 1560 (SS806) 18" (457.2mm) W x 6" (152.4mm) H Physical Properties	Imperial Value	Units	Metric Value	Units
Section Modulus	8.02	in^3/ft	431.18	cm^3/m
Moment of Inertia	24.13	in^4/ft	3295.16	cm^4/m
Typical Thickness	0.20	in	5.08	mm
Depth of Sheet	6.00	in	152.40	mm
Width of Sheet	18.00	in	457.20	mm
Weight (single pile)	3.22	lbs/ft^2	15.72	kg/m^2
Angle of the web	10	°	10	°
Cross Sectional Area of Sheet	6.17	in^2	39.81	cm^2
Standard Color	Graphite Gray			

PHYSICAL & MECHANICAL PROPERTIES

SUPERLOC™ SHEET PILES - SERIES 1560 (SS806)

Series 1560 (SS806) 18" (457.2mm) W x 6" (152.4mm) H Mechanical Properties		ASTM D7290-06 Characteristic Values				
		Polyester Resin		Vinyl Ester Resin		
	Test Method	Imperial	Metric	Imperial	Metric	Units
Tensile Modulus (LW)	ASTM D638	3.07	21.17	3.26	22.48	Msi / GPa
Tensile Modulus (CW)	ASTM D638	1.21	8.34	1.46	10.07	Msi / GPa
Compression Modulus (LW)	ASTM D6641	3.05	21.03	3.16	21.79	Msi / GPa
Compression Modulus (CW)	ASTM D6641	1.05	7.24	1.23	8.48	Msi / GPa
Tensile Strength (LW)	ASTM D638	54.65	376.80	58.95	406.45	ksi / MPa
Tensile Strength (CW)	ASTM D638	10.64	73.36	10.13	69.84	ksi / MPa
Compression Strength (LW)	ASTM D6641	48.09	331.57	50.98	351.49	ksi / MPa
Compression Strength (CW)	ASTM D6641	15.86	109.35	19.18	132.24	ksi / MPa
Inplane Shear Strength	ASTM D5379	9.44	65.09	11.04	76.12	ksi / MPa
Inplane Shear Modulus	ASTM D5379	0.42	2.90	0.42	2.90	Msi / GPa
Short Beam Shear Strength	ASTM D2344	4.25	29.30	4.58	31.58	ksi / MPa

Series 1560 (SS806) 18" (457.2mm) W x 6" (152.4mm) H Mechanical Properties		
Moment Capacity	**Imperial**	**Metric**
Moment Capacity Polyester ASD*	8,633 lb-ft/ft. of wall	38.4 kN-m/meter of wall
Moment Capacity Vinyl Ester ASD*	9,370 lb-ft/ft. of wall	41.7 kN-m/meter of wall
Moment Capacity Polyester LRFD[1]	3,883 lb-ft/ft. of wall	17.3 kN-m/meter of wall
Moment Capacity Vinyl Ester LRFD[1]	4,009 lb-ft/ft. of wall	17.8 kN-m/meter of wall
Shear Strength	**Imperial**	**Metric**
Shear Strength Polyester ASD*	23,470 lbs per ft. of wall	342.5 kN/meter of wall
Shear Strength Vinyl Ester ASD*	26,290 lbs per ft. of wall	392.9 kN/meter of wall
Shear Strength Polyester LRFD[2]	7,027 lbs per ft. of wall	102.6 kN/meter of wall
Shear Strength Vinyl Ester LRFD[2]	7,417 lbs per ft. of wall	108.2 kN/meter of wall
Full Section Modulus of Elasticity	**Imperial**	**Metric**
Characteristic Value ASTM D7290-06 Full Section Modulus of Elasticity	3.05 Msi (Polyester) 3.16 Msi (Vinyl Ester)	21.03 GPa (Polyester) 21.79 GPa (Vinyl Ester)
Average Full Section Modulus of Elasticity	3.68 Msi (Polyester) 3.86 Msi (Vinyl Ester)	25.37 GPa (Polyester) 26.61 GPa (Vinyl Ester)
Web Buckling Capacity from Wale Force based on ASTM D7290-06 Testing (based on 8" wale section)	5,899 lbs/ft of wall	86.09 kN/m of wall

Notes: All capacities have been developed based on equations and design methodologies described in the Pre-Standard Load & Resistance Factor Design (LRFD) of Pultruded Fiber Reinforced Polymer (FRP) Structures.

*Ultimate Capacity based on ASTM D7290-06 Characteristic Values.
[1]LRFD Factored for long term water exposure; Time effect factor λ of .4 applied; ϕ factor of .80 applied.
[2]LRFD Factored for long term water exposure; Time effect factor λ of .4 applied; ϕ factor of .80 applied.
[3]Average based on 30 data points; lesser of the flange or web modulus.

SHEET PILE CAPS AND CONNECTORS

Each sheet pile profile can be accessorized with FRP caps and connectors. The pultruded channel caps are made of the same durable resins and fiberglass as the sheet pile sections.

CP recommends that the caps be painted due to the direct UV exposure. Failure to paint the caps will result in fading, loss of gloss and potential fiber blooming over time.

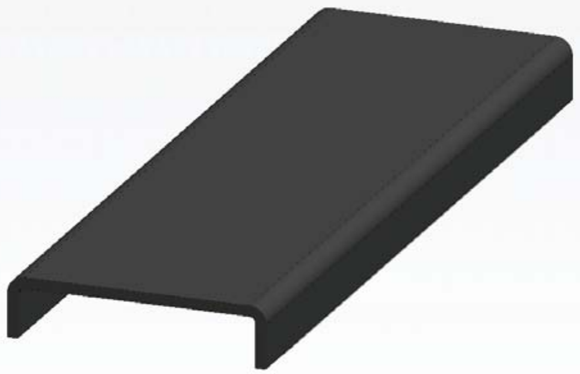
The caps should be secured to the sheet pile sections with stainless steel self drilling screws.

The Engineer of Record (EOR) is encouraged to investigate the uplift forces due to wave action, if present, prior to establishing the connection intervals. In some situations caps are not recommended due to excessive uplift caused by waves.

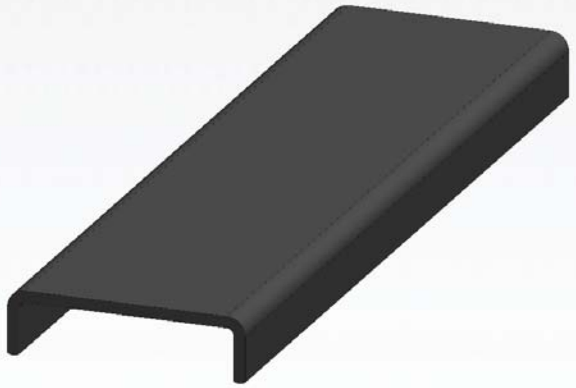
Sheet pile connectors are available for each sheet pile section for making 45° and 90° wall alignments. The 1580 sheet pile connector will permit 45°/90° and 180° connections.

art drawings for the accessories can be viewed at **http://www.assetint.co.uk.**

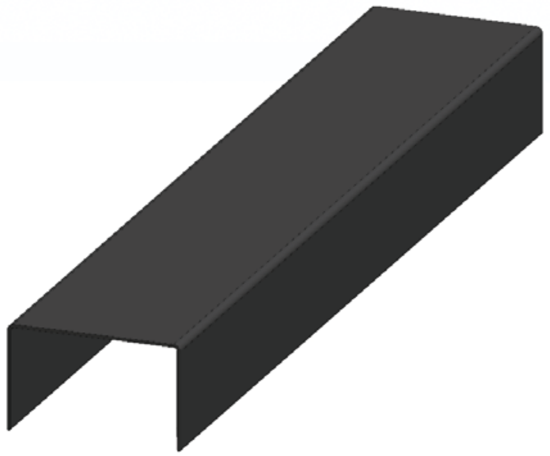
TOP CAPS:



Fits Series 1610 (CH995)



Fits Series 1580 (CH980)



Fits Series 1560 (SS051)

CONNECTORS:

45°/90°

Fits Series 1610 (SS821)

45°/90°/180°
Made of PVC

Fits Series 1580 (PVC001)

90°/180°

45°/90°

Fits Series 1560 (SS804)

Note: Consult a professional engineer when concerns of wave loads are involved.

SUPERLOC™ SPECIFICATION

The EOR should specify FRP sheet piling based on the latest standards and codes within the pultrusion industry. The proper specifications will protect the owner, EOR and the manufacturer. The specifications will effectively communicate the manufacturing and material property expectations to all involved.

CPI strongly recommends that the specification mandate that all material properties be characterized per ASTM D7290-06.

The minimum moment, shear and Modulus of Elasticity (MOE) should be specified based on the requirements of your project.

CPI strongly encourages the EOR to scrutinize the safety factors and methods used for determining the moment capacities that have been published by FRP sheet pile manufacturers.

Part drawings can be viewed at
http://www.assetint.co.uk.

1.0 SCOPE

This specification applies to the mechanical, physical and visual requirements of FRP sheetpiling.

2.0 MECHANICAL PROPERTIES

2.1 The mechanical design properties shall be published as a characteristic value per the requirements of ASTM D7290-06.

2.2 The lengthwise and transverse tensile modulus and strength shall be determined by testing per ASTM D638.

2.3 The lengthwise and transverse compression modulus and strength shall be determined by testing per ASTM D6641.

2.4 The in-plane shear strength and modulus shall be determined by testing per ASTM D5379.

2.5 The fiber reinforcements shall meet the minimum tensile strength of 290 ksi per ASTM D2343.

3.0 VISUAL REQUIREMENTS

3.1 Visual requirements shall be as prescribed in ASTM D4385.

3.2 Sheetpile sections shall contain UV light absorbers and stabilizers and a 3 mil polyester or nylon veil that encapsulates the glass fibers to diminish the possibility of fiber blooming.

4.0 DIMENSIONAL REQUIREMENTS

4.1 Per ASTM D3917.

5.0 QUALITY ASSURANCE

5.1 Quality Assurance shall be performed as described in the manufacturer's quality plan as approved by the EOR.

Signs of Abrasion and Mushrooming Due to Clamp Pressure

INSTALLATION OF SUPERLOC™ SHEETING AND ACCESSORIES

SuperLoc™ sheet piles are commonly installed with vibratory driver/extractors. The most common vibratory hammer, used by contractors, to drive the SuperLoc™ sheet pile sheets is the American Pile Driving Equipment (APE) model 6 which has a drive force capacity of 4 tons (37 kN).

Specifications	Data
Ecentric Moment	60 in-lbs (.69 kgm)
Drive Force	4 tons (37 kN)
Frequency Maximum (VPM)	0 - 2,200 vpm
Max Line Pull	6 tons (53 kN)
Bare Hammer Weight w/o Clamp	720 lbs (327 kg)
Throat Width	6.00 in (15 cm)
Length	36.25 in (92 cm)
Height w/o Clamp	38.00 in (97 cm)

SuperLoc™ sheet pile sections can be driven to elevation in clean sands and clay that exhibit a blow count N of 20 blows or less per foot as determined by the Standard Penetration Test (SPT). SuperLoc™ sheets have been driven in soils with blow counts ranging from 20 to 30 with the aid of excavation and or a steel mandrel. The steel mandrel is fabricated to mimic the profile shape of the sheet. The steel mandrel is driven into the soils ahead of the FRP sheets to punch a profile through the stiff soil prior to driving the FRP sheet.

Depending on the drive ability and the hammer type, it is not uncommon for the sheet pile to display some signs of abrasion and mushrooming at the top due to the clamp pressure and vibration of the vibratory hammer. Most contractors will add some length of sheet and cut the sheets to grade after they have been installed.

Vibratory Hammer Installation Example

EXTEND THE LIFE OF YOUR BULKHEAD BY SPECIFYING SUPERWALE™

Marina Installation
Wilmington, North Carolina

SUPERWALE™ WALE SECTION

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, Ø, 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.

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)

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)
Angle of the web	4.9 in^2 (3,160 mm^2)
Standard Color	Graphite Gray

SUPERWALE™ ACCESSORIES

Part drawings can be viewed at http://www.assetint.co.uk.

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 (82x152x19) in(mm) Hole diameter 1.125 (28.58) in(mm)	8.35 lbs. (3.79 kg)

Example of Wale Installation

CUTTING AND DRILLING INSTRUCTIONS

CUTTING SHEETS, WALES AND ACCESSORIES

SuperLoc™ can be field cut with a concrete, skill or reciprocating saw. An abrasive blade should always be used. Concrete saws work the best and can be utilized with a standard concrete cutting blade.

During drill and sawing operations, dust will be emitted. The dust is considered a nuisance dust, which can irritate your eyes and skin. Therefore, safety glasses, gloves and long sleeve shirts are recommended during the cutting and drilling process.

As documented by OSHA, FRP dust millings have potential to cause eye, skin, and upper respiratory tract irritation.

- Cause - mechanical-irritant properties of the glass fibers.
- FRP particulate is non-hazardous.
- FRP particulate is greater than 6 microns; therefore, it cannot reach the alveoli.
- The International Agency for Research on Cancer (IARC)classified FRP particulate as non-cancer causing in June of 1987.

Example of a Concrete Saw

DRILLING SHEETS, WALES AND ACCESSORIES

SuperLoc™ and its accessories can be drilled with carbide tipped drill bits. CPI recommends B & A Manufacturing Company (http://www.bamanufacturing.com) FGH series fiberglass hollow pole drill bits for applications that require multiple holes in a short period of time. Many contractors and utilities have had success when utilizing the FGH series drill bits. The bits will save time and drill thousands of holes before needing to be replaced.

FGH Series Fiberglass Pile Driving Bit

NOTES: