



FIVE STAR PRODUCTS, INC.

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DESIGN-A-SPEC™ GUIDELINES FIVE STAR® CEMENTITIOUS UNDERWATER HIGH-STRENGTH GROUT

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PART A - GENERAL CONDITIONS - CEMENTITIOUS GROUTING

1.01 SCOPE

The work covered by this document consists of furnishing all equipment, materials, labor and performing all operations required for the installation of precision non-shrink underwater grout as directed by the engineer or owner.

1.02 QUALITY ASSURANCE

- A. The manufacturer shall have been in the business of manufacturing similar products for over ten years, maintain a strict quality assurance program in accordance with ISO 9001:2015, offer technical services and provide a representative at the jobsite for product training, prior to product installation, upon written request.
- B. The contractor shall submit to the engineer or owner, at least three job references where the contractor has successfully completed similar applications.

1.03 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered to the jobsite in their original, unopened packages, clearly labeled with the manufacturer's identification, printed instructions and batch code.
- B. Store and condition the specified product in accordance with the appropriate product data sheet.
- C. For handling instructions, refer to the Safety Data Sheet.

1.04 PROJECT/SITE CONDITIONS

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 of the grouting work shall be on a cubic foot (liter) basis of material in place.
- B. Payment for the grouting work shall be at the unit price bid on a cubic foot (liter) basis. This payment shall constitute full compensation for all labor, materials, tools, equipment and other items as necessary to complete the work as described in the contract documents. Progress payments will be made on the percentage of the work satisfactorily completed during each payment period in accordance with the provisions of the contract documents.

PART B - MATERIAL SPECIFICATION - CEMENTITIOUS GROUT

2.01 MATERIALS

- A. Non-shrink cementitious grout shall be a saltwater resistant, pre-packaged, cement-based grout requiring only the addition of potable water. The grout shall be formulated for exposure to fresh or saltwater environments. The manufacturer shall be ISO 9001 certified and have at least 10 years experience in the manufacture of precision cement-based grouts. The manufacturer shall offer technical services and provide a representative at the jobsite for product training prior to product installation upon five days advance notice.
- B. The grout material shall meet all the following typical performance criteria when cured at 70°F (21°C):
1. Grout shall not contain metallic aggregate, expansive cement, or gas generating additives such as aluminum powder.
 2. Grout shall contain an air release aggregate to generate positive expansion.
 3. Early Height Change, ASTM C 827 Positive Expansion
 4. Hardened Height Change, ASTM C 1090 0.0 to 0.3%
 5. Compressive Strength, ASTM C 109
 1 Day 3500 psi (24.1 MPa)
 7 Days 8000 psi (55.2 MPa)
 28 Days 8500 psi (58.6 MPa)
 6. Bond Strength, ASTM C 882
 28 Days 2000 psi (13.8 MPa)
 7. Working Time 60 minutes
 8. Application Temperature 40°F to 90°F (4°C to 32°C)
 9. Material Temperature 40°F to 90°F (4°C to 32°C)
 10. Meets performance requirements of ASTM C 1107

The data shown above reflect typical results based on laboratory testing under controlled conditions. Reasonable variations from the data shown above may result in the field. Test methods are modified where applicable.

- C. An acceptable product which meets these criteria is:

Five Star® Underwater High-Strength Grout

As manufactured by Five Star Products, Inc., Shelton, CT 06484 (203) 336-7900.

- D. Subject to meeting the performance criteria stated above, other products may be formally submitted to the engineer for approval up to three days prior to the bid date. All requests for approval shall contain certified test data verifying conformance with this specification. Three references of successfully completed projects of similar nature and scope of the work detailed in this specification shall be provided, as well as a minimum ten year history of use in the industry. The testing laboratory shall certify to any modifications made to tests performed and provide details of modifications.

2.02 CLEARANCES

- A. For placement thicknesses less than one inch (25 mm) or greater than six inches (150 mm), contact the manufacturer. For depths greater than six inches (150mm) refer to Aggregate Extension Section 2.03.

2.03 AGGREGATE EXTENSION

- A. For pours greater than six inches (150 mm) in depth, the grout should be extended by the addition of clean, damp coarse aggregate according to the following guidelines (grout may also be extended for thinner pours down to 1 ½ inches):

<u>Depth of Pour</u> Inches (mm)	<u>Typical Extension</u> (Percentage by wt.)
6 + to 9 (150 – 225)	35% - 50%
9 + to 12 (225 – 300)	50% - 60%
12 + to 18 (300 – 450)	60% - 80%
18 +	Contact Five Star

Coarse aggregate shall be clean and washed and conform to the requirements of ASTM C 33.

PART C – PREPARATION - CEMENTITIOUS GROUTING

3.01 CONCRETE SURFACES

- A. Completely remove all loose, delaminated and weak concrete, oil, grease, laitance and other contaminants. Prepare concrete using acceptable mechanical means and concrete cleaners or degreasers as necessary to obtain clean, sound and rough concrete surfaces exposing coarse aggregate.
- B. Where surfaces are not underwater or are in tidal zones, pre-soak concrete surfaces thoroughly for a minimum of eight hour with potable water prior to installation. Concrete shall be saturated and free of standing water at time of placement.

3.02 METAL SURFACES

- A. Where reinforcement is exposed, mechanically prepare surfaces to remove all rust, scaling, oxidation, marine growth and other contaminants. Where a delay in grouting may occur, coat reinforcement with a suitable corrosion inhibitor or coating after preparation.
- B. Steel surfaces shall be clean, free of oil, grease, rust and other contaminants. Sandblast steel where necessary to remove all contaminants, marine growth and rust.

***SSPC-SP6**

Commercial blast cleaned surface is defined as one in which all oil, grease, dirt, mill scale, rust and old paint have been completely removed from the blast cleaned surface, except that slight streaks, or discolorations caused by rust stain, mill scale oxides, or slight tightly adherent residues of paint or coating may remain. If the surface is pitted, slight residues of rust or paint may remain in the bottom of the pits. The slight discolorations mentioned above are limited to one-third of every square inch.

3.03 FORMWORK / JACKETS

- A. Formwork or jackets shall be constructed of rigid nonabsorbent materials, securely anchored, watertight and strong enough to resist forces developed during grout placement.
- B. Formwork / jackets shall have sufficient ports installed when grout is to be pumped in place. Ports should be fitted with fast acting ball valves or similar valves.
- C. Jackets (where used) may be left in place. Formwork to be subsequently removed must be coated with a form release agent prior to use. Caution: Care should be taken not to contaminate grouting surfaces where bond is required.

3.04 ENVIRONMENTAL CONDITIONS

- A. Condition and maintain all materials and surfaces that contact grout to between 40°F and 90°F (4°C and 32°C). Shade from direct sunlight as necessary.
[For detailed conditioning procedures for Cold Weather or Hot Weather Grouting, refer to PART F – EXTREME WEATHER CONDITIONS.]

3.05 CLEARANCES/EXTENSION

- A. All repair / grouting should be done at a minimum 1 inch thickness to a maximum 6 inches in thickness. Larger / deeper placements may be accomplished by extending grout with a clean washed coarse aggregate. Underwater High Strength Grout may be extended for placements less than 6 inches depending upon the application. Contact Five Star Products, Inc. for further details.

3.06 EQUIPMENT AND MATERIALS

- A. All necessary tools, equipment and materials shall be as close as possible to the area being grouted, such as mortar mixers, measuring containers, trowels and grout.
- B. Appropriate clothing and safety equipment shall be worn to avoid breathing dust and prevent eye and skin contact with both dry and mixed grout.
- C. Wheelbarrows, buckets, shovels and pumps shall be clean, dampened and readily available for transporting mixed grout.
- D. Provide headbox or ramp when pouring grout.
- E. An ample source of potable water shall be available for preconditioning, mixing, cleaning and curing.

3.07 MIXING

[Select one of the following types of mixers, as appropriate.]

Mortar Mixer (Stationary Barrel 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.
- B. Pre-wet mortar mixer, empty excess water.

- C. Start by adding the minimum amount of premeasured potable water to mixer. While mixing, slowly add grout and mix to a uniform consistency.
- D. Mix thoroughly for approximately four to five minutes. To achieve desired consistency, add remaining water as necessary after 3 minutes of mixing. Do not exceed maximum water content as stated on product packaging or add an amount that will cause segregation.
- E. Do not mix more material than can be placed within the working time of the grout. Do not retemper the mix by adding additional water.
- F. Transport mixed material by wheelbarrow or buckets, taking care not to allow material to segregate.
- G. For pours requiring aggregate extension, add clean, damp coarse aggregate meeting the requirements of ASTM C 33 before final water adjustment.

Concrete Mixer (Only for Grout Extended with Coarse Aggregate)

- A. Pre-wet mixer and empty excess water.
- B. Start by adding the minimum amount of pre-measured potable water to mixer followed by coarse aggregate. While mixing, slowly add grout and mix for 2-3 minutes. Add additional water as necessary and continue mixing for 2-3 minutes. DO NOT exceed maximum water content as stated on product packaging.
- C. Transport grout as necessary to application area or to pump.

Mobile Mixer (Only for Grout Extended with Coarse Aggregate)

- A. Ensure mobile mixer is properly calibrated prior to commencing work.
- B. Water content should not exceed 17.5% by weight of grout when mixing.
- C. Use mobile mixer with extended auger to maximize mixing efficiency.

Ready-Mix Concrete Truck – Bulk Bags + Coarse Aggregate Extension

- A. **Verify working time of grout and water requirements under jobsite conditions before use in concrete truck. Contact Five Star Products prior to use in a concrete truck.**
- B. Mixing drum and mixing blades must be in good operating condition, predampened and excess water removed.
- C. First add clean, damp, coarse aggregate meeting the requirements of ASTM C 33 to drum.
- D. Add approximately 75% of premeasured potable water to mixing drum as predetermined by testing. Five gallons of this 75% shall be held back for hopper wash down. Water addition must be adjusted if wet aggregate is used or water is present in the drum.
- E. Add grout, with drum turning at a slow speed. Do not exceed half the capacity of drum or add more than 3 bulk bags per truck. Use the 5 gallons (19 liters) of held back water to wash down hopper and drum after loading. Mix thoroughly for approximately five minutes at slow speed to a uniform consistency.
- F. Reverse drum to check consistency. Add remaining water as needed, then mix to a uniform consistency. Do not exceed maximum allowable water content as stated on product packaging or add an amount that will cause segregation. Small bags of grout should be available to stiffen consistency if necessary.
- G. Position truck as close as possible to pour and promptly discharge from truck. When transporting mixed grout, take care not to allow grout to segregate.

PART D – APPLICATION - CEMENTITIOUS GROUTING

4.01 PLACEMENT PROCEDURES

POURING

- A. A headbox or ramp is suggested for a continuous pour to facilitate grout placement and minimize spillage during installation. All grouting shall take place from one side to minimize air entrapment.
- B. When started, placement should be coordinated with mixing so that the entire process is continuous
- C. When pouring, grout shall be introduced in a manner to avoid air entrapment and minimize free fall of grout. Care must be taken during grouting ensure grout does not free fall more than 3 - 4 feet. If necessary use a tremie hose or trunk as necessary.
- D. Throughout the pour, forms / jackets shall be constantly checked for leaks. All leaks shall be sealed immediately.

PART D – APPLICATION - CEMENTITIOUS GROUTING

4.01 PLACEMENT PROCEDURES

PUMPING

- A. The type and size of pump and discharge line used are dependent on the parameters of each installation. Contact the pump and grout manufacturers for recommendations. The proposed pumping equipment and procedures shall be submitted for approval.
- B. Pumping raises the grout temperature and shortens the working time while reducing its consistency. Keep mix temperature as cool as necessary, except in cold weather.
- C. The grout shall be mixed to a consistency that will not segregate while pumping.
- D. The grout shall be passed through a #4 screen prior to placement into the pump hopper.
- E. Before pumping, determine the working time under jobsite conditions. Pumpability shall be determined by field testing.
- F. The pump shall be positioned to minimize the pumping distance. Keep the discharge line as close to horizontal as possible. All hose connections must be watertight.
- G. Immediately prior to pumping, the pump and lines shall be primed with a priming slurry leaving hopper empty to prevent overwatering.
- H. Once the pumping has begun, it is important not to use any of the priming slurry from the discharge lines. Grout shall not be used until a uniform consistency is obtained at the discharge nozzle.
- I. Provide an adequate volume of mixed grout to keep the pump hopper at least half full. The grout shall be placed into pump hopper in a manner to prevent air entrapment.
- J. The discharge nozzle shall be withdrawn only while pumping, keeping it submerged within the grout at all times.
- K. When a pump is needed to transport grout and the nozzle cannot be inserted into the cavity being grouted, a headbox is required. The headbox will allow the pour to be continuous, avoiding air pockets under the plate. The grout shall be discharged from the nozzle into the headbox in a manner to avoid air entrapment. The headbox shall be kept at least half full at all times.
- L. All grouting shall take place from one side to the other.

REFERENCE

ACI 304.2R-96
"Placing Concrete By Pumping Methods"

PART F – EXTREME WEATHER CONDITIONS - CEMENTITIOUS GROUTING

6.01 COLD WEATHER GROUTING

[Low temperatures delay the set, increase working time and delay the strength development of cement-based products. The procedures below may compensate for these conditions.]

- A. Materials shall be conditioned as necessary so that the mixed grout is between 40°F and 80°F (4°C and 27°C). Due to the mass of palletized material, up to 72 hours of conditioning may be required. Store grout in an indoor or tarped and heated area when required.
- B. All surfaces in contact with grout must be preconditioned and maintained at a temperature between 40°F and 90°F (4°C and 32°C) for at least 24 hours.
- C. Heating shall be accomplished by indirect exposure. Heated enclosures must be windproof and weatherproof. Combustion heaters must be vented and shall not be permitted to heat and dry the concrete locally. *Caution: Exhaust gases may contaminate or cause carbonation within the enclosed environment.*
- D. Grout temperature shall be maintained above 40°F (4°C) until the grout reaches 1000 psi (6.9 MPa) or the required strength.
[Specify minimum required strength.]
- F. Gradually reduce temperature of grout to ambient temperature to avoid thermal shock.

REFERENCE

ACI 306R-88
"Cold Weather Concreting"

PART F – EXTREME WEATHER CONDITIONS - CEMENTITIOUS GROUTING

6.01 HOT WEATHER GROUTING

[High temperatures accelerate the set, decrease working time, and accelerate the strength gain of cement-based products. The procedures below may compensate for these conditions.]

- A. Materials should be pre-conditioned so that the grout mix temperature is between 50°F (10°C) and 95°F (35°C). Due to the mass of palletized material, up to 72 hours of pre-conditioning may be required. Store grout in a shaded area out of direct sunlight.
- B. All surfaces in contact with cement based grout shall be pre-conditioned and maintained below 95°F (35°C) for a minimum 24 hours. Pre soaking of surfaces, mixing equipment and wheelbarrows with cold or iced water will facilitate cooling of surfaces.
- C. Mix grout using cold or iced water. **Do not** put ice directly in with grout during mixing.
- D. Provide shading during grout placement and where feasible, place grout when temperatures are decreasing, at night or early morning. Provide protection from excessive wind to reduce rapid drying and evaporation of water from exposed grout surfaces.
- E. Begin wet cure immediately after grout takes initial set and continuously wet cure all exposed grout surfaces where grout is not underwater or is in tidal zones using wet rags, burlap or burlene. Place plastic sheeting over material used for wet cure to ensure continuous wet cure. Monitor condition of material used for wet cure to ensure drying does not occur.
- F. After a minimum 24 hour continuous wet cure, continue wet cure for an additional 48 hours or coat all exposed grout surfaces with an approved curing compound meeting the water retention requirements of ASTM C 309.

REFERENCE

ACI 305R-91
"Hot Weather Concreting"

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