FIBERPILE™ LARGE DIAMETER PIPE PILES

CREATIVE COMPOSITES GROUP

FRP piling for pier protection and guide wall systems

FiberPILE is manufactured using proven technology and materials that have been in service for decades in demanding applications. The FiberPILE is constructed using high strength, directional fiberglass and resin, formulated to withstand the most corrosive environments. The combination of these materials results in a maintenance-free piling product that is ideal for protecting structures from barge and ship impacts.

FiberPILES offer the strength of steel, but lower bending stiffness (EI), which allows for greater energy absorption than traditional materials. Unlike rigid concrete and steel fender systems, the FRP system is designed to deflect and then recover, without damaging either the vessel or the fender.

FiberPILE can be driven with conventional equipment, including both impact and vibratory hammers. Standard diameters range from 18 inch to 48 inch and can be fabricated in continuous lengths up to 110 feet. FiberPILES have a design modulus of 5.7 msi and an ultimate strength of 55 ksi. This results in substantially more energy absorption than a traditional steel system. This is because the system can deflect more than a traditional steel system, thus allowing more piles to absorb the load.

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OWNER BENEFITS

- Superior Energy Absorption
- High Strength
- No Maintenance
- Project Cost Savings
- Low Environmental Impact
- Low Sound Pressure

CONTRACTOR BENEFITS

- Ability to Splice
- Hollow Construction
- Lightweight
- Low Driving Friction
- Easy to Drill and Cut

ACCESSORIES

- Pile caps for a solid surface lid.
- HDPE sleeves for added wear protection in the vessel strike zone.
- Factory installed pile splices for low overhead clearance applications.

Design

FiberPILES can be engineered to a wide range of diameters and thicknesses to fulfill the requirements of any application. Piles are manufactured using a proven vacuum infusion process that guarantees consistent results. Vacuum infusion is highly controllable, as only three variables affect the resin flow: the permeability of the laminate, the pressure differential in the cavity in relation to atmospheric pressure; and the viscosity of the resin. Our closed molding method results in a high fiber-to-resin ratio that is stronger and lighter than products manufactured using other molding methods.

FiberPILE Design Properties

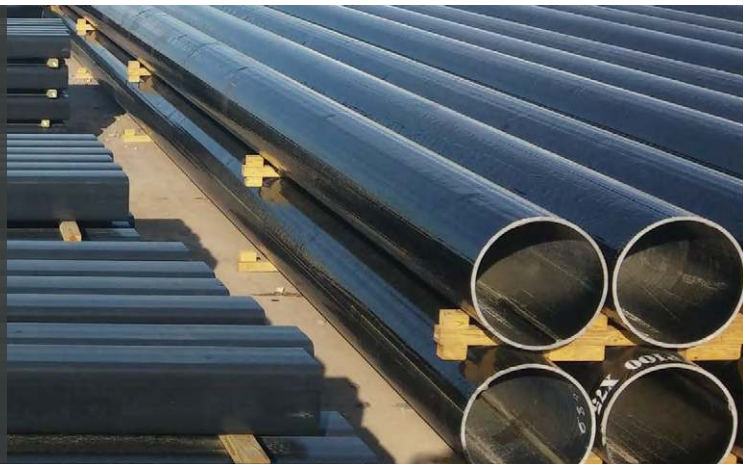
Model Number	Outside Diameter (in)	Wall Thickness (in)	Weight (lbs/ ft)	Ultimate Moment Capacity (ft. kip)[1] (ASTM D6109)	Bending Stiffness (EI) (lbs-in^2)[1] (ASTM D6109)	Ultimate Shear Capacity (kip)[1](ASTM D732)
18FP050	18	1/2	24.4	567	6.00E+09	287
18FP062	18	5/8	30.3	693	7.35E+09	354
18FP075	18	3/4	36.1	815	8.63E+09	419
18FP100	18	1	47.4	1,041	1.10E+10	544
24FP075	24	3/4	48.6	1,495	2.11E+10	571
24FP100	24	1	64.2	1,931	2.73E+10	745
24FP112	24	1-1/8	71.8	2,139	3.02E+10	830
24FP125	24	1-1/4	79.3	2,339	3.30E+10	913
24FP150	24	1-1/2	94.2	2,719	3.84E+10	1,073
30FP100	30	1	80.9	3,095	5.47E+10	947
30FP125	30	1-1/4	100.3	3,772	6.66E+10	1,165
30FP150	30	1-1/2	119.3	4,413	7.79E+10	1,374
36FP125	36	1-1/4	121.2	5,548	1.18E+11	1,417
36FP150	36	1-1/2	144.4	6,518	1.38E+11	1,677
36FP175	36	1-3/4	167.2	7,446	1.58E+11	1,930
42FP150	42	1-1/2	169.5	9,034	2.23E+11	1,980
48FP150	48	1-1/2	194.6	11,960	3.38E+11	2,283

FiberPILE Physical Properties

Property	Value
Allowable Pin Bearing Capacity (ksi)[1]	15
Coefficient of Thermal Expansion (CTE) (in/in/°F)	6.10E-06
Fiber Volume Fraction (%)	54%
Sound Pressure-10m (dB)[2]	160
Sound Pressure-20m (dB)[2]	147
Max Axial Compression (ksi)	10

Tolerances

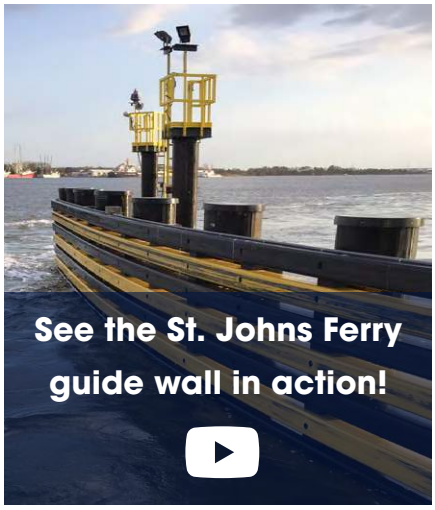
- Length +6” / -0”
- OD - +3/4” / - 3/4”
- Wall Thickness - +3/16” / - 3/16”
- Weight - +/-10%
- Fiber Volume % - 54% +/- 5%



Energy Absorption

One of the key benefits of FRP composite piles is their ability to absorb impact energy. The flexibility of FiberPILES and an accompanying fender wall system allows them to bend under vessel contact and then return to their original shape without breakage or damage.

For applications where higher stiffness is needed to protect piers or waterfront structures, FiberWALES can be implemented. FiberWALES have a higher stiffness than plastic lumber and distribute the force of impact to more pilings in a system. The product was developed for fender geometries that require the wales be formed to a tight radius, which can be important in narrow channels or areas where many structures are in close proximity.



Shipping

Shipping and Storage

The FiberPILES are shipped directly to the job site or laydown yard using flatbed trailers. The piles can be shipped in lengths up to 110' using stretch trailers. The number of piles loaded on each trailer depends on the FiberPILE diameter and weight.

The piles should be stored off of the ground on supports that will not yield to their weight. The FiberPILES are typically shipped on cribbing that is made from 4x4 dunnage. This dunnage can be re-used for storing the FiberPILES. For long term storage, the dunnage should be placed a maximum of 30' apart and no further than 10' from the ends of the piles. We do not recommend storing the FiberPILES more than 2 rows high.

The piles should be stored in a flat area where they will not be prone to rolling. Composite Advantage recommends using blocking to ensure the FiberPILES do not shift or move while in storage (The dunnage included with the pile shipment has blocking built in).

Handling

Nylon slings should be used to avoid damaging the surface of the pile. Nylon slings should be secured to the pile using a choker configuration to ensure the straps do not slip during the lift. Straps and slings need to be appropriately rated for the weight of the piles.

For movement in a storage yard or job site, it is also acceptable to tandem lift the piles with fork trucks or lulls that are utilizing nylon slings. Do not attempt to set the FiberPILES on the ground and roll them. Care should be taken not to gouge or damage the piles during handling.

Cosmetics

Upon delivery, FiberPILES should be inspected for any structural damage. Normal scuffs and scrapes from handling are normal and not a cause for concern. Because of the way FiberPILES are manufactured, there are surface imperfections on the piles. These are a normal part of the processing and do not affect the pile's structural performance.

Installation

Driving Recommendations

FiberPILE can be efficiently driven using industry standard methods, including both vibratory and impact hammers. When using vibratory hammers, a hydraulic caisson clamp can be attached directly to the pile. The clamping surface should be level in order to minimize damage at the point of contact during driving. The size of the vibratory hammer should be selected based on site-specific soil conditions along with the diameter and weight of the pile.

Variable movement hammers are ideal since they attach directly to the fiberglass wall of the pile. The maximum eccentric movement of the vibratory hammer recommended for FiberPILES is 300 ft-lbs.

FiberPILES can also be driven with either diesel or hydraulic impact hammers as necessary, depending on the site-specific soil conditions. If using impact hammers, anvil blocks are required to ensure the driving energy is distributed equally over the entire top surface of the FiberPILE.

Cutting and Drilling

FiberPILE can be field cut using most traditional concrete cutting equipment with a diamond or abrasive grit blade. With either, it is important to make sure the cut line is accurately marked to ensure a level cut. Care should be taken to wear proper PPE to keep fiberglass dust off the skin and out of the airways.

Drilling of the FiberPILES for waler connections is best done using carbide tipped drill bits. Please contact Creative Composites Group for specific bit information and recommended suppliers.

FiberPILE Testing

Pile testing consists of the three levels of testing. First is material property testing of laminates to determine the basic strength and stiffness of the material. Environmental effects such as temperature and moisture are included in this type of testing. Second level is testing of structural details. This includes bolt bearing and crushing. The top level is full scale testing of the piling. FiberPILES are loaded in four point bending configuration to determine bending moment capacity and bending stiffness.

Test Configuration

The flexure of FiberPILES has been tested in accordance with ASTM D6109. Piles were supported on a simple span with two loading points near the center of the pile to create a 4 point bending configuration. High capacity slings were used in tension to avoid problems related to slipping or rolling of hard point supports. The slings restrict the vertical movement, but allow rotation during the testing. 18FP062 pile testing was done on a 20:1 span to depth ratio and 24FP112 pile testing was done on a 14:1 span to depth ratio.

Outcome

Model Number	Ultimate Moment Capacity (ft.kip)[1] (ASTM D6109)	Bending Stiffness (EI) (lbs-in^2)[1] (ASTM D6109)
18FP062	697	8.70E+09
24FP112	2,140	3.00E+10

Acoustic Testing

The results of hydro-acoustic monitoring during installation of the 30 inch diameter composite pipe piles at the James River, Virginia with a vibratory hammer indicate that very low peak sound pressure levels are generated. Review of the event reports indicate that the peak sound pressure levels recorded during installation with the vibratory hammer were so low that they were not distinguishable from the sound pressure levels attributed to the background construction activities such as operation of a generator for the barge cabin, operation of the crane, and normal everyday impacts on the barge (i.e. dropping of shackles).

At a distance of 10 meters from the pile installation, a peak sound pressure level of 160 dB was recorded. At a distance of 20 meters, a peak sound pressure level of 147 dB was recorded, which did not exceed the background sound pressure levels generated from construction activities. In coordination with the Federal Highway Association (FHWA), the California Department of Transportation has established the California Fisheries Working Group (FWGP) to develop guidelines for hydro-acoustic impacts of pile driving activities.

The FWGP established an interim criteria for impact hammers in 2008, where a threshold peak sound pressure level of 206 dB is recommended for injury to all fish. The recorded maximum peak sound pressure level of 160 dB at a distance of 10 meters from the pile, is significantly lower than the FWGP threshold.

The FWGP further established a threshold "Sound Exposure Level – Accumulated" of 187 dB for all fish except those less than 2 grams, for which the threshold "Sound Exposure Level – Accumulated" is 183 dB. Due to the fact that sound pressure levels were so low with vibratory installation of the composite piles, reliable waveform data from which "Sound Exposure Levels – Accumulated" could be calculated was not obtained during this study. This study clearly established that injury to fish from composite pipe piles installation with the ICE 28D vibratory hammer in the James River is not possible, in accordance with standard practices currently specified by the FWGP and endorsed by the FHWA, for impact pile driving.

Results:

- Low peak sound pressure levels generated
- Injury to fish from the installation of the composite pipe piles with the ICE 28D vibratory hammer in James River is not possible
- Peak sound levels did not exceed the background sound pressure levels generated from construction activities
- The recorded maximum peak sound pressure level is significantly lower than the FWGP threshold

Case Study: Guide Walls

St. John's Ferry Terminal

The Jacksonville Transportation Authority (JTA) secured funding for upgrades to the St. Johns River Ferry Terminal and took over operations of the terminal in March of 2016. Aggressive currents and strong winds make berthing operations very difficult; the JTA needed energy absorbing guide walls to address these challenging conditions.

The existing steel and concrete fender wall guiding the ferry into its slip was repeatedly subjected to hard impacts. Steel and concrete are by nature very stiff, resulting in hard landings which at times damage the vessel and the guide wall, compromising passenger safety.

The JTA considered different alternatives with the primary goal of finding a low maintenance fender guide wall system that would also provide greater energy absorption. Durability, flexibility, low maintenance and corrosion resistance made FiberPILE the product of choice. The energy absorbing system reduces fender wall damage and improves comfort and safety, resulting in a more enjoyable ride for passengers. Because FiberPILE uses fewer, large diameter pipe piles than traditional systems, installation costs were reduced. The horizontal wales were composite timbers bolted to the piles to distribute impact loads. FRP channels splice the sections of timber together, and caps cover the hollow piles and become the base for navigation lights.

Project Details

Piling Count	48 (Phase 1), 40 (Phase 2)	**Installation Method**	Vibratory Hammer
Piling Diameters	24 and 36 in.	**Wale Type**	Composite Lumber
Piling Length	60 to 100 ft.	**Installation Date**	March 2016 and 2017
Piling Wall Thickness	1, 1.25, and 1.5 in.	**Owner**	JTA

Case Study: Fender Protection

Dominion Transmission Towers

Dominion Energy began creating a plan to replace the foundations and fender system of their transmission towers in the James River after inspections revealed severe deterioration. In addition to the challenges of working in a river at varying depths, planners also had to account for heavy shipping traffic and local wildlife, including active falcon nests on some towers.

Dominion chose a FiberPILE fender protection system to replace the existing steel barriers. Originally constructed in 1968, the marine-grade steel fender system had deteriorated and was in need of replacement. Two pairs of fender walls protect the foundations of the transmission towers and the parallel bridge from barge impact. 30 in. pilings in lengths of up to 100 ft. were used to support a FiberWALE system. The FiberWALE beams have a higher stiffness than composite lumber used in other applications where more flexibility and impact absorption is desired. The wale sections are spliced together using channels and then mounted to the piling to distribute impact energy across multiple piles. Installation of both the fender systems and rehabilitated foundations was completed in December of 2015.

Project Details

Piling Count	56 (for 2 fenders)	**Installation Method**	Vibratory Hammer
Piling Diameters	18 and 30 in.	**Wale Type**	FiberWALE
Piling Length	Up to 100 ft.	**Installation Date**	December 2015
Piling Wall Thickness	0.75 to 1.5 in.	**Owner**	Dominion Energy

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Your Single Source for Innovative Engineered Waterfront Solutions Using Fiber Reinforced Polymer Composites

Advance your products and projects beyond the limitations of traditional concrete, steel, and wood by leveraging the combined strength of Creative Composites Group. We are a leader in technical innovation that is backed by the industry's most comprehensive FRP manufacturing group for infrastructure.

As Creative Composites Group, we can help you engineer and manufacture waterfront infrastructure projects to meet the needs of future generations.

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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Creative Composites Group is committed to becoming a trusted business partner who is keenly interested in your project's success. Creative Composites Group works alongside your team, from owners to design engineers and contractors, to help you develop and customized FRP solution that meets the most demanding structural requirements and environmental conditions.

Contact us for your next engineered FRP pier protection, guide wall system or waterfront infrastructure project. We'd be thrilled to discuss it with you.

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