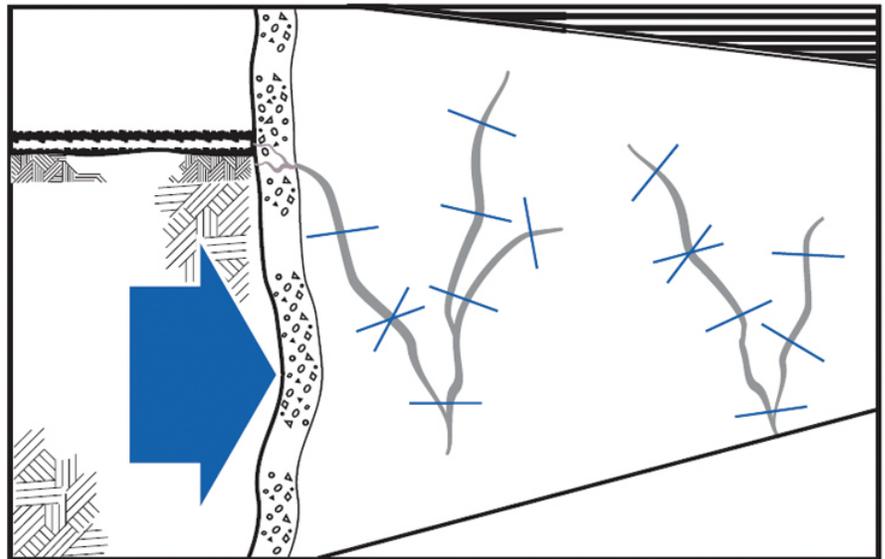
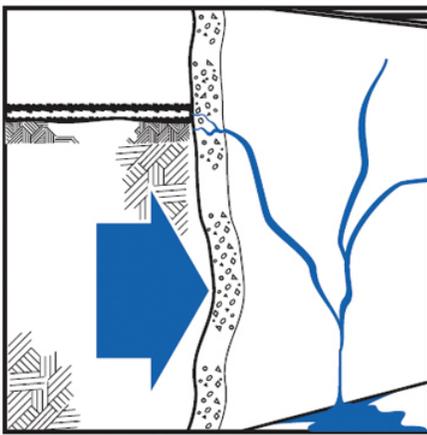




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(800) 348-1316  
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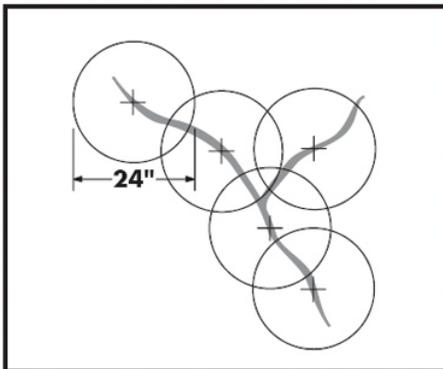
## Carbon Fiber Staple Installation Instructions

Carbon fiber countersunk staples are installed in conjunction with the repair of a foundation crack using low-pressure injection. This kit includes all of the materials required for attaching the repair staples. Jake dual cartridge dispenser and crack injection materials sold separately.



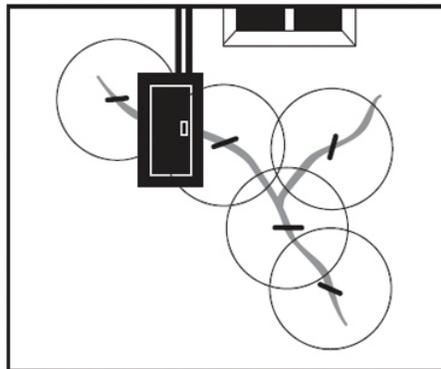
This product is intended to accompany a typical crack filling procedure. This kit includes only enough epoxy for attaching the repair straps. The crack injection must be fully cured before using this product.

### LAYING OUT THE JOB/ PREPARING THE WALL

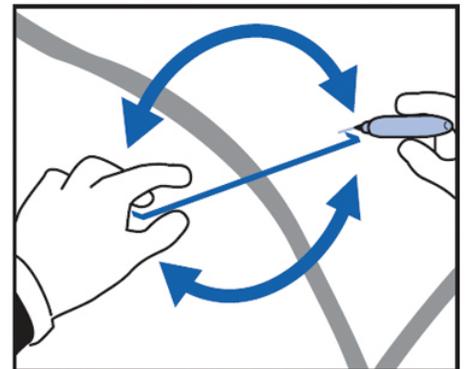


**Step 1** Measure the length of cracks and divide the length into 2 ft. segments.

**IMPORTANT:** There must be no more than 24" between segments.



**Step 2** Make sure that no obstructions interfere with the planned strap locations. Mark the location.

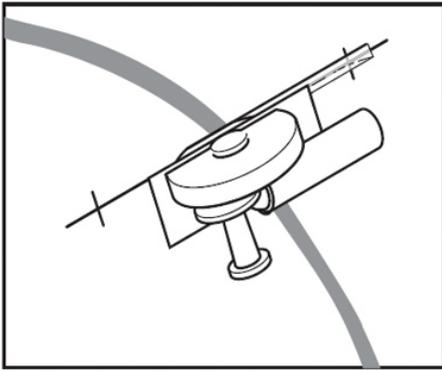


**Step 3** Hold staple over the determined location at the appropriate angle and mark.

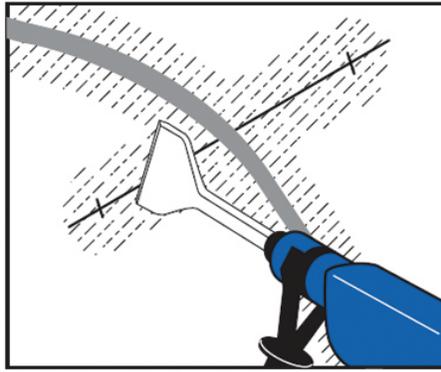
See the included guidelines to help determine the correct orientation of each staple according to angle and nature of the crack.



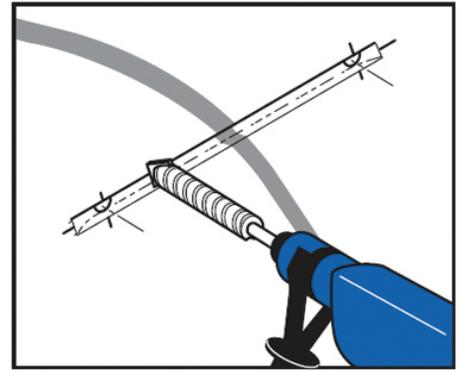
**CAUTION:** Carbon Staples can shed very fine splinters. Use gloves at all times when handling staples.



**Step 4** Use the Wall Slotter to cut a groove 1/4" deep where the staple is to be applied.



— If you don't have a wall slotter to inset the staple, mount a 3" chisel and prepare the concrete surface around the crack and where the staple will attach.

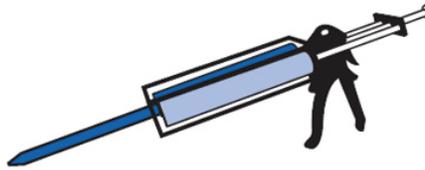


**Step 6** Mount a 1/2" dia. masonry drill and make a hole 1" deep at each mark.

## APPLYING THE REINFORCING STAPLE

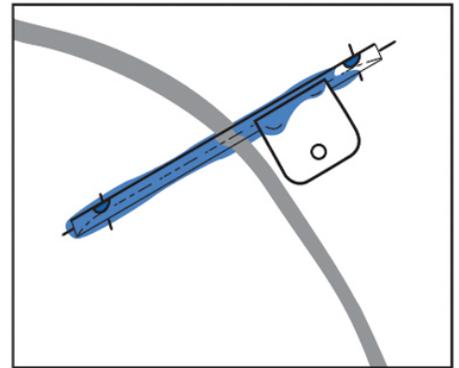
For proper adhesion, the wall surface within this space must be **FREE OF PAINT** and as smooth as possible. Use a grinder to remove all bumps and irregularities in the wall, as well as any surface latency in the epoxy area.

**NOTE:** This area must also be cleaned free of all dust before you can proceed.

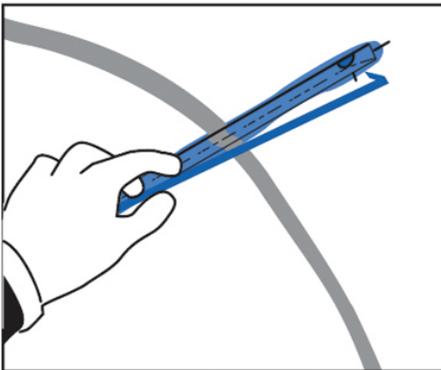


**Step 1** Load the double-cylinder epoxy cartridge into the Jake applicator and "burp" the cartridge so that an even flow of material exits both cylinders. Then fasten the Static Mixing Tube to the end of the applicator. The epoxy will mix to a uniform green color.

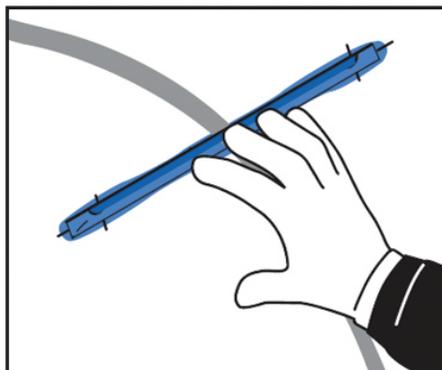
**Tip:** The warmer the epoxy adhesive is, the faster it will set. You can save setting time by warming the epoxy. Do not exceed 120°F.



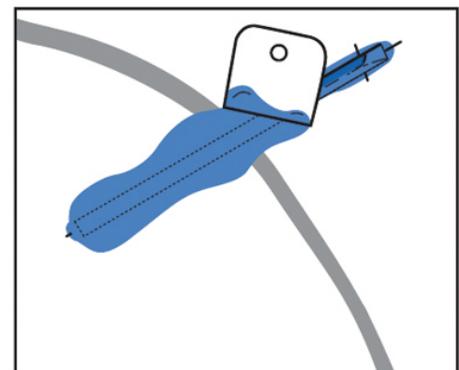
**Step 2** Fill the two holes and apply a coat of epoxy between them. Put on as much adhesive as needed to make a smooth, flat, layer 1/8" thick.



**Step 3** Wearing protective gloves, position the staple over the two holes.



**Step 4** Push the staple into the epoxy until it touches the wall.



**Step 6.** Use the trowel to push epoxy to fill gaps and unfilled spaces. staple must be completely covered with epoxy when finished.



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St. Paul, MN 55117  
(800) 348-1316  
[www.leaktools.com](http://www.leaktools.com)

## Carbon Fiber Staples for Stitching Cracks in Concrete

Understanding crack movement: The first step is to understand the variables which can cause cracking. Cracking of concrete is a natural consequence of the concrete going from a plastic state to a solid state, due in part to stress caused by temperature change and restraint. This is often referred to as drying and shrinkage cracking. Depending on the moisture content, this process is over within a maximum of 3 years. In poured concrete, cracks are usually vertical in nature. The concrete will typically perform the way it was designed after chemically welding the crack back together.

Structural Cracks: This cracking pattern will be larger in diameter than shrinkage cracks and usually more of a 45-degree angle. Understanding settlement vs. lateral loading allows for proper procedure of repair. If settlement exists, no method of repair will withstand the in-differential and loading resulting from the settling (whether it be grouting and sealing, or epoxy/urethane grout injection).

Lateral loading may present the same cracking patterns as settling (with the exception of mapping out cracks into floor slab). Distinguish whether there are lateral load or settlement problems. Always check for proper seal plate anchorage (or building staying put and foundation sliding inward). In either settlement or seal plate slide conditions, the problems need to be corrected or cracking will continue (in some cases elsewhere in foundation).

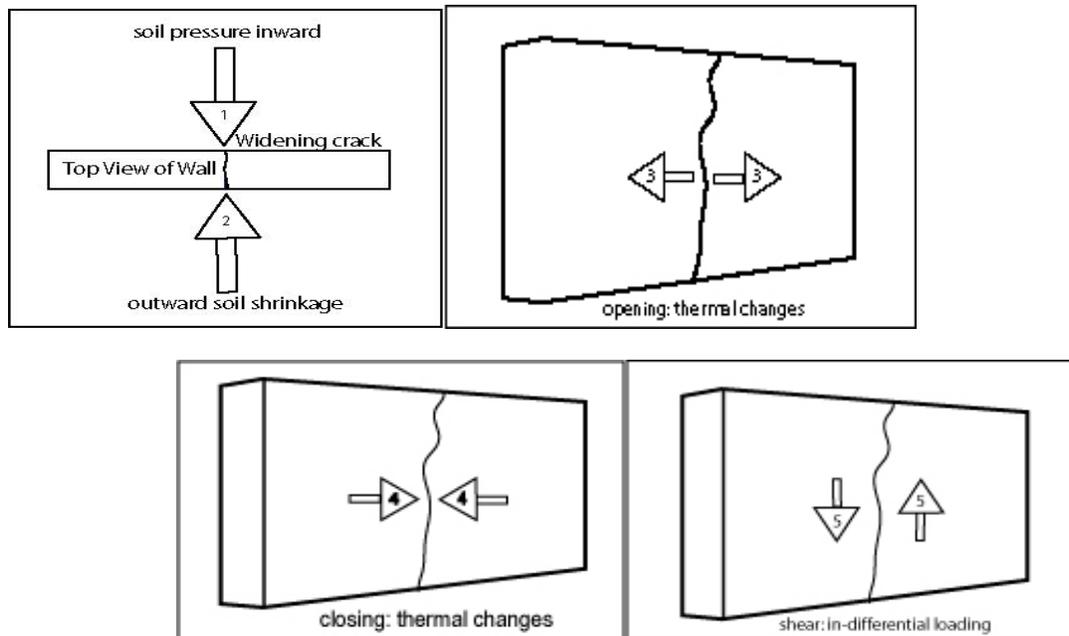
In drying and shrinkage crack repair, the most commonly used technique is a standard epoxy injection or urethane grout. Stitching has proven to take the load away from the repair material glue line and increase long-term success. Time is the enemy of a successful repair of concrete and the interaction between repair material and concrete substrate.

Structural cracking in poured concrete: The goal is to return a given structure to its designed condition. You must diagnose and solve initial problem before addressing the cracking. Failure to address cracks will allow cracks to worsen with time. Cracks that are larger than 3/8 of an inch may require a gel epoxy rather than a low viscosity epoxy. By their nature, gels or pastes have less wetting or bonding capabilities than liquid materials. Stitching provides a superior upgrade to these types of repairs, when done in conjunction with crack injection.

How cracks move: Understanding the movement of cracks increases the success rate of repair. There are 6 ways in which a crack in a below grade poured concrete wall generally moves:

1. Tensile / inward: due to lateral loading
2. Outward: due to shrinkage of soils
3. Opening: due to thermal changes
4. Closing: due to thermal changes i.e. cold, wet, dry, etc.
5. Shear: due to in-differential loading
6. Combination: all of the above conditions, plus the added load of structure

## Examples of crack movement:



There are actually more factors than 6, but these are the most common. Many of these six, if not all, are the same in masonry walls (although their behavior is somewhat different)

Imagine one repair material and technique that address all 6 movements.

Carbon fiber reinforcement or steel has little benefit without making concrete one again. A poured wall with 3 cracks is actually 3 separate sections of concrete, susceptible to all 6 movements. In most cases the wall was not designed to be 3 individual moving sections, unless control joints were part of original design. All control joints must be respected for their purpose. Understanding these principles is the difference between successful crack repairs or mind-boggling failures.

## **How Carbon Fiber Staples for Stitching Cracks Work:**

**Epoxy injection:** This is the best marriage because the two work in harmony. The epoxy does the work of #2 because it creates a wedge instead of a hinge point. It also does the work on #4; the crack cannot close due to its high compression. On numbers 1, 3, 5 and 6 it also performs well to a point. The carbon fiber excels in #1 and #3. It can also increase success in #5 and #6. In #1, the inward movement is a tensile force which carbon is tailor-made for. #3 is also a tensile force. In #5 and #6 you have a combination tensile force or pulling and shear forces. The carbon fiber can be aligned for tensile in a shear force.

**Polyurethane injection:** Carbon fiber stitching can increase long-term success of polyurethane injections. However, in some instances, they may fight each other over different goals. Urethane by design works by allowing for crack movement. Carbon's purpose by design is to arrest crack movement. Interestingly enough, movement alone is not the enemy of urethane, but rather too much movement. This is where carbon stitches aids polyurethane injections. By eliminating some of the 6 movements, stitches allow the urethane to function better for its designed movement capabilities. Urethane grout is very good in compression but has limited tensile properties. Carbon fibers help dramatically in #1 inward and #3 opening, but help very little in #2 outward and #4 closing of crack. A high compressive material such as epoxy, or cement based grout, must be pushed into face of crack to eliminate #2 outward, #4 closing and #5 shear when using urethane foam as well as aligning carbon properly for shear movement with #5 and #6.

Such materials act as a wedge in these hinge conditions, thus allowing foam to perform to its primary strengths. NOTE: This is not easily done on small or tight cracks. Short of filling entire crack with a high compression material, there is no way of knowing if wedge is sufficient for arresting conditions of hinging.

Carbon vs. Steel: Have you ever seen steel re-rod bend? Once it is bent, it will not bend back to original form. Carbon loads up much quicker, and will not move back. That is why it is important to understand outward movement, etc. Carbon can be used in tensile and in shear by placing loading in tensile or redirecting load.

Carbon fiber staples for stitching cracks: The next logical step in the progress from steel stitching dogs and the creation of flat carbon stitches is the Carbon Staples. They are 12 inches long on profile.

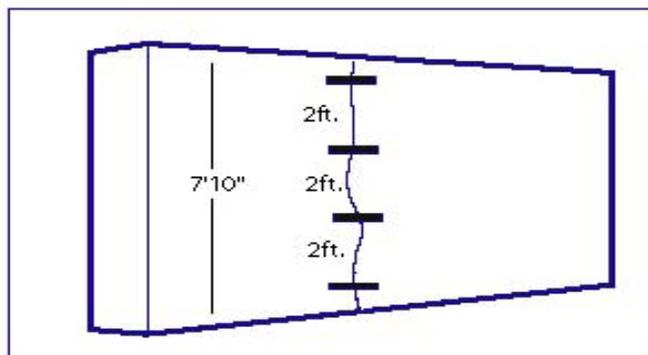


Anchoring: By anchoring ends of staples into concrete or masonry, fewer loads are exerted on weak surface substrate and transferred into actual concrete or masonry. This improves its entire inter-workings with the repair material of choice.

Spacing: Many engineering organizations (such as The American Concrete Institute and The Army Corp of Engineers) make reference to stitching dogs, stapling, and doweling. Due to the intertwining of the 6 factors discussed earlier, they only make recommendations rather than guidelines.

For instance, you may repair a crack in tension unaware of shear movement and suffer failure due to combination loading. To calculate actual movements and loadings is difficult. However you can assume movements and gain assurance of a successful repair based on experience and education.

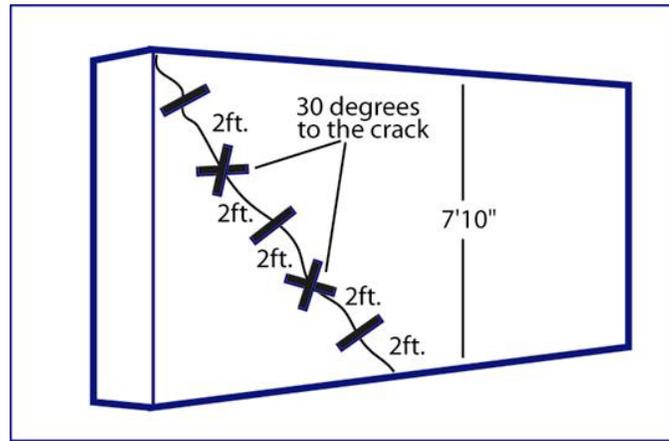
Guide for Stitching Cracks: Most common drying and shrinkage cracks are vertical (basically straight up and down) and are mostly affected by tensile forces:



Note: Carbon fiber tows are perpendicular to the crack face to maximize tensile function in conjunction with injecting the crack.

Stapling Structural cracks: These are usually caused by settlement, lack of reinforcement, in-differential loading, or improper anchorage at top or inadequate concrete. Once cracking occurs, lateral forces also contribute.

Stapling Structural cracks: These are usually caused by settlement, lack of reinforcement, in-differential loading, or improper anchorage at top or inadequate concrete. Once cracking occurs, lateral forces also contribute.



Note: These types of cracks experience all six loads. Carbon fiber and repair materials are not very good in shear loads, which may be the dominant movement. However, aligning the carbon tows at 30 degrees to the expected shear loads will load the carbon in tension, allowing carbon to function in shear.

Finally: The straight Carbon Kevlar Grid Strap works similar to the Staple. The Staple simply improves the bond, pull-off and performance on cracking because of less surface area relative to the straps.

This is designed to be a simple guide to understanding crack movement and carbon fiber function in repair, not Technical Specification in nature.