

# SeaShield Marine Systems



*The SeaShield Series 400 System has been independently tested by Texas A&M University, Department of Civil Engineering, Structural and Materials Testing Laboratory.*



## Series 400

**Structural repair system that doubles the strength of the original timber pile**

SeaShield Series 400 System is comprised of the SeaShield Fiber-Form Jacket, C-GRID® 450 and SeaShield 510 UW Grout or SeaShield 550 Epoxy Grout. The Series 400 is a revolutionary encapsulation system that not only protects timber piles from aggressive saltwater environments and marine borers, but also strengthens deteriorated piles with a durable, lightweight and non-corrosive reinforcement.

### Features

- Provides double the strength of the original timber pile
- Non-corrosive reinforcement
- Reduced weight when compared to steel reinforcement
- Requires inexpensive pumping equipment
- Flowable non-shrink grout
- Manufactured to be translucent with clear gel coat
- High impact resistance
- UV resistant
- Long maintenance-free service life

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The lightweight and non-corrosive C-GRID® 450 is installed around the pile.



The SeaShield Fiber-Form jacket is then snapped in place around the C-GRID® 450.



Grout can be pumped as soon as the SeaShield Fiber-Form jacket is secured in place.

### SeaShield Series 400 System

The SeaShield Series 400 System is comprised of a SeaShield Fiber-Form Jacket, C-GRID® 450, and either SeaShield 510 UW Grout or SeaShield 550 Epoxy Grout. The complete system doubles the strength of the original timber pile.

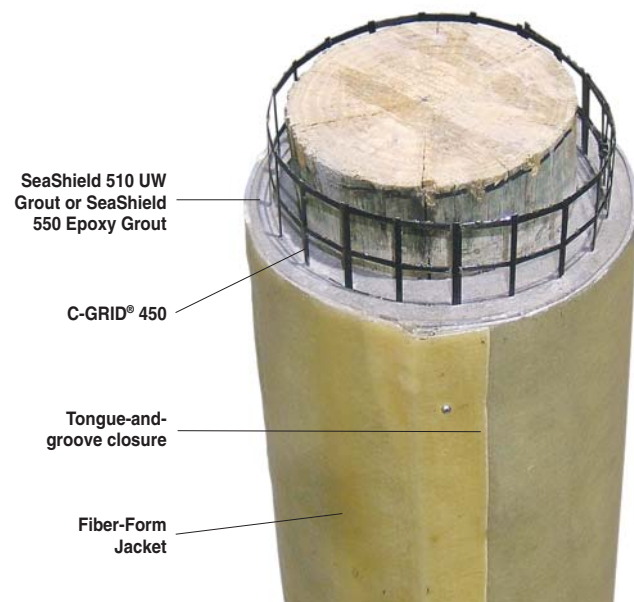
The C-GRID® 450 should be unrolled and cut using tin snips or other suitable method. The cut width of C-GRID® 450 is determined by including enough material to be imbedded within the grout and a 6" overlap along vertical seam. Locate the C-GRID® 450 between the elevations indicated in the specification and drawings. Then, the SeaShield Fiber-Form Jacket is installed around the pile and C-GRID® 450. A foam seal should be installed at the bottom of each jacket to prevent any grout from leaching out of the bottom of the jacket during in-

stallation. Once jacket is in place, inject grout approximately 6" to 12" into the bottom port and allow it to cure before proceeding with subsequent lifts. The injection process should be continuous, except when the injection hose is moved from port to port.

For further information please refer to the technical data sheets for the SeaShield Fiber-Form Jacket, C-GRID® 450 and SeaShield 510 UW Grout or SeaShield 550 Epoxy Grout. Complete details can be found on the SeaShield Series 400 Engineering Specifications.

*C-GRID® 450 utilized by Denso North America in the SeaShield Series 400 System is protected under the following US and European Patents: 6,263,629; 5836,715; 6,123,879; 6,454,889; 6,632,309; 0861353; 1094171.*

*C-GRID is registered trademark of Chomarat North America, LLC.*



**DENSO NORTH AMERICA**

**HOUSTON:**  
9747 Whithorn Drive,  
Houston, Texas,  
U.S.A. 77095  
Tel: 281-821-3355  
Fax: 281-821-0304

**TORONTO:**  
90 Ironside Crescent,  
Unit 12, Toronto,  
Ontario, Canada M1X1M3  
Tel: 416-291-3435  
Fax: 416-291-0898

e-mail: [info@densona.com](mailto:info@densona.com)

[www.denson.com](http://www.denson.com)

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# Engineering Specifications for **SeaShield Series 400** Timber Pile Rehabilitation

## 1.0 Scope

- 1.1 This specification may be used for the materials and application of SeaShield Series 400 Timber Pile Rehabilitation System.
- 1.2 The engineer shall select appropriate sections of the specifications to ensure that the specification is comprehensive for specified work.

## 2.0 General Requirements

- 2.1 Contractor shall comply with all written recommendations of the manufacturer regarding application of the specified system.
- 2.2 The manufacturer of specified materials shall be Denso North America, 9747 Whithorn Drive, Houston, TX 77095, Tel: 281-821-3355 or 90 Ironside Crescent, Unit 12, Toronto, Ontario, Canada M1X1M3 Tel: 416-291-3435. E-mail: info@densona.com
- 2.3 All materials used to comprise the SeaShield Series 400 System must be purchased from the same manufacturer. These include SeaShield Fiber-Form Jackets, C-GRID® 450, SeaShield 525 Epoxy, and either SeaShield 510 UW Grout (Cementitious) or SeaShield 550 Epoxy Grout.

## 3.0 Materials

- 3.1 Fiberglass Jacket (SeaShield Fiber-Form)
  - 3.1.1 The fiberglass jacket thickness shall be a minimum of 1/8 inch (3 mm) constructed of layers of woven roving and mat.
  - 3.1.2 The jacket shall be translucent to provide visual inspection during the injection of the grout.
  - 3.1.3 The jacket shall have minimum one inch injection ports spaced at intervals not to exceed five feet. To provide even distribution of the grout, the injection ports shall be placed on alternate sides.

3.1.4 The jackets shall have adjustable stand-offs inserted through the jacket to maintain the specified annulus between the pile and the jacket. A UV gel coat shall be applied to the outside of the completed fiberglass jacket.

3.1.5 The fiberglass jackets shall have the following properties:

Ultimate Tensile Strength	ASTM D638	15,000 PSI
IZOD Impact Strength	ASTM D256	20 ft.-lbf/in.
Barcol Hardness	ASTM D2583	35
Water Absorption	ASTM D570	1% Max
UV Stability	ASTM G23	500 Hr. Pass

3.1.6 The fiberglass jacket may be manufactured as either a single unit or as two pieces that shall be joined in the field. The jackets can be placed one above the other via bell and spigot.

## 3.2 Carbon-Fiber Grid

3.2.1 The Carbon-Fiber Reinforcement shall be C-GRID® 450 as provided by Denso North America.

3.2.2 Please refer to the C-GRID® 450 data sheet for complete property specifications.

3.2.3 All C-GRID® 450 shall be stored in a sheltered area to prevent degradation of the epoxy resin due to UV exposure.

## 3.3 Grout

3.3.1 The grout shall consist of either SeaShield 510 UW (Cementitious) Grout or SeaShield 550 Epoxy Grout as manufactured by Denso North America. For detailed grout specifications, please refer to the SeaShield 510 UW (Cementitious) Grout or SeaShield 550 Epoxy Grout product data sheets.

3.3.2 All grout shall be stored in a sheltered area away from rain and water.

## 3.4 Marine Epoxy

3.4.1 The SeaShield 525 Epoxy shall be used



to adhere the fiberglass vertical seams. The 525 Epoxy may also be used to finish the tops of the encapsulation.

## 4.0 Equipment

- 4.1 The grout shall be pre-mixed and pumped through a peristaltic pump or other suitable pump. The equipment shall be capable of delivering mixed grout through hoses into the jackets at a rate 1 GPM or greater.
- 4.2 Prior to using the pump, all lines shall be primed by circulating 1 gallon of the SeaShield Hose Lubricant.

## 5.0 Surface Preparation

- 5.1 Prior to application, thoroughly clean and remove marine growth, oil, grease and any other deleterious material which might prevent proper bonding between the pile and grout. Surface preparation shall be accomplished by water blasting to provide a clean surface.

## 6.0 Installation

- 6.1 Installation of C-GRID® 450 and Fiberglass Jacket
  - 6.1.1 The inside surface of the jacket shall be lightly roughened to remove residue and contamination.
  - 6.1.2 Adjustable stand-offs shall be inserted through the jacket at 18" to 48" intervals (depending on diameter size, length and thickness of jacket) along entire length of jacket.
  - 6.1.3 All longitudinal and transverse seams shall be sealed with SeaShield 525 Epoxy as described in Section 3.3.1 and fastened with 3/16" diameter stainless steel hex screws that shall not exceed 6" spacing.
  - 6.1.4 The C-GRID® 450 shall be unrolled and cut using tin snips or other suitable method. The cut width of C-GRID® 450 shall be determined by including enough material to be imbedded within the grout and a 6" overlap along vertical seam. The grid will require a minimum of ¼" grout cover.
  - 6.1.5 Locate the C-GRID® 450 between the elevations indicated in the specification and drawings. The C-GRID® 450 shall be wrapped around the timber pile with a minimum 6" overlap along the vertical seam. Use nylon zip ties, plastic clips or other plastic accessories to secure vertical seam and maintain the position of the grid during the pumping of grout. On long length repairs which require more than one panel of grid, the C-GRID® 450 shall be overlapped 6" above or below the first panel of grid.

6.1.6 The fiberglass jacket shall be installed around the pile and C-GRID® 450. The jacket shall be supported by temporary nylon straps or other means to assure that the jacket or C-GRID® 450 will not move or distort during placement of grout.

6.1.7 A foam seal shall be installed at the bottom of each jacket to prevent any grout from leaching out of the bottom of the jacket during installation. A ratcheting strap shall be placed on outside of jacket to compress the foam seal.

## 6.2 Grout Placement

6.2.1 Once jacket is in place, inject grout approximately 6" to 12" into the bottom port and allow it to cure before proceeding with subsequent lifts.

6.2.2 Grout injection shall begin at the bottom injection port and proceed upwards. As the jacket is filled to each port, the lower port shall be capped off and repeated until the top of the jacket is reached.

6.2.3 The injection process shall be continuous, except when the injection hose is moved from port to port.

## 6.3 Completion

6.3.1 After the injection process is completed and the epoxy grout has cured, all temporary supports shall be removed.

6.3.2 The top of each fiberglass jacket may be finished with the SeaShield 525 Epoxy described in Section 3.4.1.

C-GRID® 450 utilized by Denso North America in the SeaShield Series 400 System is protected under the following US and European Patents: 6,263,629; 5836,715; 6,123,879; 6,454,889; 6,632,309; 0861353; 1094171.

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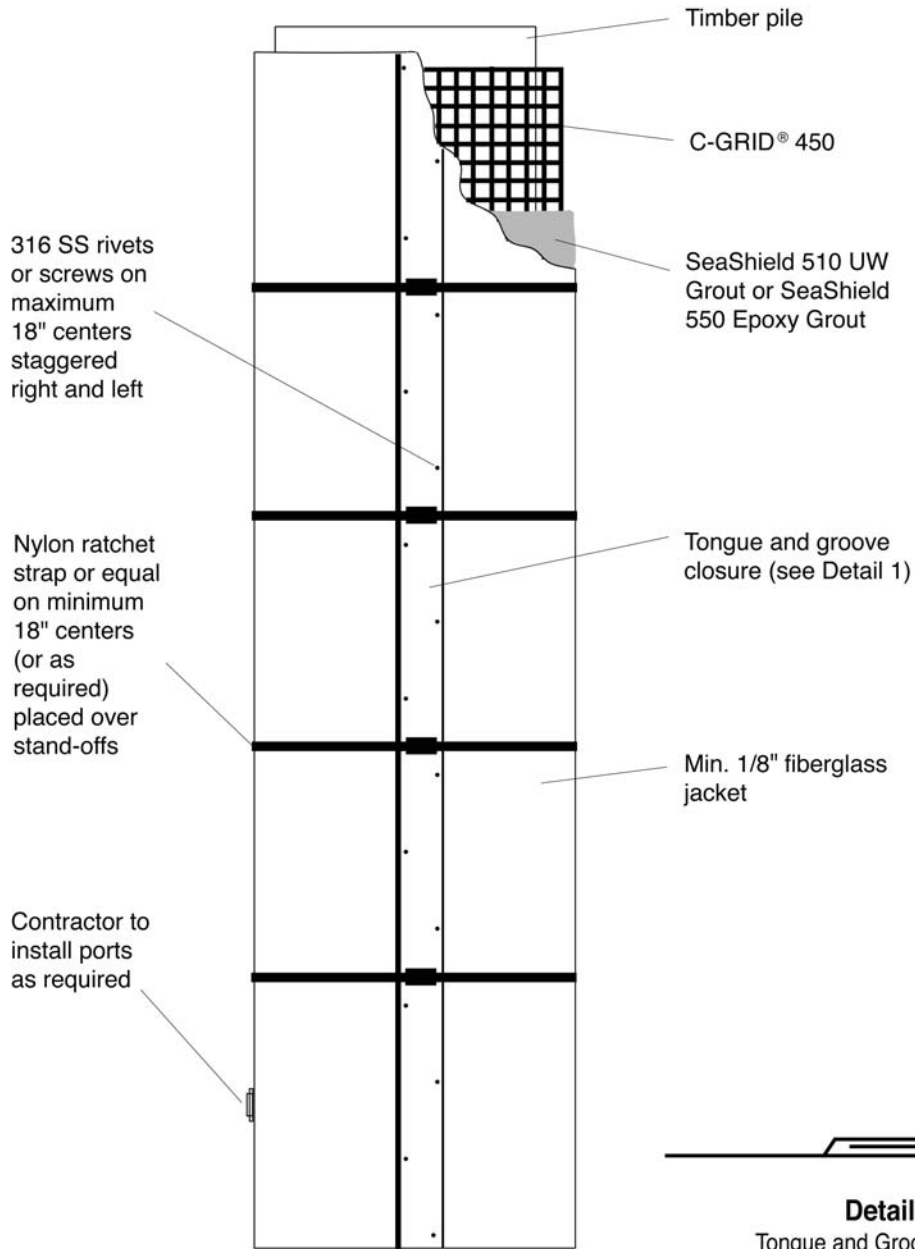
**DENSO NORTH AMERICA**

**HOUSTON:**  
9747 Whithorn Drive,  
Houston, Texas,  
U.S.A. 77095  
Tel: 281-821-3355  
Fax: 281-821-0304

**TORONTO:**  
90 Ironside Crescent,  
Unit 12, Toronto,  
Ontario, Canada M1X1M3  
Tel: 416-291-3435  
Fax: 416-291-0898

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**Elevation View**

**Sheet 1**  
(Not to Scale)

**SeaShield Series 400  
Detail Drawing**





### Step 1

Position SeaShield Fiber-Form Jacket around pile/ C-GRID® 450 and seal longitudinal seams.



### Step 2

Affix bottom seal gasket with select strapping.



### Step 3

Connect grout hose to lower injection port and pump SeaShield 510 UW Grout or SeaShield 550 Epoxy Grout. Visually check for leaks. Plug upper port(s) and pump grout until it reaches top of jacket. (Upper ports are used only if pumping from lower ports becomes difficult.)



### Step 4

#### (Alternate Pumping Method)

Contractor may choose to inject approximately 6" of SeaShield 510 UW Grout or SeaShield 550 Epoxy Grout and let cure before moving grout hose to next higher port and pumping remainder of grout. Pumping would then continue until grout reaches top of jacket.

Cured SeaShield 510 UW Grout or SeaShield 550 Epoxy Grout

**Sheet 2**  
(Not to Scale)

# SeaShield Series 400 Grout Placement Sequence



# C-GRID<sup>®</sup> 450

## Carbon-Fiber Grid for Strengthening Timber Piles

### Description

C-GRID<sup>®</sup> 450 is a high strength carbon-fiber/epoxy grid for structural repairs of timber piles. The C-GRID<sup>®</sup> 450 requires less grout fill leading to a much lighter structure when compared to typical steel reinforced repairs. The composition is carbon-fiber and epoxy resin. The C-GRID<sup>®</sup> 450 geometry is longitudinal and transverse spacing (2.36" x 2.36").

### Features

- Provides double the strength of the original timber pile
- Reduced weight when compared to steel reinforced repairs
- Non-corrosive (no steel to corrode)
- Lightweight and easy to install
- High tensile strength and modulus
- Requires much less grout when compared to steel reinforcement repair
- Requires only 1/4" grout cover
- Grid has excellent bond to grout
- Independently tested by Texas A&M University, Department of Civil Engineering, Structural and Materials Testing Laboratory

### Installation

The C-GRID<sup>®</sup> 450 shall be unrolled and cut using tin snips or other suitable method. The cut width of C-GRID<sup>®</sup> 450 shall be determined by including enough material to be imbedded within the grout and a 6" overlap along vertical seam. The grid will require a minimum of 1/4" grout cover. Locate the C-GRID<sup>®</sup> 450 between the elevations indicated in the specification and drawings. The C-GRID<sup>®</sup> 450 shall be wrapped around the timber pile with a minimum 6" overlap along the vertical seam. Use nylon zip ties, plastic clips or other plastic accessories to secure vertical seam and maintain the position of the grid during the pumping of grout. On long length repairs which require more than one panel of grid, the C-GRID<sup>®</sup> 450 shall be overlapped 6" above or below the first panel of grid. The fiberglass jacket shall be installed around the pile and C-GRID<sup>®</sup> 450.

*Please refer to the SeaShield Series 400 Engineering Specifications for complete installation guidelines.*



# C-GRID<sup>®</sup> 450

## Property Specifications

PROPERTIES	LONGITUDINAL PROPERTIES	TRANSVERSE PROPERTIES
Individual strand cross-sectional area	0.00321 in. <sup>2</sup> (2.07 mm <sup>2</sup> )	0.00321 in. <sup>2</sup> (2.07 mm <sup>2</sup> )
Average number of strands per unit width	5.0 strands/ft (16.6 strands/m)	5.0 strands/ft (16.6 strands/m)
Area of strands per unit width	0.0241 in. <sup>2</sup> /ft. (50.9 mm <sup>2</sup> /m)	0.0241 in. <sup>2</sup> /ft. (50.9 mm <sup>2</sup> /m)
Strand tensile strength	830 lbs (3.7 kN)	730 lbs (3.2 kN)
Grid tensile strength per unit width	4565 lbs/ft (66.4 kN/m)	4015 lbs/ft (58.4 kN/m)
Tensile modulus of elasticity	34,000 ksi (234,500 MPa)	34,000 ksi (234,500 MPa)
Elongation at break	0.99% (0.99%)	0.94% (0.94%)

### Notes:

- Centerline-to-centerline spacing between strands is nominal and based on the average number of strands per unit width. Actual spacing may vary by  $\pm 0.10$  inch ( $\pm 2.5$  mm).
- The longitudinal direction is in the direction of the roll and the transverse direction is across the width of the roll. For example, if a roll of C-GRID<sup>®</sup> 450 is 47.5" wide the carbon strands in the transverse direction are 47.5" in length. If a roll of C-GRID<sup>®</sup> 450 is 500 yards long, the longitudinal strands are 500 yards in length.
- Individual strand cross-sectional area is normalized to the cross-sectional area of the fibers in accordance with ACI 440.2R. The actual measured thickness and width are larger and shall not be used for design purposes.
- Reported tensile strengths are typical or average properties based on testing. Tensile modulus values are based on properties reported by the carbon fiber supplier. C-GRID<sup>®</sup> 450 exhibits linear elastic behavior so failure strains are estimated using Hooke's Law.
- C-GRID<sup>®</sup> 450, utilized by Denso North America in the SeaShield Series 400 System, is protected under the following US and European Patents: 6,263,629; 5836,715; 6,123,879; 6,454,889; 6,632,309; 0861353; 1094171.



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