



PSI Cementitious Patching Guide

Material

Use **TuffPatch VOH** for **Vertical and Overhead Repairs** and **TuffPatch DOT** for any **Horizontal or form and pour applications**.

Use neat materials for applications up to 2 inches thick. Use extended materials for repairs exceeding 2 inches.

Consult **PSI's** technical data to determine minimum thicknesses when determining minimum acceptable thickness, especially when working with extended materials.

For ease of application in vertical and overhead repairs, limit lift thickness to 2 inches. Roughen the surface of materials that will receive subsequent lifts, and ensure substrate is clean and saturated prior to placing additional repair material.

Repair Procedure

- Surface preparation:
 - Remove any damaged or loose concrete.
 - Avoid damage to sound concrete that is to remain in place.
 - Unless otherwise approved by the Engineer, use only hand tools or power-driven chipping hammers (15-lb. class maximum) to remove concrete.
 - If more than 1/2 the perimeter of any mild reinforcement is exposed or if the exposed bar exhibits significant corrosion, remove the concrete from around the entire bar.
 - Provide 3/4-inch clearance or 1.5 times the largest sized aggregate in the repair material, whichever is greater, between the steel and surrounding concrete to permit adequate flow of the repair material.

NOTE: A good rule of thumb is that adequate clearance is attained when you are able to wrap your fingers around the bar. Ensuring you can grab the bar is a simple but highly effective method of confirming there is adequate clearance to permit the repair material to flow around the exposed bar.
 - Do not chip around prestressing strands that are exposed anywhere away from the immediate end of the member. Consult the Engineer when patching an area in which prestressing strands have been exposed. When repair dictates that chipping occur around



- exposed strands, the Contractor must avoid striking the strands directly or otherwise causing damage that could lead to wire or strand breaks.
- Use **RustCheck**, abrasive blasting or other approved technique to remove rust from exposed steel surfaces.
 - Saw-cut the patch perimeters to eliminate feathered edges and to ensure that the repair material will be applied in depths no less than ½-inch.
 - Handheld grinders or saws may be used to square the patch perimeters.
 - Do not over-cut the patch perimeters at the corners of the repair areas.
 - When practical, undercut the patch perimeter at an approximate angle of 30 degrees such that the profile will help hold the patch material in place.
 - **Roughen the substrate** to ensure that there will be a mechanical bond between the patch material and the parent concrete. Though difficult to quantify and measure, Contractor should attempt to attain a minimum surface roughness profile of 1/8 inch or CSP (Concrete Surface Profile) 6 per ICRI.
 - If the damage occurs at the end of a member and prestressing strand is exposed, recess the strands a minimum 3/8 inch using a torch or other approved method. Do not overheat or damage the surrounding concrete.

NOTE: In the past some Contractors and Fabricators opted not to recess prestressing strands in spalled areas so the protruding sections could serve as dowels for the patch material. While the strands would serve well as dowels in those circumstances, they could be exposed to moisture and chlorides if the patch fails over the life of the structure. For that reason, it is more important that the strand be completely recessed. Install anchors to hold the patch material in place.

- Mechanical ties that bind repair material to the substrate can greatly decrease the risk of future delamination and spalling. For most intermediate repairs, exposed steel serves that purpose. However, there are scenarios in which no reinforcement is exposed and thickness of the spall dictates that cementitious repair material be utilized. In such cases it is necessary to install anchors to help mechanically tie the patch material to the parent concrete. When no mild reinforcement is exposed, install anchors at no more than 4 inches on center each way or as required by the Engineer. The anchors must consist of one of the following:
 - Stainless steel expansion anchors. The Contractor may propose to use other anchors, such as galvanized or zinc-painted metal lag bolts, all thread, coil rod, etc.



- Rebar or threaded stainless steel pins (1/2-inch diameter minimum) anchored in place using **TuffPoxy 3 FS, TuffPoxy 3 or TuffPoxy 8** with aggregate. Remove any epoxy that leaks onto the patch substrate area after the anchor is placed.
- **If installing expansion anchors:**
 - Drill and clean the holes as required by the anchor manufacturer. Do not use a drill bit that has a larger diameter than that required.
 - Embed the anchor the minimum amount required by the manufacturer. However, the anchor should not be driven further than necessary. In order to function as intended the head of the anchor must protrude into the repair material.
- **If installing dowels, bolts, all thread using structural epoxy:**
 - Drill a hole 1/8 to 1/4 inch greater than the dowel diameter. Make the hole deep enough to permit a minimum 2-inch embedment of the dowel or twice the depth of the surrounding patch.
 - Remove any contaminants from the hole using a brush or other mechanical cleaner.
 - Just prior to installing the anchor, clean the hole using a high-pressure air compressor equipped with filters to remove all oil from the compressed air.
 - Dry the concrete surface inside the hole prior to installing the dowel.
 - Fill the hole approximately 1/3 full with structural epoxy. Twist the dowel as it is inserted. Ensure that the space between the dowel and the concrete is completely filled with epoxy. Remove all epoxy from the concrete surface that leaks from the hole after the dowel is inserted.

NOTE: When using epoxy, it is difficult to properly drill and clean the anchor holes and to place a proper amount of material to keep the anchors in place. If there is too little epoxy, the anchor will not have enough pullout resistance. If there is too much epoxy, the material can leak out of the anchor hole and create a bond breaker on the patch substrate. It is imperative that the Contractor follow the manufacturer's instructions and the above guidelines.
- Where anchors are installed, ensure there will be a minimum coverage of 1/2 inch for stainless steel and 1 inch for non-stainless steel after the patch material is applied. Oftentimes anchors or dowels do not protrude far enough from the concrete substrate, leaving large depths of patch material unanchored to the parent concrete. Contractor should install anchors with the exposed edge of the patch in mind, not the outside surface of the parent material.



POLY-TUFF SYSTEMS
INTERNATIONAL
HIGHWAY DIVISION

- Substrates must be clean and sound. Remove any contaminants, including laitance, oil, dust, debris, or other foreign particles.
- Just prior to patching, blast the repair area using a high-pressure air compressor equipped with filters to remove all oil from the compressed air.

- **Mixing:**

For small applications (less than 1 cubic yard total) use measuring cups or containers to determine the proper quantity of each component per the manufacturer's requirements, then dispense into a clean container. Mix the components thoroughly until they are well-blended (3 minutes minimum) using a low-speed electric drill (400 – 600 rpm) and a clean "Jiffy" type mixing paddle. Do not mix repair mortar or concrete by hand.

- Do not estimate the proper amounts while adding the different components.
- For vertical and overhead applications, Contractors often need to limit the amount of water or liquid component in order to achieve a stiff mix. Consult PSI's literature for minimum requirements.
- If extending the mortar to produce concrete, add aggregate and mix in accordance with the manufacturer's requirements.

When mixing more than 1 cubic yard use a mortar mixer, volumetric mixer, or other method approved by the engineer.

Many cementitious repair materials have relatively short working times (15 to 30 minutes).

- Do not mix materials until the surface preparation is complete and the substrate is ready for application of the repair material.
- Mix only the amount of material necessary for immediate application.
- Do not attempt to make the material workable by over-mixing or adding additional liquid after it has begun to set.
- Overmixing can reduce the compressive strength and increase the permeability of the material.
- **The beneficial properties of bagged mixes are often lost when the repair material is retempered.**



- Application: Hot and cold weather application:
 - The temperature of the patch material and the concrete substrate at the time of application must be between 40°F and 95°F. Contractor must also adhere to manufacturer limits if they are more stringent.
 - Do not apply patch material when the ambient temperature in the shade is below 40°F and falling. Patch material may be placed when the ambient temperature in the shade is 35°F and rising or above 40°F.
 - Shade the repair material components and the patch substrate if the ambient temperature is above 100°F.

In almost all cases, the repair material should be applied over a Saturated Surface Dry (SSD) substrate. Obtain an SSD condition using one of the following methods:

- **Horizontal:** Pond water over the substrate for a minimum of 24 hours if possible.
- **Vertical:** Several minutes before patching, apply high-pressure water blast to the surface for a brief period (1 or 2 minutes depending on the porosity of the concrete). An SSD condition is achieved if the surface remains damp until the patch material is applied.

Surface may be damp, but must be free of standing water.

Do not use a proprietary epoxy bonding layer in lieu of an SSD substrate unless approved by **PSI**. If use of a bonding agent is authorized/required, mix it in accordance with the **PSI's** requirements.

If trowel-applying the repair material:

- Apply over a bonding layer, which typically consists of a scrub coat brushed into the SSD substrate.
- The scrub coat consists of a thin layer of repair mortar that is pushed into the surface using a stiff brush, completely covering the substrate and filling all voids. Ensure that there is not an excess amount of water on the brush used to apply the scrub coat.
- Do not dilute the scrub coat material with additional liquid.
- Apply the repair material while the bonding layer is still wet (scrub coat) or tacky (proprietary bonding layer).
- Apply in minimum 1/2-inch and maximum 2-inch lifts unless otherwise approved by **PSI**.
- For multiple lift applications, roughen the surface of the preceding lift before it has reached initial set.
- Wait until the preceding lift has reached initial set (30 minutes minimum) to prevent sagging prior to applying the next lift.



- Wet the surface just prior to applying the subsequent lift.

If patching, using a form-and-pour method:

- Prepare and install the forms prior to mixing the repair material.
- Ensure that forms are tight enough to prevent grout leakage.
- Place the repair material in the forms while the bonding layer is still wet (scrub coat) or tacky (epoxy).
- Consolidate the material by rodding, vibrating, and/or hammering the forms. Do not over-vibrate the mix.

If required by the Engineer, determine the compressive strength of the patch material by making concrete test cylinders or mortar cubes.

- **Curing:**

Failures often occur in cement-based repair materials due to inadequate curing.

- Large plastic shrinkage cracks can develop if rapid moisture loss occurs before the patch has the capacity to resist tensile loads that develop as a result of the shrinkage.
- Drying shrinkage can lead to elevated stress levels that cause cracking within the repair material or at the bond line between the patch and the parent concrete.
- It is paramount to the long-term success of the repair that proper moist curing commences as soon as possible after application of the repair material, and that it continues for a sufficient amount of time thereafter.

After placing repair material, use **TuffCure P** non resin based curing compound or moist cure exposed patch material surfaces for a minimum of 72 hours using wet mats, water spray, or ponding. Do not use any resin or acrylic curing compounds in lieu of moist curing unless approved by **PSI**. If use of another curing compound is authorized, any remaining residue must be completely removed after the required curing period. **TuffCure P** requires no preparation before applying any top coating or paint.

In form-and-pour applications, leave forms in place for a minimum of 72 hours after placing the repair material. Place wet mats on exposed sections and over the openings used to place the material.

The Engineer may reduce required curing time in some cases, such as when there is a need to return the member to service quickly or when CFRP will be placed over the patch material.

Do not allow concrete surfaces to become dry during the specified moist curing period. Ensure that wet mats are kept wet during the entire cycle or reapply **TuffCure P**.



POLY-TUFF SYSTEMS
INTERNATIONAL
HIGHWAY DIVISION

Insulate the patch material to ensure that there is adequate heat for curing if ambient temperature is expected to fall below 50°F. If using artificial heating methods, do not heat the air around the repair material to above 130°F.

- **Finish**

Ensure the patches closely resemble the surrounding concrete. Blend in the repair area if after completion, the patch material does not closely resemble the surrounding concrete. The Contractor may use a slurry coat finish to blend in the patch.

Patches should not be easily discernible if viewed from more than 25 feet away.