



FIVE STAR PRODUCTS, INC.

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FIVE STAR® HIGHWAY PATCH DESIGN-A-SPEC™ GUIDELINES

CONTENTS

▶	PART A - GENERAL CONDITIONS
▶	PART B - MATERIAL SPECIFICATIONS
▶	PART C - PREPARATION
▶	PART D - APPLICATION
▶	PART E - FINISHING AND CURING
▶	PART F - EXTREME WEATHER CONDITIONS

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PART A - GENERAL CONDITIONS - CONCRETE REPAIR

1.01 SCOPE

The work covered by this document consists of furnishing all equipment, materials, labor and performing all operations required for concrete spall repairs 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, 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 as per the appropriate product data sheet.
- C. For handling instructions, refer to the Material 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.

PART B - MATERIAL SPECIFICATION - CONCRETE REPAIR

2.01 MATERIALS

- A. The concrete repair material shall be a pre-blended, packaged cement-based mortar requiring only the addition of potable water. The material shall not contain any chlorides or lime other than amounts contained within the hydraulic cement composition. The manufacturer shall be ISO 9001 certified and have at least fifteen years experience in the manufacture of concrete repair materials. 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 concrete repair material shall meet all the following typical performance criteria when cured at 70°F (21°C):
1. **Compressive Strength, ASTM C 109**

2 Hours	2,000 psi (13.8 MPa)
3 Hours	3,500 psi (24.1 MPa)
1 Day	5,000 psi (34.5 MPa)
7 Days	7,000 psi (48.3 MPa)
 2. **Bond Strength, ASTM C 882**

1 Day	1,500 psi (10.4 MPa)
7 Days	2,000 psi (13.8 MPa)
 3. **Length Change, ASTM C 157**

28 Days Wet	+0.05%
28 Days Dry	-0.05%
 4. **Freeze Thaw Resistance, ASTM C 666A**

Relative Durability Factor	90%
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 5. **Flexural Strength, ASTM C 78**

3 Hours	400 psi (2.7 MPa)
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 5. **Chloride Ion Permeability, ASTM C 1202**

28 Days	Very Low
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 6. **Working Time at 70°F (21°C)**

	10 minutes
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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® Highway Patch

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 the tests performed and provide details of modifications.

2.02 AGGREGATE EXTENSION

- A. For pours greater than two cubic feet (56.5 liters) in volume, the concrete repair material may be extended by the addition of coarse aggregate according to the following guidelines:

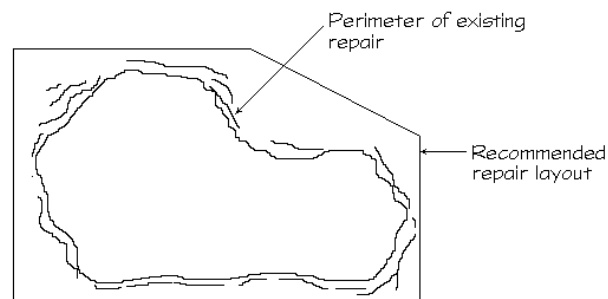
Depth of Pour (Inches)	Typical Extension (Percentage by wt.)
1 to 2 inches	0%
2 + inches to 4 inches	50%
4 + inches to 6 inches	60%
6 inches +	Contact Manufacturer

While not required, Five Star® Highway Patch may be extended for pours beginning at 2 inches in depth (50% extension). Coarse aggregate shall conform to the requirements of ASTM C 33 and be DOT approved aggregate source. Maximum size of coarse aggregate shall not be greater than one-third the depth of the repair. Coarse aggregate shall be clean and damp.

PART C – PREPARATION - CONCRETE REPAIR

3.01 CONCRETE SURFACES

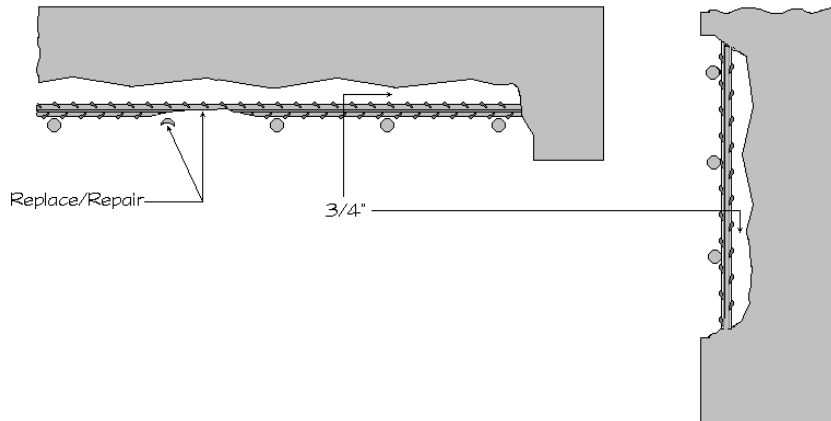
- A. Completely remove all loose, delaminated and weak concrete, oil, grease, laitance and other contaminants. Prepare concrete using acceptable mechanical means as necessary to obtain clean, sound and rough surfaces. Coarse aggregate shall be exposed in the substrate concrete. Blow prepared surfaces clean with oil free compressed air.
- B. The edges of the repair shall be vertical and have a rough profile. Avoid abrupt changes in depth.
[The minimum repair depth specified should be determined by the product selected, the maximum size of aggregate, and the nature of the repair.]
- C. The perimeter of the repair shall be kept to a simple shape. Avoid reentrant corners.



- D. 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 application of the repair material.
- E. All existing joints shall be maintained. New joints, if any, shall be installed as detailed on the drawings.
- F. Pre-soak concrete surfaces thoroughly with liberal quantities of potable water prior to repair material placement. Concrete shall be saturated and free of standing water at time of repair material placement. Five Star® Bonding Adhesive may be used in lieu of pre-soak. Contact Five Star Products for further details.
[For more detailed information, refer to the following source: "Surface Preparation Guidelines For The Repair of Deteriorated Concrete Resulting From Reinforcing Steel Oxidation", Report of International Concrete Repair Institute, 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.



- B. All reinforcement shall be rigidly secured and supported.
- C. If more than 20% of the diameter of a reinforcing bar has been deteriorated, the bar will require replacement or will need to be spliced as directed by the engineer.
- D. All exposed reinforcing steel shall be free of all loose scale and rust, and other contaminants.
- E. The minimum cover over reinforcement shall be in accordance with job specifications or 2 inches (50 mm), whichever is greater.

3.03 ENVIRONMENTAL CONDITIONS

- A. Condition and maintain all materials and surfaces that contact repair material to between 40°F and 90°F (4°C and 32°C), but optimally between 55°F and 75°F (13°C and 24°C) whenever possible. Shade from direct sunlight as necessary.
[When faster strength gain is required at low temperatures, or longer working time is required at high temperatures, revise the temperature range above as appropriate and refer to detailed conditioning procedures for Cold Weather or Hot Weather Repairs, PART F – EXTREME WEATHER CONDITIONS.]

3.04 EQUIPMENT AND MATERIALS

- A. All necessary tools, equipment and materials shall be in good condition and as close as possible to area being repaired.
- B. Appropriate clothing and safety equipment shall be worn to avoid breathing dust and prevent eye and skin contact with both dry and mixed repair materials.
- C. An ample source of potable water shall be available for preconditioning, mixing, cleaning and curing.

3.05 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 repair material and mix to a uniform consistency.
- D. Mix thoroughly for approximately 3 minutes. To achieve desired consistency, add remaining pre-measured water if necessary as a final water adjustment and continue mixing for 1 to 2 minutes. Do not exceed maximum water content as stated on product packaging or an amount that will cause segregation. Total mix time should be 4 to 5 minutes. Product mixed at lower water content will provide best physical properties.
- E. Do not mix more material than can be placed within the working time of the repair material. Do not retemper the mix by adding additional water.
- F. For pours requiring aggregate extension, add clean, damp coarse aggregate meeting the requirements of ASTM C 33 before final water adjustment.

* *Concrete mixers are acceptable only when product is extended with coarse aggregate. Add pre-measured water and coarse aggregate to mixer first then add Five Star[®] Highway Patch and mix for 4 to 5 minutes.*

Drill and Paddle Mixer (Single Bag Mixes Only)

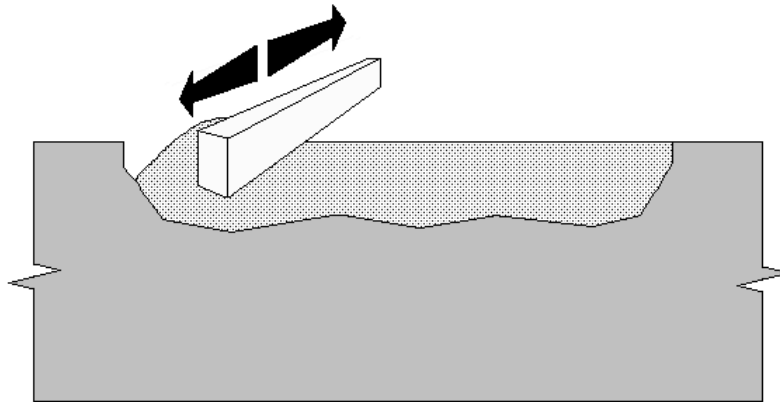
- A. Start by adding the minimum amount of premeasured potable water into large pail or mortar tub. While mixing at a slow speed, slowly add repair material and mix to a uniform consistency. Add remaining water to achieve desired consistency. Do not exceed maximum water content as stated on product packaging or an amount that will cause segregation.
- B. Continue to mix thoroughly for approximately 4 to 5 minutes.
- C. Do not mix more material than can be placed within the working time of the repair material. Do not retemper the mix by adding additional water.

PART D – APPLICATION - CONCRETE REPAIR

TROWEL - HORIZONTAL

[For horizontal repair areas with limited reinforcement.]

- A. Substrate shall be saturated and free of standing water, or bonding adhesive shall be tacky during application.
- B. When bonding adhesive is not used, firmly work repair material into roughened substrate completely filling all pores and voids. Firmly working repair material into substrate will maximize bond development. Do not simply drop repair material into area and screed / finish. Whenever possible, place repair material full depth from one side of the repair to the other. Where this is not practical, placement shall be continuous to prevent cold joints.
- C. Once desired level is achieved, screed repair material and finish to desired texture. Do not over-finish surfaces as this will create excess surface water and increase propensity for surface cracking.



PART E - FINISHING AND CURING - CONCRETE REPAIR

5.01 FINISHING

- A. Finish repair material to desired texture when it offers stiff resistance. A wood float, sponge float, brush, or trowel may be used for finishing.

5.02 CURING

- A. No wet curing or curing compounds required after placement. For excessive wind or hot temperature conditions, protect surfaces from rapid moisture loss by covering with plastic sheeting for 2 to 3 hours after placement.

PART F – EXTREME WEATHER CONDITIONS - CONCRETE REPAIR

6.01 COLD WEATHER REPAIRS

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

- A. All surfaces shall be preconditioned and maintained between 45°F and 90°F (7°C and 32°C) and materials conditioned to between 60°F and 80°F (15°C and 27°C). Higher substrate and material mix temperatures will result in faster strength development. Due to the mass of palletized material and bulk packaging, up to 72 hours of conditioning may be required. Presoak area with hot water where applicable.
- B. Heating the repair area 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. Ensure repair material does dry out during heating.*
- C. Maintain temperature above 40°F (4°C) minimum until material reaches 1000 psi (6.9 MPa) or the minimum required strength.
[Specify minimum required strength.]
- D. Gradually allow temperature of material to cool to ambient temperature to avoid thermal shock.

REFERENCE: ACI 306R-88, "Cold Weather Concreting"

6.02 HOT WEATHER REPAIRS

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

- A. Materials shall be conditioned as necessary so that the mixed material is between 50°F and 90°F (10°C and 32°C). Due to the mass of palletized material and bulk packaging, up to 72 hours of conditioning may be required.
- B. All surfaces in contact with material should be preconditioned and maintained below 90°F (32°C).
- C. Cooling of surfaces, materials and equipment can be accomplished by using iced water for mixing and presoaking concrete. Do not put ice directly into repair material. Shade area from direct sunlight or pour material when temperatures are decreasing.
- D. Wind breaks shall be provided when necessary to prevent rapid evaporation.
- E. Repair material shall remain protected and curing shall be dependent on specified product. Cure repair material in accordance with manufacturer's recommendations. *[Specify appropriate curing method.]*

REFERENCE:

ACI 305R-91, "Hot Weather Concreting"