Foundation Crack Repair

BEST PRACTICES

Permanent Solutions

Dry Foundation, Healthy Home

Emecole Metro LLC
www.emecole.com
Since, 1987, I have been manufacturing and supplying a complete line of epoxy and polyurethane foams, the “Jake” Manual Dispensing Gun, along with the necessary accessories for the repair of poured foundations using low pressure injection. As the president of Emecole, I have seen the low pressure injection process used on a daily basis by contractors throughout the United States and Canada. My continued interaction with these contractors allows me to witness just how effective low pressure injection truly is.

My initial idea was to somehow duplicate the convenience of the standard caulk gun, by developing a more efficient tool equipped for the injection of two-component materials – either epoxy or polyurethane foam.

With the development of my spring-assisted manual dispensing gun, the injection of these materials at low pressure became a reality. This gave me the impetus to develop a line of epoxies and polyurethane foams specifically formulated to accommodate these types of crack repairs.

Since, 1987, I have been manufacturing and supplying a complete line of epoxy and polyurethane foams, the “Jake” Manual Dispensing Gun, along with the necessary accessories for the repair of poured foundations using low pressure injection. As the president of Emecole, I have seen the low pressure injection process used on a daily basis by contractors throughout the United States and Canada. My continued interaction with these contractors allows me to witness just how effective low pressure injection truly is.

The low pressure crack injection process has given contractors a more efficient and affordable solution for the repair of poured foundation cracks. Today, society is becoming more conscious of basement and whole home health. The waterproofing of basements, which includes the repair of foundation water leaks, has become a high priority among homeowners, not only for keeping moisture and soil gases (such as radon) out of the basement but preventing formation of molds, mildew and other allergens which could otherwise permeate the living area of a home.
Before discussing the repair of concrete cracks, it is first necessary to discuss how and why concrete cracks.

The first reason is when moisture permeates tiny breaks within the concrete substrate. These breaks occur during the hardening process of the concrete with the evaporation of water from the cement mix. In colder climates, the freeze-thaw cycle of moisture results in expansion and contraction around the foundation. The tiny breaks within the concrete begin to enlarge and therefore become full-fledge leaking cracks.

In discussing typical foundation cracks in the basement, water seepage occurs when there is sufficient hydrostatic pressure in the surrounding ground. It also occurs when the water table is exerting sufficient hydrostatic pressure to leak through cracks in the basement slab or the seam formed where the wall meets the floor – also referred to as the cove.

The second reason crack formation occurs is a result of movement around the foundation. As the ground stabilizes, any movement can cause the rigid concrete substrate to separate where the tiny breaks within the concrete exist. These tiny breaks become large enough to leak water.
In extreme situations, the ground remains unstable, and therefore added stress on the concrete is sufficient enough to cause cracking. In this instance, the added stress, or movement, is exceeding the strength of the concrete substrate. This type of problem should not be addressed unless done jointly with soil stabilization, piering or mud-jacking to eliminate the cause of continuing settling or movement.

If the ground remains unstable and continues to put stress on the concrete ................................

**cracking will occur in other areas**
The injection of epoxy at high pressure has been a viable component for the repair of bridges, columns and roads for over 50 years. The same process was eventually used in residential homes, specifically in the Midwest and New England, for the repair of poured foundation cracks in basements. The use of high pressure injection with epoxy was used in cracks that were structural in nature, as well as non-structural water leaking cracks. The use of polyurethane foams or grouts have since joined injection epoxies as products of choice in repairing leaking poured wall foundations.

Low pressure injection is recommended for concrete foundations for several reasons. First, high pressure tends to be more costly to both applicators and homeowners. High pressure injection requires the maneuvering of large equipment, in addition to the need of having to drill into concrete - all of which means that the time spent at the job is significantly longer.
As previously stated, the low pressure injection process for repairing foundation cracks has become a cost effective alternative to repair using high pressure. It is important to specify that low pressure crack injection is applicable to poured foundations. Homes today throughout most of the country are now built on poured foundations. Previously, homes commonly were built on concrete block, which unfortunately can not be repaired using low or high pressure injection.

Leaking cracks in concrete block can only be dealt with by incorporating some form of an internal drain tile system or an above the slab base-board approach.

**Crack Injection Skepticism**

There is an old-school of thought that must be put to rest. There continues to be some waterproofing contractors in select parts of the country who still recommend repairing poured foundation cracks using the same expensive methods they learned while repairing cracks in concrete block. Specifically utilizing outside excavation and/or inside drainage systems. Crack injection involves a less intrusive approach to your customer’s basement leak and wallet.

For example, drainage tile repair of a poured foundation wall involves diverting the water after it has already entered the basement. As a result, humidity in the basement can increase, creating an ideal environment for the growth of mold and mildew, unless the system happens to be a closed one. The installation of an internal and/or external drainage costs thousands, not hundreds of dollars. An internal drainage system typically involves the breaking up of the basement slab and takes days to complete rather than two hours or less for the crack injection method. The installation of a drain tile system may be worth considering with poured foundations as additional security against future cracking of the foundation.
Defining Low Pressure Crack Injection

Low pressure injection utilizes surface ports placed directly on the surface of the crack as the entry point of the injection material. While this technique can be utilized at up to 250 psi of injection pressure, I do recommend keeping the pressure at 20 to 40 psi.

The secret to effective crack injection, whether epoxy or polyurethane foam, is patient, low-pressure introduction of the liquid polymer into the crack. Low pressure, approximately 20 to 40 psi, allows the applicator to properly monitor the injection process. At this pressure range, the applicator can be confident that the crack has been saturated with the injected material up to that point when liquid begins to collect at an adjacent surface port.

At the 20-40 psi range, neither the epoxy nor the polyurethane liquid can overcome gravity. Therefore, when injected into the crack through the surface port hole, the liquid resin can only flow to the back of the crack and after this point begin to fill the crack upwards.

As a consequence, when the filling process reaches the level of the port above the initial port, it will begin to leak out of the second port. The applicator knows that the crack is filled completely up to this port. The applicator can then cap shut the initial port and pump liquid into the second port until liquid comes out of the next port. By continuing this process to the top of the crack, the applicator knows that the

At pressures above 40 psi, the liquid resin can overcome gravity and take the path of least resistance. This is often the front half of a crack which is typically larger than the back of the crack. As a consequence, the liquid may fill upwards only filling the front half of the crack. It can reach the level of the port above the port being injected without filling the entire depth of the crack. The applicator cannot determine whether the crack is filled, only that a portion of the liquid has reached the next port. The incomplete filling of a crack is the number one reason that polymer injection of a crack can fail in eliminating crack leakage. Keeping injection pressure at less than 20-40 psi eliminates this possibility.
Epoxies and polyurethane foams are typically two component systems – each of which requires precise proportioning. The development of dual cartridge dispensing has significantly simplified the equipment needed for many applications. It is now possible to dispense fast reacting dual-component systems with equipment which require little maintenance and virtually no cleanup. One can utilize manual dispensing tools which generate sufficient and controllable force to inject both epoxy and polyurethane foam systems.

It is important to note that it is best to choose a dispensing gun with a spring attachment to control injection pressure at 20-40 psi. Other manual guns without such spring control are capable of generating pressures in excess of 100psi which can lead to incomplete filling of the crack. Air-powered tools are also available for dual cartridge dispensing and have the means of controlling injection pressure.

A common question that I receive from contractors pertains to the use of dual cartridge dispensing versus more expensive two component dispensing equipment, which requires more maintenance. Even if the applicator has such equipment available, it may be more practical and/or economical to use dual cartridge dispensing when repairing foundation cracks. The advantages of mobility and minimal cleanup may overcome the cost advantage of beginning with bulk-packaged product versus dual cartridges. As a rule of thumb, if the application calls for less than three to five gallons of material usage, dual cartridges may be the more effective approach.

Two component manual dispensing tools are not costly relative to automatic dispensing machines; the price range is typically 50 to 150 dollars versus 2 to 10,000 dollars. In many applications, such as low pressure crack injection, any of these dispensing methods are viable and it typically gets down to economics. It is less costly to purchase material packaged in five gallon pails or drums than packaged in dual cartridges. However, the clean-up and maintenance of this equipment can end up being more costly because of the extra labor involved.
The pre-injection phase involves the placement of surface ports and the application of epoxy surface seal paste. The epoxy surface paste serves two distinct purposes. It first acts as an adhesive when placing surface ports on the foundation. The remaining surface seal paste is used to cover the surface of the crack.

There are several conventionally formulated epoxy surface seal pastes which harden sufficiently to a thin film in less than three hours, at which time, injection of the crack can begin. Mercaptan based epoxy pastes, however, still are the best suited for those applications which require injection within 20 to 30 minutes after beginning the sealing of the surface of the crack and still offer the applicator and adequate working time of seven to 10 minutes to seal the surface of the crack other than the immediate surface port area. Past objection to using mercaptan-based epoxies was the rotten egg sulfur odor. Newer formulations are now offered minimizing this problem without sacrificing working time.

Styrene-based car repair pastes, such as Bondo, are sometimes used for crack sealing as a more economic alternative to epoxy surface seal pastes. These products are not as effective in sealing the crack and material leakage is more common than with surface seal paste. More critically, the odor of these materials is significant and the vapors are toxic, requiring good ventilation while in use.

Hydraulic cement is often used to seal when the crack is actively wet and the surface cannot be adequately dried for the surface seal paste to be applied. The ports, however, must be anchored within the crack’s surface, as the hydraulic cement cannot otherwise keep the ports from “blowing off” the surface during injection.

Preparation of Concrete Surface:

For the sake of this discussion, we will assume that the material used to seal the crack is indeed an epoxy surface seal paste. Before applying it or any surface ports, it is first necessary to prepare the concrete surface by removing any loose or flaking concrete with a wire brush or by sand blasting. Either way, the surface should always be wiped, and must also be dry prior to applying surface ports and surface seal paste.
Placement of Surface Ports:

As previously mentioned, the epoxy surface seal paste used to cover the crack’s surface may also be used as an adhesive to properly glue the ports to the wall. Surface ports eliminate the chore of drilling into the concrete, which reduces labor, time and clean-up. To glue the port to the wall, we first mix a small amount of the surface seal paste and apply it to the flange portion of the port. It is important that the hole of the port is not covered. After applying the paste to the port, place the port directly over the crack and press firmly to ensure a strong bond. The ports are placed eight to 10 inches apart along the crack. For wider foundation cracks or in corners where standard surface ports cannot be utilized, a corner port should be more suitable.

Application of Epoxy Surface Seal Paste:

After the surface ports have been placed on the foundation, the next step is to cover the rest of the surface of the crack using epoxy surface seal paste. Surface seal paste is typically formulated to cure anywhere between 10 minutes to four hours. The long working time with some surface seal pastes are better suited when fixing more than 40 feet of cracks in one location. The more surface seal paste that is mixed at one time, the faster it will cure. To avoid waste of material, mix in small amounts.

The fast setting surface seal paste makes an excellent seal over the crack, with high bond characteristics which allows injection easily at 20 to 40 PSI pressures. The entire exposed crack should be covered with surface seal leaving only the surface injection port hole uncovered. The surface seal paste should extend one to two inches on either side of the crack and feathered edged to reduce seepage.

Surface Seal Paste can cure anywhere between 20 minutes to four hours, pending on the product used. Manufacturer instructions with any product used should properly specify such curing times. After the recommended curing time, you can test to make sure the surface seal paste is ready for injection by using your fingernails. If the surface seal is “fingernail hard,” there will be no impressions left from your fingernail. At this point, you will know that you are ready for injection. It is recommended that injection is completed the same day that the surface seal paste was applied. This is especially important when repairing structural cracks, which move when concrete goes through a temperature cycle normally occurring over a 24 hour period. Surface seal paste has the potential to crack open if such movement within the crack has not been restrained by the injection material.

Stabilizing Injection Material & System Components:

After the surface seal paste has properly cured, the next step is to stabilize injection material and system components. In packaging the epoxy or polyurethane foam in their respective dual cartridges, it is probable that air was entrapped and that both parts are not at the exact same level.

The proper procedure is first to remove the plugs of the cartridges and attach an appropriately sized mixer with a retaining nut. The cartridge is then placed into the manual dispensing gun. It is necessary to hold the gun with the mixer pointing upwards – this allows any trapped air to rise towards the front of the tubes. The cartridges are pressurized by moving the plungers forward until the air is forced out of the cartridges you may need to continue pushing until the plungers are even. Any material that has passed through the attached mixer should be discarded. After this process, you should be ready to begin injection.
Injection Process:

This discussion will be relevant to the use of either epoxy or polyurethane foam. I will specifically address the differences between these two materials on the following page.

Injection begins at 20 to 40 psi into the lowest port on the wall, until the injection material begins to flow from the port above it. As soon as this occurs, you plug the first port with the provided cap, and move up to the next port, repeating the process until the entire crack has been filled.

Removal of Surface Ports:

The removal of surface ports may take place after the injected material has fully cured – this will vary depending on the injected material used. When using conventional epoxies, surface ports can typically be removed after 24 to 48 hours, assuming that the basement is at room temperature. When using polyurethane foam, removal of surface ports can be done after one to two hours. This allows adequate time for the epoxy or polyurethane foam to penetrate into the cracks and harden.

The ports can be removed by striking with a trowel or hammer. If a cosmetic appearance is preferred, the surface seal can be chipped or ground off with a sanding disk. The surface seal is paintable if grinding is not desired. If grinding, you should wear protective clothing and mask.

Since the curing of injected material may take several hours, the surface port removal process is often done by the homeowner. In some scenarios, a contractor may return later to remove the ports himself, pending any prior arrangements between the contractor and the homeowner. Another viable option is to simply leave the surface ports as they are.
Epoxy and Polyurethane Foams

The question often arises as to which is better in low pressure injection - epoxy or polyurethane foam? If the crack needs to be structurally repaired and the area needs to be as strong as, or stronger than the concrete around it, the answer is simple. You will use epoxy.

The answer is less simple if the crack needs only to be repaired to prevent water leaking through it. Either epoxy or polyurethane foam can accomplish this task. The applicator typically chooses the material they are most experienced with. It is worth mentioning that polyurethane foams are typically more “user-friendly” and require less material than epoxies as a result of its foaming capability. Polyurethane Foams can be seen as a less costly repair.

Epoxies have the advantage of introducing structural integrity, whether needed or not. Epoxies used for structural crack repair are often used in-conjunction with carbon fiber countersunk staples. I will discuss the use of staples later in this presentation. Meanwhile, polyurethane foams are often more versatile when the crack is actively leaking at the time of repair, or if the area is still subject to limited movement.
Hydrophobic and Hydrophilic Polyurethane Foams

When discussing polyurethane foam, it is important to identify the two specific types and how each may affect your job. Such polyurethane foams used in low pressure injection to prevent water penetration through concrete cracks are said to be either hydrophobic or hydrophilic in behavior.

Both types can be used to stop water in concrete crack repair, and are best suited for permanent repair of most leaking basement cracks where there is minimal movement or water is present, unless there are structural issues.

A hydrophobic system will absorb and mix with only as much water as is needed to complete the foaming and curing of the two polyurethane foam components. A typical hydrophobic system will expand up to 30 times its initial volume. Historically, most hydrophobic foams were rigid and could be brittle if not carefully formulated to be more stable. As a consequence, concrete crack repair contractors initially used hydrophilic systems to stop water. Today, there are hydrophobic formulations available which are flexible and stable, and are suitable for concrete crack repair. They bond well to concrete, do not shrink even in the absence of water, and can expand enough to fill voids behind the crack economically.

Two component hydrophobic systems can be formulated where one side contains the catalyst and the other side contains the reacting ingredients. These systems require very little water to initiate the foaming reaction. There is typically enough water present in a crack to initiate the reaction. Thus unlike hydrophilic systems, where water is typically first mixed with the hydrophilic, these hydrophobic systems do not react until already present in the crack and have time to fully permeate all parts of the crack before beginning to foam. A hydrophilic system will usually be foaming before entering the crack, and can clog up the mixing unit before entering the crack. A hydrophobic system has time to not only permeate the crack but to fill any void behind the crack.

A void is a separation of the foundation wall and the back-fill which can allow collection of water behind the crack and cause it to leak. A hydrophobic will react with the water, filling the void as it forms a rubber membrane behind the foundation which blocks water from reaching the crack to cause leaking. These systems work very well in residential basement concrete crack repair, especially when packaged in dual cartridges.
A hydrophilic system acts like a sponge and will absorb as much water as is available in its surroundings during the foaming process. It reacts with the amount of water needed for reaction and subsequently contains the excess water within its structure, as would a sponge. In dry circumstances, some of the excess entrapped water can evaporate and result in a shrinking of the foam. When water is again present, the foam can absorb the water and return to its original size, as would a sponge (at least theoretically).

A typical hydrophilic system is very flexible and has good adhesion to concrete, even better than hydrophobics, and thus bonds well to the sides of a concrete crack. This excellent adhesion, plus flexibility, can minimize the shrinkage in a crack. In the foaming process, a typical hydrophilic will expand 2 to 4 times its starting volume. It is an excellent product where there is limited movement around a crack which is greater than 3/8 of an inch, and where its flexibility can be realized. It is also effective in situations where water is always present. It is not well suited in dealing with a void behind a crack, where the hydrophobic foams are recommended because of their expansion and non-shrinkage features.

In summary, hydrophobic systems, which have been modified for flexibility and good adhesion, are excellent choices for most basement concrete crack repair. Hydrophilics are good where there is minimal movement and/or water is always present.
In the past, an objection to injection crack repair, especially when using epoxies, was the possibility that on-going movement around the foundation could either re-open the initial repaired crack or re-crack immediately adjacent to the original repair. While this is a valid concern and something that occasionally happens, it can be properly addressed.

It is a fact that very few crack repairs fail immediately. More times than not, it is the long-term creeping and fatiguing of concrete with the movement of foundations that causes concrete to crack. Epoxies alone cannot guarantee that further movement of the wall is arrested. The crack may re-occur in the same area without further stabilization. This stabilization can be typically attained by cross-stitching a crack repair with carbon fiber countersunk staples. Cracks that can move do so because they are allowed to move, not necessarily because they need to move for concrete to function as designed. Repairing a crack which is exhibiting structural damage - namely that the stress being put on it is exceeding its strength - needs to be reinforced. By applying staples across the face of the crack, the load is distributed away from the bonding line to the portion of the concrete that is not cracked. This prevents fatigue and re-cracking at the injection bonding line.

### Carbon Fiber Staples for Foundation Cracks

While on this discussion, I briefly would like to make mention of cracks in concrete slabs, most typically referring to floor cracks in basements and garages, as well as cracks in driveways and pool decks. Such cracks are repairable with the appropriate filling material – most typically a polyurea. These cracks may be chased and opened to ¼ to ½ inch deep and across. If the crack is acting as a control joint, it is filled in with a semi-flexible polyurea sealant commonly used to fill warehouse control joints. If it is a shrinkage or stress crack, the chased crack is filled with dry sand and a polyurea product is used to encapsulate and seal the crack. In regards to the cove area, which is the space where the wall meets the floor, a very flexible sealant is used to seal the space.

It is also worth mentioning an important precaution in regards to the seepage of water. If water is indeed coming up through any of these floor cracks, it is necessary to examine the drain system. The polyureas used in floor crack repair typically will not prevent water seepage from coming through the cracks. You do not want to address these floor cracks until a drain tile system has been added to the repair, or an existing drainage system has been repaired.
Added Emphasis on Indoor Air Quality

Until recently, basement waterproofing just meant keeping water from entering the basement via cracks in the walls, basement floor, and the cold joint formed at the intersection of the wall and the basement floor or slab.

More than 50% of the air in the living area of a home originated from the basement and/or crawl space.

Today, basement waterproofing is now focused on improving the indoor air quality of the entire home. Air pollutants and water vapor can enter the basement and crawl spaces through cracks in the foundation and floor. In addition, soil gases, including radon gas, can migrate into the basement through cracks in the floor and infiltrate the living areas of your home.

STOP UNHEALTHY INFILTRATION

The next step to consider...........

for a healthy and waterproof basement or crawlspace
Finally, you might be asking yourself if contractors can profitably market the low pressure injection approach?

THE ANSWER TO THAT QUESTION IS YES

Cost effective = PROFIT
Reduced time = PROFIT
Eliminate callbacks = PROFIT

Since beginning this venture more than 20 years ago, I am proud to have seen low pressure injection adopted throughout the United States and Canada. Crack injection for the repair of poured foundation cracks is both effective and economically efficient. Compared to other approaches, crack injection is a more affordable solution to the homeowner. This process increases the size of the potential market since many consumers are willing to spend hundreds of dollars, as opposed to thousands of dollars, for the increased usage of their basements. The present techniques make possible for a contractor to perform multiple repairs each day at a cost which allows for a profitable bottom line.
EMECOLE METRO LLC
Romeoville, IL 60446
800-844-2713 / 815-372-2493
www.emecole.com

EMECOLE METRO LLC
Romeoville, IL 60446
800-844-2713 / 815-372-2493
www.emecole.com

Foundation Crack Repair Best Practices

by
LOU COLE
Founder of Emecole

EMECOLE METRO LLC
Romeoville, IL 60446
800-844-2713 / 815-372-2493
www.emecole.com

Foundation Crack Repair Best Practices

by
LOU COLE
Founder of Emecole

EMECOLE METRO LLC
Romeoville, IL 60446
800-844-2713 / 815-372-2493
www.emecole.com