



FIVE STAR MARINE, INC.

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DESIGN-A-SPEC™ GUIDELINES FIVE STAR MARINE® PILE JACKET GROUT

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This document is provided as a general guideline for consideration by contractors and engineers. While every reasonable effort has been made to ensure that this information is accurate and authoritative, Five Star Marine® does not warrant the accuracy or completeness of this information or for its appropriateness for any particular purpose. The user of this document remains solely responsible for the specification of all methods, materials and practices.

PART A - GENERAL CONDITIONS

1.01 SCOPE

The work covered by this document consists of furnishing all materials and performing all operations required for pile repair/encapsulation using fiberglass pile jackets and moisture insensitive epoxy grout.

If it is determined that structural repairs to the pile are needed they must be performed in conjunction with the repairs described in this document. These repairs can include, but are not limited to, chipping out loose concrete, exposing rebar, cleaning rebar, replacing or adding rebar and filling the repaired area with grout.

1.02 QUALITY ASSURANCE

The manufacturer shall be ISO 9001 certified and have a 15 year history of use in the manufacture of epoxy grout systems. The manufacturer shall provide on site technical service at no cost to the engineer or contractor when sufficient advance notice is provided.

1.03 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered to the jobsite in their original, unopened packages, clearly labeled with the product identification, printed instructions and batch code.
- B. Store and condition the fiberglass jackets and pile jacket grout at 60°F to 80°F (16°C to 27°C) for at least 24 hours prior to use. Refer to the product data sheet for more information.
- C. For handling instructions, refer to the Material Safety Data Sheet.

1.04 PROJECT / SITE CONDITIONS

- A. Refer to Part C – PREPARATION, ENVIRONMENTAL CONDITIONS, or contact the manufacturer directly for any physical or environmental limitations required by the product.

1.05 MEASUREMENT AND PAYMENT

- A. Measurement for pile repair/encapsulation shall be on a linear foot/cubic foot basis of material in place.
- B. Payment for pile repair/encapsulation shall be at the unit price bid on a linear foot/ cubic foot basis. This payment shall constitute full compensation for all labor, materials, tools, equipment and other items as necessary to complete the work bid. Progress payments may be made on the percentage of work satisfactorily completed during each payment period in accordance with the contract provisions.

PART B - MATERIAL SPECIFICATIONS

2.01 MATERIALS (EPOXY GROUT)

A. The pile encapsulation epoxy grout material shall be a 100% solids, premeasured, pre-packaged epoxy system containing thermosetting epoxy resins, expansive additives and inert fillers. The material shall be non-shrink and suitable for placement underwater via pouring or pumping. The manufacturer shall have at least 10 years experience in the manufacture of epoxy grout systems and be ISO 9001 certified. The manufacturer shall offer technical services and provide a representative at the job site for product training prior to product installation.

B. The pile repair/encapsulation material shall meet the following performance criteria:

1.	Compressive Strength, ASTM C 579 B	
		<u>psi (MPa)</u>
	1 Day	5,000 (34.5)
	7 Days	9,000 (62.1)
	28 Days	9,500 (65.5)
2.	Tensile Strength, ASTM C 307	2,200 (15.7)
3.	Bond to Concrete, ASTM C 882	3,000 (20.7)
4.	Linear Shrinkage ASTM C 531	0.0%
5.	Water Absorption ASTM C 413	0.0%
6.	Working Time	45 minutes

C. An acceptable product that meets this criteria is:

Five Star Marine[®] Pile Jacket Grout

As manufactured by Five Star Marine, Inc. Fairfield CT 06825

2.02 AGGREGATE REDUCTION

Do not reduce aggregate loading beyond manufacturer's recommendations.

2.03 CLEARANCES

A. The grout shall be placed from ½ to 6 inches (12 mm to 150 mm) around piles when used with a jacket retainer system.

B. The maximum annular area of grout around piles shall be 6 inches.

2.01 MATERIALS (PILE JACKET)

A. The pile jacket shall consist of a fiberglass mat woven in a polyester resin matrix. Wall thickness of jacket shall be 1/8 inch unless otherwise specified. Jacket closures shall be tongue and groove. The manufacturer shall have at least 10 years experience in the manufacture of fiberglass jackets. The manufacturer shall offer technical services and provide a representative at the job site for product training prior to product installation.

B. The fiberglass jacket shall meet all the following typical performance criteria:

1. Flexural Strength ASTM D 790	34,000 psi (234 MPa)
2. Flexural Modulus ASTM D 790	1.9 x 10 ⁶ psi (13,100 MPa)
3. Ultimate Tensile Strength ASTM D 638	23,000 psi (158 MPa)
4. Tensile Modulus ASTM D 638	1.7 x 10 ⁶ psi (11,724 MPa)
5. Water Absorption ASTM D 570	0.09%
6. Barcol Hardness	50
7. UV Resistance ASTM G 153 500 hours	No chipping, flaking or peeling

C. An acceptable product that meets this criteria is:

Five Star Marine[®] Pileform F Fiberglass Jackets

As manufactured by Five Star Marine, Inc., Fairfield CT 06825 USA

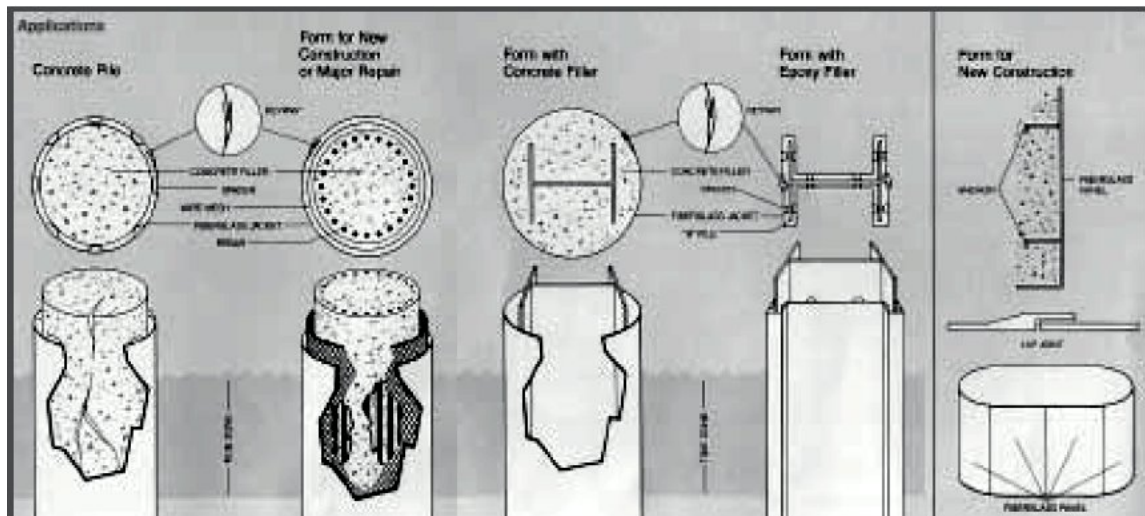


Diagram A: Examples of pile jackets

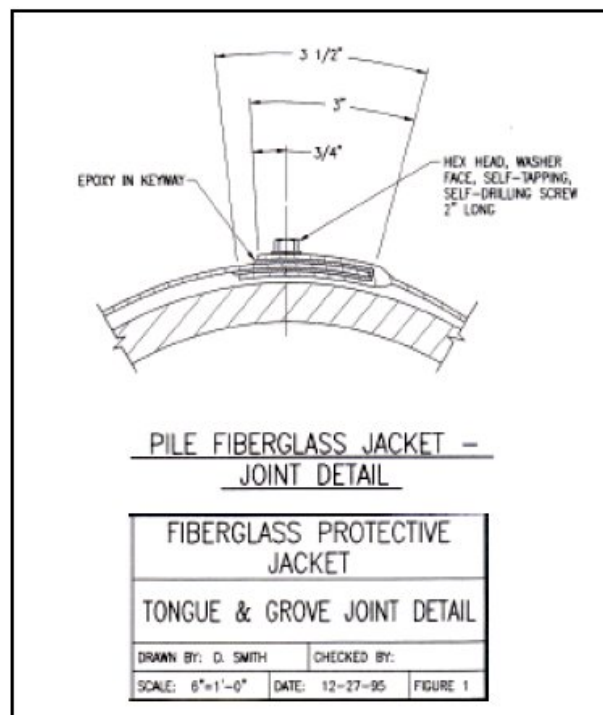


Diagram B: Tongue and Groove Joint Detail

PART C – PREPARATION

3.01 CONCRETE SURFACES

- A. Completely remove all loose, delaminated and weak concrete, oil, grease, laitance, marine growth and other contaminants. Prepare concrete using acceptable mechanical means and concrete cleaners and degreasers as necessary to obtain clean, sound and rough surfaces. Coarse aggregate shall be exposed.
- B. All cracks shall be brought to the attention of the engineer and a determination made of whether the cracks are subject to movement. The cracks shall be repaired as directed prior to installation of fiberglass jacket and epoxy grout.
- C. For more detailed information, refer to the following publication: "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion", Guideline No. 03730, prepared by the Technical Guidelines Committee of ICRI, March 1995.

3.02 REINFORCEMENT

- A. All reinforcing steel that has lost bond with the concrete or has more than one-half of its circumference exposed shall be undercut by at least 3/4 inch (18 mm) or two times the maximum aggregate size.

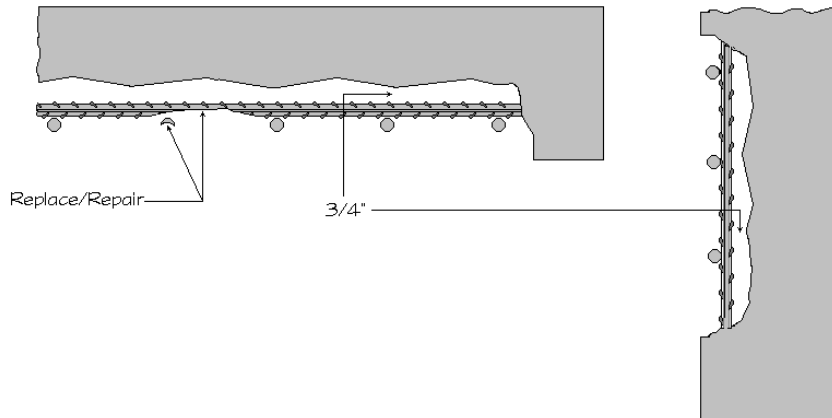


Diagram D: Reinforcement Profile Example

- B. If more than 20% of the diameter of a reinforcing bar has been deteriorated, the bar may require replacement or will need to be spliced as directed by the engineer.
- C. All reinforcement shall be rigidly secured and supported.
- D. All exposed reinforcing steel shall be free of all loose scale, rust, oxidation and other contaminants. Blast steel to an SSPC – SP6 commercial finish or better. Exposed

reinforcing steel may be sealed or primed if a delay occurs between surface preparation and epoxy grout placement.

3.03 JACKET PLACEMENT

- A. One piece jackets are typically full circle and will fully cover the pile. Two piece jackets are typically used on square or H piles. Spacers/standoffs inside jackets are placed at regular intervals to provide the maximum support and maintain the annular space between the jacket and the pile. Spacers/standoffs may be pre-molded into jackets or applied at job site. Spacers can be made of wood, plastic or metal. When placing spacers use a fast-setting epoxy adhesive suitable for exposure to water such as Five Star[®] RS Anchor Gel.
 - B. For pumping applications, secure suitable pump ports to jacket. Mount port approximately 12 inches from the bottom of the pile. Additional ports may be needed for jacket lengths over 5 feet. Where necessary, place a additional port approximately three feet above the first port and 180° opposite the first port. If additional ports are needed alternate the placement 180° from the previous port and three feet above.
 - C. Piles should be cleaned with a high pressure water jet blast to remove all loose material and marine growth.
- A. Use a sealing compound to fill the groove side of the opening. Five Star[®] RS Anchor Gel is an excellent rapid setting epoxy gel adhesive that can be used to seal the tongue and groove joint. Five Star[®] RS Anchor Gel is packaged in a dual cartridge system with a static mixer tip. Insert the mixer tube into the groove and inject a generous amount of epoxy in the entire length of the groove. Hold the jacket up right next to the pile. Pull open the jacket and slip it around the pile. Allow the tongue to slip into the groove. Position the jacket to cover the area desired. Press the jacket closed and the tongue into the groove as far as it will go. Use ratcheting straps around the jacket to secure it.
 - B. Wooden braces, battens or strong backs, should be placed on the outside of the jacket to prevent bulging. Use 2 x 4 or 2 x 6 that is about the same length as the jacket and attach one with screws to the middle of each jacket face. Place straps 12 to 18 inches apart vertically and around the braces to insure that the jacket is secure. When the jacket is in position and the straps tight use stainless steel self drilling/tapping screws to secure the tongue and groove joint. Locate the screws so that they go through both sides of the groove and the tongue. Use screws that are long enough to penetrate the jacket but not long enough to extend to the pile itself. Place screws three to six inches apart for the entire length of the jacket.

3.04 JACKET SEALING

- A. Pile jackets need a seal at the bottom of the jacket to prevent the grout from leaking out of the bottom of the jacket. The choice of bottom seal can be determined by environmental restrictions, owner preference or contractor experience. The most common types include closed foam strips, oakum and resin, nylon retainers and epoxy packing. Depending on the type used it will be put in place before or after the positioning of the jacket around the pile.

- B. Foam strips should be placed around the interior bottom of the jacket before the jacket is placed around the pile. The foam should be of sufficient height and thickness to form a tight seal. Foam should be three to four times the thickness of the annular space and three to five inches in height. Be sure that the ends of the strips overlap when in place to prevent leaks. Secure the bottom seal with stainless steel strapping or nylon ratchet straps.
- C. Oakum is placed after the jacket is in place and secured to the pile. Oakum can be used alone or with an expanding resin. The oakum alone or with the resin should be packed up into the jacket annular space to insure a full seal. The resin will expand upon contact with water and completely fill the annular space at the bottom of the jacket. Working time of the oakum-resin is about five minutes.
- D. Jackets can also be sealed with an integral nylon sleeve. This sleeve is molded into the bottom of the jacket at the time of manufacture of the jacket. It has a water tight zipper closure and is attached to the pile below the jacket with stainless steel straps or nylon zip strapping.

3.05 MIXING

Mortar Mixer (Stationary Barrel Mixer with Moving Paddles)

- A. Provide an adequate number of mortar mixers in good operating condition for uninterrupted placement. Do not exceed one-half the maximum capacity of the mortar mixer. A concrete mixer (spinning barrel mixer) is not recommended for mixing epoxy grout.
- B. Pour all Component B (hardener) into the pail containing Component A (resin). Mix thoroughly for 2 minutes by hand with paddle or slow speed mixer to avoid air entrapment. Pour mixed liquids into the mortar mixer. While mixing, slowly Component C (aggregate) and mix until aggregate is completely wet.
- C. Do not mix more material than can be placed within the working time of the grout.
- D. Pour the mixed grout into a suitable wheelbarrow or carrier to transport it to the work site.

4.01 APPLICATION

Pumping

- A. A peristaltic type pump is recommended for pumping epoxy grout. When using any other type of pump, consult epoxy grout manufacturer first to ensure the epoxy grout is pumpable with another type of pump.
- B. Prime pump and lines with a suitable primer that will not contaminate epoxy grout. Ensure material used for priming is discarded and not used for jacket filling.

- D. Attach the pump hose to the bottom port and commence pumping. For tremie pumping, insert hose into jacket to bottom and commence pumping. Keep pump hose submerged in epoxy grout and slowly raise pump hose as jacket fills with epoxy grout.
- E. When the grout in the jacket rises to the level of the next port stop the pump, remove the hose and close the port with a plug. Then attach the hose to the next higher port and continue pumping. Repeat this until the jacket is full of grout.
- F. When the jacket is full, the top of the jacket can be topped off with additional grout placed by hand or by a later placement of a suitable marine mastic such as Five Star Marine[®] Splash Zone.
- G. Do not mix more material than can be placed within the working time of the grout.
- H. All tools and equipment may be cleaned with high pressure water and a strong detergent prior to hardening. Sand may be used as an abrasive to aid clean up.

Pouring

- A. Use a headbox or ramp at top of jacket opening to facilitate pouring of epoxy grout into jacket.
- B. Mixing and pouring of epoxy grout should be a continuous process to minimize air entrapment. Headbox or ramp used for pouring may be moved or alternated from side to side to also help reduce air entrapment.
- C. Continue pouring epoxy grout until jacket is full. Grout level may be topped off using additional material placed by hand or by a later placement of suitable marine mastic such as Five Star Marine[®] Splash Zone.
- D. Do not mix more material than can be placed in the working time of the epoxy grout.
- E. All tools and equipment may be cleaned with high pressure water and a strong detergent prior to hardening. Sand may be used as an abrasive to aid clean up.

PART E – FINISHING AND CURING

5.01 FINISHING

- A. Prior to hardening, epoxy grout can be finished with a solvent wiped steel trowel. Maintaining a sufficient solvent coat is important as epoxy grout will adhere to a dry trowel.
- B. Epoxy grouts cannot be trimmed after set except by mechanical means. Final level in the forms should be brought to the finished elevation before curing.

5.02 CURING

- A. Protect the grout from temperatures below 40°F (4°C) for 24 hours or until required minimum compressive strength is achieved.

Warranty

Five Star Marine, Inc. warrants that at the time and place we make shipment, our materials will be of good quality and will conform to our published specifications in force on the date of acceptance of the order. THE FOREGOING WARRANTY SHALL BE EXCLUSIVE AND IN LIEU OF ANY OTHER WARRANTY, EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND ALL OTHER WARRANTIES OTHERWISE ARISING BY OPERATION OF LAW, COURSE OF DEALING, CUSTOM OR TRADE OR OTHERWISE. As the exclusive remedy for breach of this Warranty, we will replace defective materials, provided, however, that the buyer examines the materials when received and promptly notify in writing of any defect before the materials are used or incorporated into a structure. Twelve (12) months after Five Star Marine, Inc. has shipped the materials, all our Warranty and other duties with respect to the quality of the materials delivered shall conclusively be presumed to have been satisfied, all liability therefore terminates, and not acting for breach of any duties may thereafter commence. Five Star Marine, Inc. shall in no event be liable for consequential damages. Unless otherwise agreed to in writing, no warranty is made with respect to materials not made by Five Star Marine, Inc. We cannot warranty or in any way guarantee any particular method of use of application or the performance of materials under any particular condition. Neither this Warranty nor our liability may be extended or amended by our sales people, distributors or representatives or by any sales information or drawings.



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