



STORMSTRONG® LEGACY DOCK PILES

# FRP Dock Piles Designed Specifically for the Harsh Marine Environment



ENGINEERED TO STAND THE TEST OF TIME



## GREEN ALTERNATIVE

- **NON-POLLUTING**

Meets the New Jersey pile requirements pertaining to non-polluting.

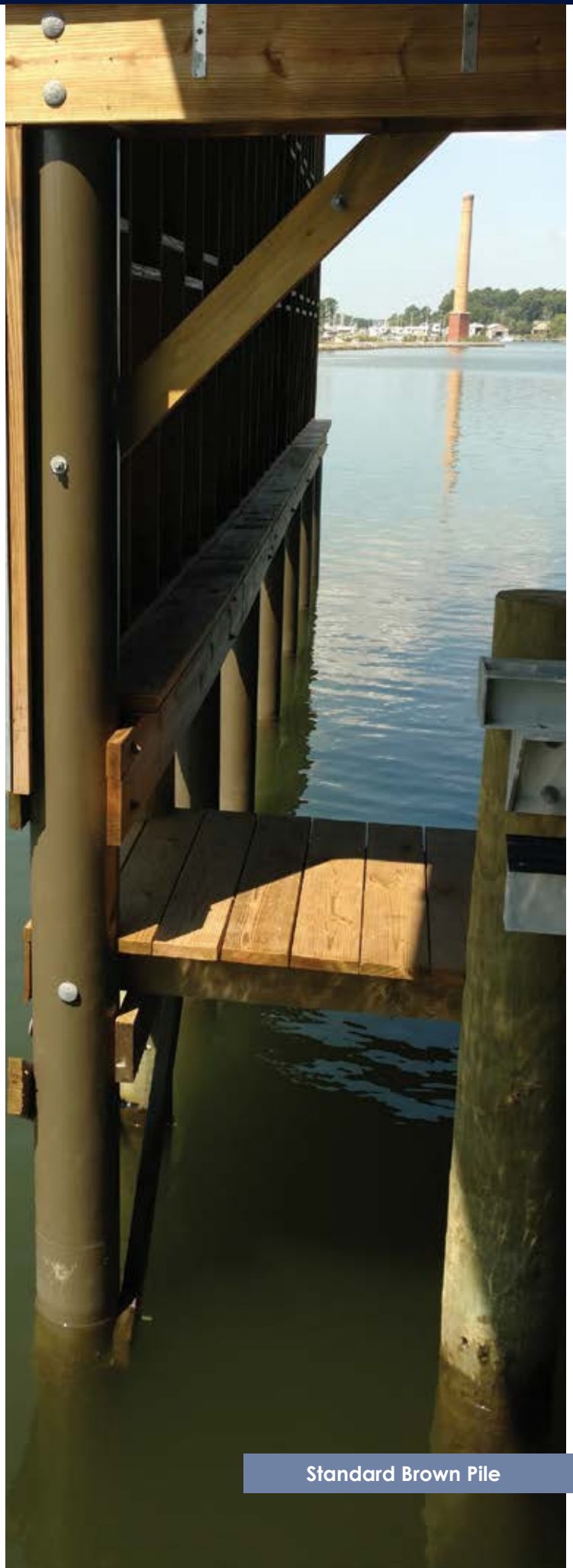
StormStrong Legacy Dock Pile is a fiber reinforced polymer (FRP) pile that has been specifically designed for the dock pile market. The 10" x 3/8" round pile is manufactured with a thermoset resin and an optimal UV protection package.

CCG's clients prefer the StormStrong Legacy Dock Pile for its exceptional strength and stiffness attributes, coupled with the fact that the piles will not rot, decay, or succumb to marine borers.

Our piles are projected to last 80+ years. If you are designing your dock structure to withstand the test of time, StormStrong Legacy Dock Pile is the right choice.

The StormStrong Legacy Dock Pile is an ideal substitute for treated yellow pine and greenheart wood piles.

If you are concerned about the environment and want your dock structure to stand up to storms and deterioration, then StormStrong Legacy Dock Pile is the right choice.



Standard Brown Pile

## PILE CAP OPTIONS

The StormStrong Legacy Dock Pile can be capped with a standard polyethylene pile cap that is either flat or cone shaped. For dock applications that require a more robust cap for lighting or other attachments, CCG recommends the HDPE structural flat cap or the fiber reinforced polymer cap. Consult CCG's staff for recommendations for your project.

## SLEEVE OPTIONS

CCG recommends that a wear sleeve, made of HDPE, be utilized for dock piles that are going to be susceptible to severe vessel abrasion. The thin walled sleeve can be applied at the plant or on the job site. Simply slide the sleeve over the pile and attach with 316 stainless steel 1/4" self drilling screws with washers positioned only near the top of the sleeve on each quadrant. The sleeves are available in light gray, beige, and white colors.

## UV PROTECTION

The exposed section of the StormStrong Legacy Dock Pile will arrive coated with a UV protection coating that meets the mechanical requirements set forth in the American Architectural Manufacturers Association (AAMA) 623 standard. Coating options, such as polyurea are available upon request.



Standard Color: Light Gray

## DOCK CONSTRUCTION OPTIONS

The StormStrong Legacy Dock Pile can be integrated into your project as a hybrid solution where the FRP pile is in the water and splash zone with wood used above. The renderings depict typical connection, framing and decking details. Naturally, the details will be dependent upon the wind and wave loadings specific for your geographical area.



Typical Dock Connection



FRP Shear washer that is to be sandwiched between the wood or FRP braces and stringers and used as a washer on the backside of the connection.



Available in Light Gray, Brown, Black and Beige (minimum quantities apply)

## DOCK PILES

### BENT CAPACITY LOAD CHARTS - BASED ON PILE MOMENT CAPACITY

#### Single Pile - Lateral Load Capacity of the Bent

Top of Pile to Point of Fixity, ft.	Allowable lateral load, lbf*	Lateral Load Producing the Exposure to Deflection (L/D) Ratio, lbf		
		120	240	360
5	11,523	5,763	2,881	1,921
6	9,603	4,002	2,001	1,334
7	8,231	2,940	1,470	980
8	7,202	2,251	1,126	750
9	6,402	1,779	889	593
10	5,762	1,441	720	480

\* Allowable loads include Safety Factor of 2.5



#### Two Piles (No Braces) - Lateral Load Capacity of the Bent

Top of Pile to Point of Fixity, ft.	Allowable lateral load, lbf*	Lateral Load Producing the Exposure to Deflection (L/D) Ratio, lbf		
		120	240	360
5	23,047	11,525	5,763	3,842
6	19,205	8,004	4,002	2,668
7	16,462	5,880	2,940	1,960
8	14,404	4,502	2,251	1,501
9	12,804	3,557	1,779	1,186
10	11,523	2,881	1,441	960
11	10,476	2,381	1,191	794
12	9,603	2,001	1,000	667
13	8,864	1,705	852	568
14	8,231	1,470	735	490
15	7,682	1,281	640	427

\* Allowable loads include Safety Factor of 2.5  
Capacity based on pile moment and shear strengths only.



## DOCK PILES

### BENT CAPACITY LOAD CHARTS - BASED ON PILE MOMENT CAPACITY

#### Two Piles with X-Bracing<sup>1,2</sup> - Lateral Load Capacity of the Bent

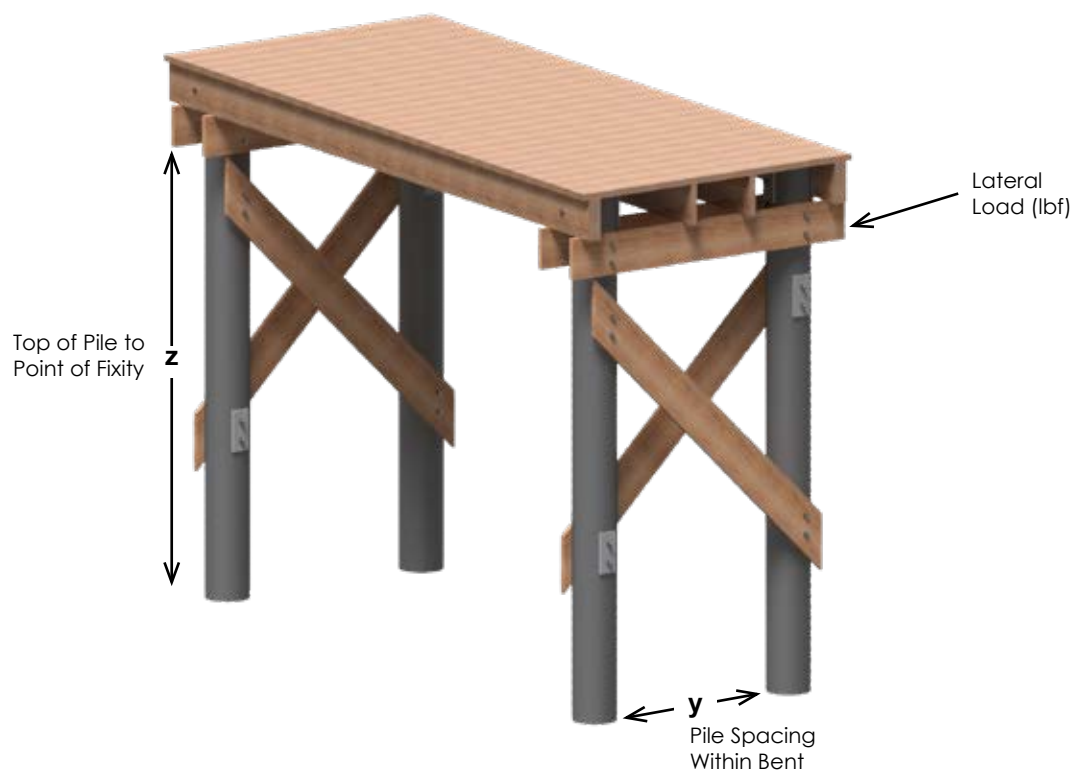
Top of Pile to Point of Fixity, ft. (z)	Pile Spacing, Within Bent, ft. (y)	Allowable lateral load, lbf <sup>3</sup>	Lateral Load Producing the Exposure to Deflection (L/D) Ratio, lbf		
			120	240	360
10	4	38,411	22,016	11,008	7,339
10	8	42,889	-	28,957	19,305
12	4	28,808	12,398	6,199	4,133
12	8	42,889	-	22,235	14,823
14	4	23,047	7,715	3,857	2,572
14	8	38,411	26,236	13,118	8,745
14	12	42,889	-	27,771	18,514
16	4	19,205	5,198	2,599	1,733
16	8	28,808	15,278	7,639	5,093
16	12	42,889	-	22,907	15,271
18	4	16,462	3,718	1,859	1,239
18	8	23,047	9,503	4,752	3,168
18	12	38,411	29,363	14,682	9,788
20	4	14,404	2,783	1,391	928
20	8	19,205	6,334	3,167	2,111
20	12	28,808	17,752	8,876	5,917

<sup>1</sup> X-Bracing assumed 2" x 10" Southern Yellow Pine Timber on 45-degree angle.

<sup>2</sup> Load assumed equal in tension and compression brace members.

<sup>3</sup> Allowable loads include Safety Factor of 2.5

<sup>4</sup> Capacities based on pile moment and shear capacities only. Wood strength shall be evaluated based on species and grade. Connections must be evaluated using other tables within this brochure.



## MECHANICAL & PHYSICAL PROPERTIES

Mechanical Properties	Round FRP Pipe Pile TU440 Polyester 10"x3/8" (254mm x 9.52m)	
Average Flexural Strength per ASTM D1036 psi (Mpa)	65,722	(453)
Average Compression Strength per ASTM D1036 psi (Mpa)	65,722	(453)
Average In-Plane Shear Strength psi (Mpa)	10,792	(74)
Characteristic In-Plane Shear Strength psi (Mpa)	9,456	(65)
Average Shear Capacity lbs (Kg)	61,185	(27,753)
Characteristic Shear Capacity lbs (Kg)	53,611	(24,317)
Average Torque Strength lb-ft (kN•m)	49,076	(67)
Characteristic Torque Strength lb-ft (kN•m)	43,001	(58)
Average Axial Compression Strength psi (Mpa)	65,722	(453)
Average Axial Compression Capacity (Short Column) lb (kg)	745,222	(338,027)
Average Modulus of Elasticity per ASTM D638 psi (Gpa)	6.31E+06	(43.5)
Bending Stiffness (EI) lbs•in <sup>2</sup> (kg•mm <sup>2</sup> )	8.30E+08	(2.43E+11)
Average Moment Capacity per ASTM D1036 kip-ft (kN•m)	144	(195)
Average Pin Bearing Strength Crosswise psi (Mpa)	19,155 <sup>1</sup>	(132) <sup>1</sup>
Characteristic Pin Bearing Strength Crosswise psi (Mpa)	16,577 <sup>1</sup>	(114) <sup>1</sup>
Average Pin Bearing Strength Lengthwise psi (Mpa)	31,824 <sup>1</sup>	(219) <sup>1</sup>
Characteristic Pin Bearing Strength Lengthwise psi (Mpa)	27,755 <sup>1</sup>	(191) <sup>1</sup>
Average Washer Pull Through Strength lb (kg) using a 6"x3/8" square/radius washer	17,377	(7,882)
Characteristic Washer Pull Through Strength lb (kg) using a 6"x3/8" square/radius washer	14,812	(6,719)
Allowable torque permitted on a bolted connection with a 6" radius washer lb-ft (N•m)	50	(68)

### Notes:

- Capacity based on testing conducted with 3/4" hardware for the TU440.

Physical Properties	Round FRP Pipe Pile TU440 Polyester 10"x3/8" (254mm x 9.52mm)	
Diameter in (cm)	10	(25.4)
Wall thickness in (mm)	0.375	(9.5)
Moment of Inertia in <sup>4</sup> (cm <sup>4</sup> )	131.51	(5,474)
Section Modulus in <sup>3</sup> (cm <sup>3</sup> )	26.3	(431)
Radius of Gyration in (mm)	3.41	(87)
Weight lb/ft (Kg/m)	10.3	(15.3)
Coefficient of Thermal Expansion (CTE) Lengthwise in/in/°F (mm/mm/°C)	5.00E-06	(9.00E-06)
Water Absorption ASTM D570	1.0% (24hrs)	1.0% (24hrs)
Fiber Volume Fraction %	≥50%	≥50%
Cross Sectional Area in <sup>2</sup> (cm <sup>2</sup> )	11.3	(72.9)
Surface Area ft <sup>2</sup> /ft (m <sup>2</sup> /m)	2.62	(0.80)



Marginal Dock  
Delray Beach, Florida

## COLUMN LOAD CHARTS

10" x 3/8" Round Pipe TU440 Pile Ultimate Column Capacity			
Column Length (ft)	KL/r	Column Load (lbf)	Column Load (kg)
2	7.0	661,949	300,255
4	14.1	650,587	295,101
6	21.1	639,226	289,948
8	28.2	887,924	402,756
10	35.2	568,271	257,764
12	42.2	394,633	179,002
14	49.3	289,934	131,512
16	56.3	221,981	100,689
18	63.3	175,392	79,557
20	70.4	142,068	64,441
22	77.4	117,411	53,257
24	84.5	98,658	44,751
26	91.5	84,064	38,131
28	98.5	72,484	32,878
30	105.6	63,141	28,640
32	112.6	55,495	25,172

Notes: CCG recommends a 3x S.F. be applied to the ultimate capacities noted in the chart.  
 Effective length coefficient  $K=1$ , pinned-pinned end conditions  
 Capacity may be dictated by the connection capacity details

## FRP SHEAR WASHERS (SS815)

FRP shear washers should be used at all connections. The FRP shear washer distributes bolted connection compression forces over an area of the pile, as opposed to the tangential loading without the washer. The FRP shear washers can be bonded to the pile for increased bearing capacity. Bonding of the FRP shear washers to the pile should be performed using the following procedure.

1. Abrade both the pile and washer using a 100-grit sandpaper. All gloss must be removed from the pile surface.
2. Clean the sanded areas using isopropyl alcohol-soaked cloths.
3. Apply the adhesive to one of the bonding surfaces. All load capacities presented within this document used Simpson Strong Tie Set 3G Epoxy adhesive.
4. Use a putty knife or body filler scraper to spread the adhesive to a uniform thickness over the entire bonding area.
5. Self-drilling screws should be installed to hold the FRP washer in position while the adhesive cures.
6. Holes for the dock joint should be drilled after the washer is bonded to the pile to ensure the bearing surfaces of the holes are aligned.

FRP shear washers are produced and stocked in 10 ft. lengths. Therefore, washers can be supplied in custom lengths to provide full support of the adjoining member.

## DOCK PILES

### BOLTED CONNECTION CAPACITY CHARTS

#### Characteristic Strengths of Bolted Connections, lb (kg)

10" x 3/8" Round Dock Pile (TU440)	Single 5/8" Bolt	Two 5/8" Bolts	Single 3/4" Bolt	Two 3/4" Bolts	Single 1" Bolt	Two 1" Bolts
Force applied parallel to pile axis	6,505 (2,951)	13,010 (5,901)	7,806 (3,541)	15,612 (7,082)	10,408 (4,721)	20,816 (9,442)
Force applied perpendicular to pile axis	3,885 (1,762)	7,770 (3,525)	4,662 (2,115)	9,325 (4,230)	6,216 (2,820)	12,433 (5,639)

Notes:

All bolt loads based on single shear loading.  
Data published per ASTM D7290.

#### Characteristic Strengths of Bolted Connections with Bonded Washer Plate, lb (kg)

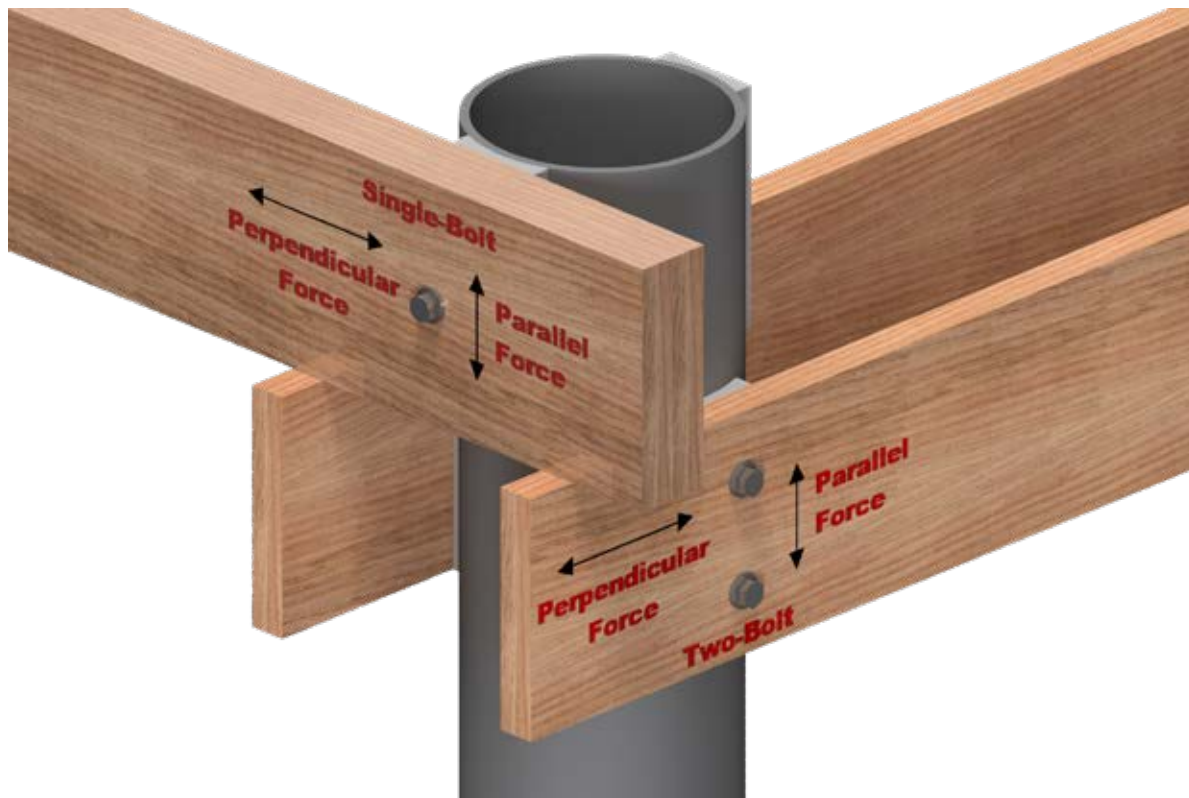
10" x 3/8" Round Dock Pile (TU440)	Single 5/8" Bolt	Two 5/8" Bolts	Single 3/4" Bolt	Two 3/4" Bolts	Single 1" Bolt	Two 1" Bolts
Force applied parallel to pile axis	11,673 (5,295)	23,345 (10,589)	14,007 (6,354)	28,014 (12,707)	18,676 (8,471)	37,352 (16,943)
Force applied at 45-degrees to pile axis	9,580 (4,345)	19,160 (8,691)	11,496 (5,214)	22,992 (10,429)	15,328 (6,953)	30,656 (13,905)
Force applied perpendicular to pile axis	8,547 (3,877)	17,094 (7,754)	10,257 (4,652)	20,513 (9,305)	13,676 (6,203)	27,351 (12,406)

Notes:

All bolt loads based on single shear loading.  
Data published per ASTM D7290.

Adhesive utilized in connection SET-3G by Simpson Strong-Tie.

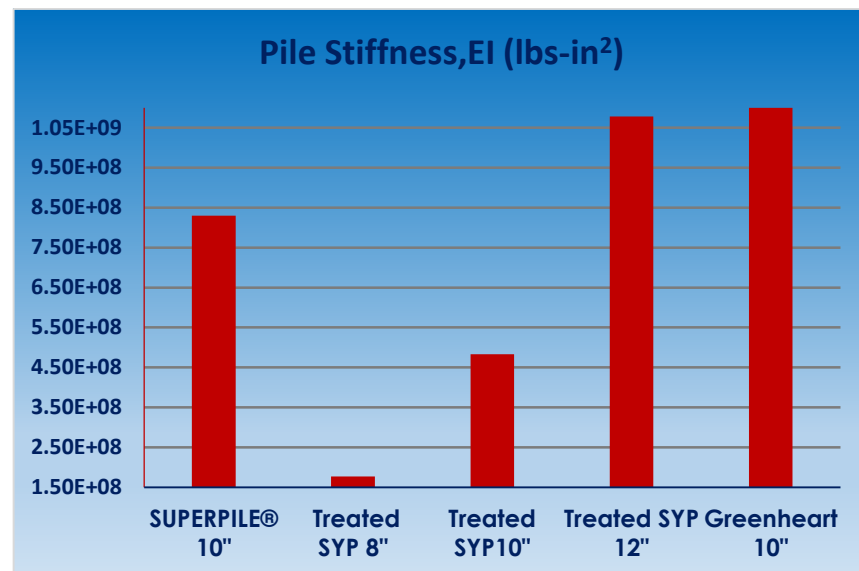
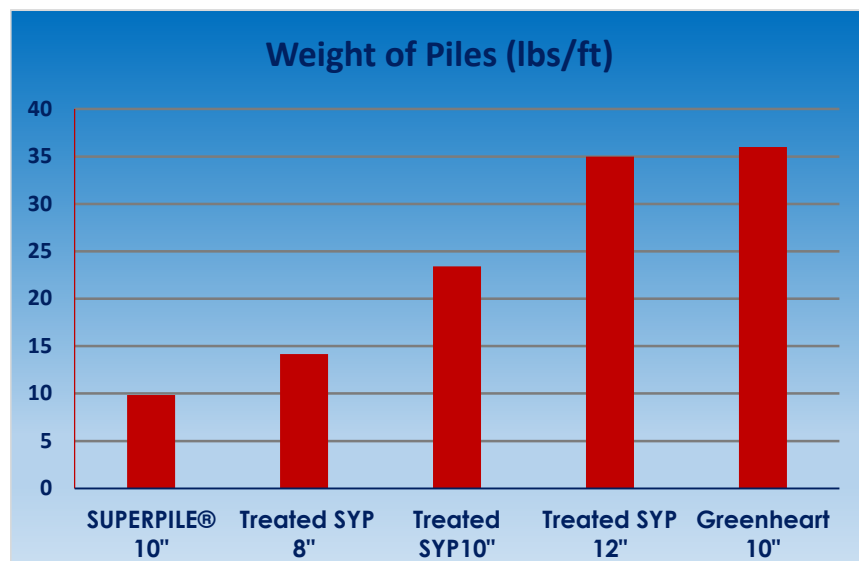
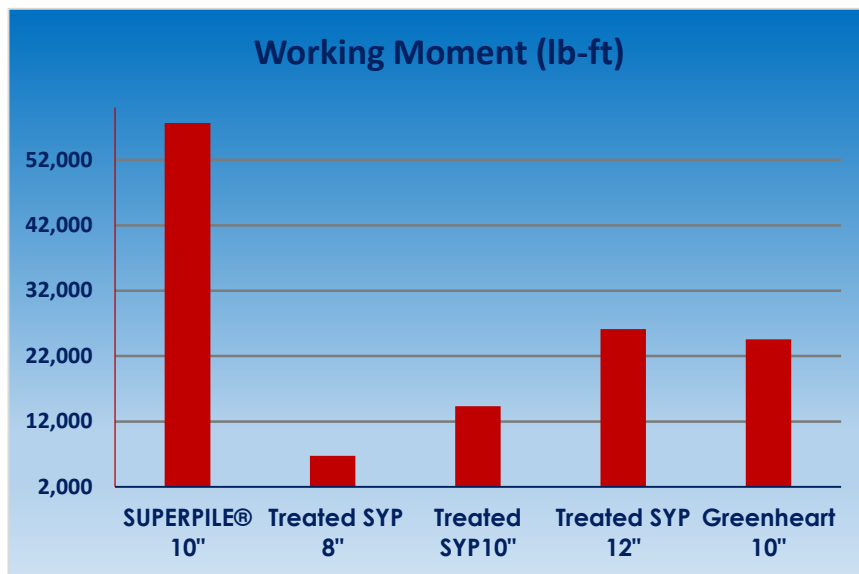
Timber capacity should be evaluated by others, based on wood species and treatment method.



Typical Dock Connection



## WOOD VS. STORMSTRONG COMPARISON



## INSTALLATION METHODS

StormStrong Legacy Dock Piles can be efficiently driven with a vibratory hammer. When utilizing a vibratory hammer, an adaptor shall be fabricated to connect the pile to the vibratory hammer. The adaptor shall include an interior steel pipe that fits into the pile to guide it. The interior tube should be between 0.5" to 2" less than the interior diameter of the FRP pile. The interior pipe shall be welded onto a flat steel plate. The steel plate will apply the compression force into the top of the pile. The steel plate shall be connected to a beam that can be clamped by the vibratory hammer.

The contractor is cautioned that, on some occasions, the pile may require an FRP insert for added compression or pin bearing strength. Therefore, the interior diameter of the pile will change. The contractor should base the vibratory adaptor fabrication on the approved job drawings.

In the event a pile needs to be pulled, a vibratory hammer can be utilized to pull the piles. Through bolt the pile and the drive head with three 1" diameter bolts spaced a minimum of 5" apart. Vibrate the pile and pull tension until the pile begins to move. Once the friction has broken, pull the pile without the vibratory hammer engaged. The vibratory hammer oscillation will cause the bolt holes to elongate if engaged for an extended period-of-time.

Diesel and air impact hammers have been successfully utilized to drive the 10" diameter StormStrong Legacy Dock Pile. A pipe insert driving head or steel pipe cap is required for driving the hollow FRP piles. It is important that the piles are impacted so that the driving force is dissipated over the cross section of the top of the pile. A plywood or composite material pile cushion is recommended to reduce driving stresses.



Statue of Liberty Dock Rehabilitation  
Liberty Island, New York



# STORMSTRONG LEGACY DOCK PILE SPECIFICATION

This specification is intended to define pultruded FRP pipe piles for procurement purposes.

## 1.0 SCOPE

- 1.1 This specification applies to the material requirements, the manufacture and performance of fiber reinforced polymer piles.
- 1.2 The mechanical properties shall be published based on a 95% confidence level.

## 2.0 MATERIAL DESIGN

- 2.1 The pultruded pipe pile shall be manufactured by the pultrusion process using a polymer binder containing a minimum 58% "E-CR" or "E" fiberglass by volume. Glass volume shall be 49% in the lengthwise direction and 11% in the crosswise direction.
- 2.2 E-glass reinforcements shall meet a minimum tensile strength of 290 ksi per ASTM D2343.
- 2.3 Pipe dock piles shall be pultruded with a high-performance thermoset resin.
- 2.4 The piles shall contain Ultra Violet (UV) protection as a long-term light stability promoter. Second, the fiberglass piles shall be encompassed with a 10 mil polyester surfacing veil. The 10 mil veil shall create a resin rich surface and protect the glass reinforcements from fiber blooming.

## 3.0 STRENGTH & STIFFNESS PROPERTIES

- 3.1 The dock pipe pile strength and stiffness values shall be derived per ASTM D1036 and shall be the minimum mechanical and physical properties. Reference Mechanical and Physical Properties Section on pages 7 and 8.

## 4.0 FINISH

- 4.1 The surface of the pile shall contain a UV resistant, resin rich, smooth and aesthetically pleasing finish uniform along the entire pile length. The piles shall be manufactured and visually inspected in accordance with ASTM D4385.
- 4.2 Dock piles shall contain a third layer of UV protection in the form of a HDPE sleeve or high -performance coating meeting the minimum requirements of the American Architecture Manufactures Association (AAMA) specification 623.

## 5.0 MANUFACTURING TOLERANCES

- 5.1 Pile Length ( $\pm 2''$ ) or 50 mm
  - 5.1.1 Squareness of end cut ( $1/4''$ ) or 6.35 mm.
  - 5.1.2 Pile profile dimensions per ASTM D 3917.
  - 5.1.3 Straightness: 0.030"/ft. (2.5mm/m) with weight minimizing.
  - 5.1.4 Weight: +/- 10%.

## 6.0 SHIPPING

- 6.1 Crated piles shall be individually protected in cardboard or equivalent protective material in areas in which dunnage makes contact with piles.
- 6.2 Piles shall be crated in bundles for ease of handling and transfer without damage to the piles by lift equipment.

## 7.0 QUALITY ASSURANCE

- 7.1 Quality Assurance shall be performed as described in the organizations quality plan, as approved by the Engineer of Record.

# Choose Creative Composites Group for Comprehensive Project Support

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CCG can help you engineer and manufacture waterfront infrastructure projects to meet the needs of future generations.

Other companies commoditize FRP in off-the-shelf shapes and forms; Creative Composites Group does not. We offer comprehensive engineering, design and consultation for shoreline and asset protection. Our manufacturing capabilities include the broadest range of engineered FRP solutions to build your ideal projects. That's possible only with our proven engineering processes, end-to-end collaboration, service and support resources. Since FRP composites last longer than conventional materials they often have a lower lifetime cost when you consider longer service life and low to no maintenance costs.

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*Contact us for your next engineered FRP dock pile or waterfront infrastructure project. We'd be thrilled to discuss it with you.*

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### **Creative Composites Group**

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