

## *Pile System* Timber Pile Strengthening System

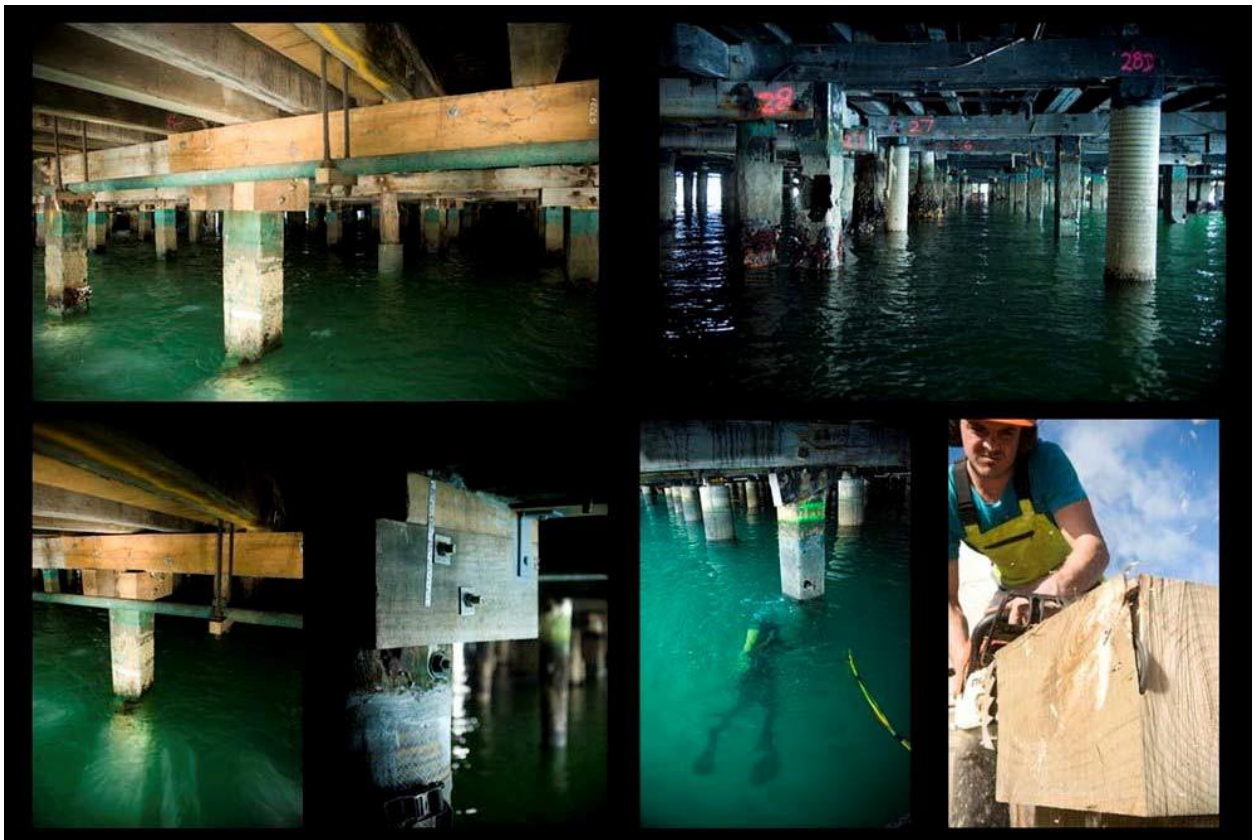
Description:

The *Pile System* utilizes pre-cured fiber reinforced composite jackets for use in repairing and strengthening damaged wood piles. The jackets are pre-formed around steel mandrels in a controlled manufacturing facility in order to obtain their designed diameter and length. Once cured the jackets are slit lengthwise to allow placement around existing circular piles.



Uses:

The *Pile System* is designed to provide flexural strength, shear strength and axial strength to existing piles. The jackets can be used to increase the capacity of existing piles or can be used to remediate damaged piles. The jackets can be designed with varying thicknesses in order to provide specific levels of engineered strength enhancement.



*Underwater Installation*

Benefits:

The preformed nature of the jackets allow placement around deteriorated and damaged piles, regardless of the level of roughness. The system can also be installed under water by means of using temporary strapping and a unique under-water curing epoxy bonding agent to “weld” the joint and provide a continuous confining action.

The pre-cured jackets are cured to their final diameter and shape, yet are flexible enough to allow “opening” around an existing pile. The overlap seam is “welded” with epoxy and allows the placement of grout or epoxy inside of the jacket in order to fill all voids caused by deterioration or rot, and provide intimate contact and transfer of forces between the existing pile and the new structural jacket.

### Unique Design Structure:

The *Pile System* is comprised of three unique fiber types oriented in a tri-axial manner. This unique design provides numerous benefits by utilizing carbon fiber, glass fiber, and aramid fiber. Each fiber is unique in terms of its material properties and structural benefits. As such, the tri-axial fabric and resulting tri-axial jacket is designed to provide various levels of strength and performance and has been specifically developed to be compatible with the material properties of timber materials.

### TRIAXIAL CONSTRUCTION



*Tri-Axial Fabric*

Glass Fiber – the main workhorse of the tri-axial fabric is the primary glass fibers which are oriented in a vertical manner, longitudinally along the axis of the pile. The glass fibers were specifically chosen because of the compatibility in terms of elastic modulus and strength with existing wood species. These vertical fibers provide a similar stiffness as wood and therefore provide a compatible level of flexural strength and axial capacity. A large cross section of glass fibers are used to provide the necessary vertical capacity while maintaining a cost effective solution.

Carbon Fiber – the fiber with the highest strength to weight ratio is used in an optimal manner in the tri-axial construction in order to minimize cost and maximize performance. The carbon fibers have a very high elastic modulus and are much stiffer than wood materials; as such the carbon is used in a spaced manner to act like confining rings or stirrups. The horizontally, or transverse, oriented fibers provide confinement to the vertical glass fibers, enabling the glass fibers to carry compressive forces along the length of the pile without being subject to buckling. In addition, the strong carbon fibers provide a level of shear enhancement to the existing piles and allow the cured jacket to be pressure injected with grout by providing confining action to the filler material.

Aramid Fiber – the unique aspect of the tri-axial construction is the ability to place fibers in a third orientation. The aramid fibers are stitched in to the fabric at a +/- 45 degree orientation, therefore providing torsional capacity and shear capacity to the pile.

### Custom Manufacturing:

Another unique aspect of tri-axial fabrics used in fiber reinforced polymer (FRP) composites is that when engineered properly that can be designed to cure with a curve. The tri-axial fabric construction developed as part of the *Pile System* is designed to develop a curve during cure so that it facilitates placement around circular piles.....enabling ease of installation, optimized performance, and exceptional strength enhancement.



### Structural Engineering Design

The *Pile System* has been utilized on numerous underwater pile repair projects. The design of the system is performed by Structural Assurance's Design Team according to design loads and design criteria provided by individual clients. The *Pile System* is designed to provide vertical load capacity, flexural strength, and shear strength as necessary to meet design loads. The final design thickness is project dependent and calculations can be provided as necessary. The *Pile System* is available in varying diameters and lengths, and can be field cut for custom installations.