

How to Reattach Stalactites

(Or many other gravity-defying speleothems)

by Jonathan B. Beard

Before attempting stalactite repair, please read the ENTIRE procedure below to make a list of equipment and supplies you will need for the particular repair you are doing. There are two methods detailed below, Method A and Method B. Be prepared. NOTE: This procedure is about reattaching simple, common stalactites. The repair of soda straws is quite a different matter.

It is recommended that stalactites be repaired only when you are confident vandals won't come along and break them again! The only thing worse than having to repair a broken stalactite is having to repair it again and again! My experience is that stalactite repairs last longer in a gated cave than they do in a non-gated cave.

The reattachment of broken stalactites has much in common with repairing broken stalagmites—after all, they consist of the same calcite and they exist in the same environment. So much of this procedure to repair things that hang down from the ceilings of caves is redundant with that of repairing those things that are supposed to stick up from the floor. However, gravity makes all the difference!

Whereas stalagmites and columns can be repaired using only a good two-part epoxy (see **How to Reattach Stalagmites**), stalactites are quite the different story. Stalagmites hold under their own weight—gravity is on your side. With stalactites, however, gravity is your enemy. There are cases where epoxy alone has held a stalactite repair in place, but you may be more likely to win the lottery than to regularly make permanent repairs of stalactites with adhesive alone.

It's not that you can't use epoxy to reattach a typical stalactite. Epoxy can be very useful in the repair of broken stalactites, but something more is needed, something that cannot be defeated by water or gravity. You'll need a drill, some accessories, gloves, epoxy, mixing accessories and a combination of skill, patience and luck.

Allow yourself enough time to do it right. Don't rush it. Some stalactites are easier than others are, and the more experienced you are, the faster it will go.

The Gloves

When handling speleothems, it is recommended that you wear disposable nitrile or nylon gloves—the kind a dentist, nurse or doctor uses. Latex disposable gloves are okay as long as you or anyone in your restoration crew isn't allergic to latex. Disposable gloves are useful in keeping the dirt and oils from the skin of your hands off the speleothems. They also prevent epoxy from getting onto your hands (I hate when that happens).

Make Sure it Fits!

The piece might *appear* as if it belongs there, but until you “dry fit” it into place, you don't *know* it belongs there. Take the broken piece and align it where you think it belongs. If it's a great fit, then you can proceed to the next step. If it's not a good match, don't go any further.

I have made the mistake of assuming the piece was a perfect match, cleaned the surfaces, applied the adhesive only to find it a “no go”! The next several minutes were spent removing the adhesive from the surfaces while still soft enough to do so. From this experience, I have learned that adhesive is much easier to apply than it is to remove!

Cleaning the Stalactite

When I have found a match—that is, when I have found where the broken piece was broken from, the surfaces to be bonded are to be totally cleaned and dried. This is important—there cannot be mud, dirt or water on the surfaces. These act as barriers that prevent the epoxy from coming into contact with the calcite surfaces—the epoxy simply won’t “stick” to the calcite if there’s something in the way. If there is only a little dirt, sometimes using a dry plastic brush is enough to clean the surfaces. However, if there’s significant mud or water, then brushing and spraying with water may be needed to clean the surfaces. An absorbent towel or cloth is then used to dry the surfaces. Only when I am confident the surfaces are clean and dry do I prepare the adhesive. I make a point of not over-cleaning the outside (visible) surfaces of the stalactite—many have a “patina,” that is, a natural coating from the settling of suspended air particulates over a long span of time. Remove the excess mud, but don’t remove the patina if possible.

The Drill

A drill is that “extra something” you need to repair stalactites that you don’t normally need for most simple stalagmites. You’re going to drill at least one hole in the stalactite into which a threaded stainless steel or galvanized “pin” will be inserted (Method A) or wire (Method B). This is similar to how doctors repair a broken pelvic bone—inserting a pin to hold the repair in place. Most likely, the procedure will require two people—one person to hold the broken piece in place and another person to drill the hole(s).

Equipment you will need to drill holes in speleothems and use them to reattach pieces:

1. A cordless drill with an appropriate size of masonry drill bit. The larger the stalactite, the larger the drill bit. The range of sizes I use is 1/16th to ½ inch diameter.
2. A squirt bottle with cave water. If needed, this not only cleans the calcite powder but also cools the surrounding calcite. If calcite gets overheated, it can become brittle and shatter.
3. A small collection cup or bowl. When not using water to cool the drill hole, this is held under the drill bit to catch the calcite powder that results from the drilling. The powder is quite useful, when mixed with soil, water and/or epoxy to fill in gaps or holes later in the procedure.
- 4 a. For Method A: Threaded stainless or galvanized threaded pin. The larger the stalactite, the larger diameter and longer the pin. The pin can be a cut section of “all-thread”; a section of steel -threaded all the way along its length, available at Home Depot, Lowe’s and other hardware stores. Be sure to cut a slot in the end of each piece so that a screwdriver can be used to loosen or tighten it (if it’s exactly the same diameter as the drill hole). Alternatively, you can use a bolt or screw with its head ground so that the head is the same diameter as the rest of the bolt or screw.
- 4 b. For Method B: Thin gauge stainless or galvanized wire. The larger the stalactite, the larger diameter the wire. Remember that units of “gauge” are such that the larger the gauge, the smaller diameter the wire. Know that 22-gauge wire is thinner than 20 gauge wire.

5 a. For Method A: Screwdriver.

5 b. For Method B: Wire cutters and pliers. Used to cut and twist the wire.

Method A Drilling: For those stalactites that are round, oval or thick enough in cross section:

1. You will be drilling one hole from one side of the break through the break into the other side of the break at roughly a 45-degree angle to the break line. The hole should be drilled so that it is long enough to hold a pin that will be long enough to hold the repair in place all by itself. In especially large heavy pieces, a second hole can be drilled on the opposite side of the stalactite at a roughly 90-degree angle to the first hole, if two pins are needed to hold the stalactite together. This is my most often method of drilling. However:
2. An alternate drilling method is to drill a hole in the center of the stalactite parallel to the axis of the stalactite, then drilling a matching hole in the center of the broken piece. The hole will need to be as wide as necessary to guarantee the pin will align with both drill holes. The excess volume of each hole will later be filled with epoxy. This is done especially if an exterior hole is undesirable and impossible to mask.
3. Drill slowly and carefully. Remember that calcite is brittle and relatively soft, and the drill bit can get very hot. A squirt bottle filled with cave water is useful to keep things cool, but isn't necessary if you drill slowly and carefully and give the drill a rest now and then. Holding a cup under the drill bit will catch the calcite powder. This powder is useful for later in the procedure. Besides, you don't want to leave a white powdery mess below on the floor of the cave do you? Drill deep enough that the drill hole will accept the entire pin with a little to spare. Clean out any powder or moisture when finished drilling. When you have the hole(s) drilled to sufficient depth, you're ready for the epoxy.

Method B Drilling: For those stalactites that are thin (draperies) or small in cross section:

1. Align the broken piece to its parent "base." Mark opposing spots on either side of the break about half an inch away from the break. Should look like an arithmetic division symbol with a dot over the break line and another dot directly below the first on the other side of the break line. Small stalactites may need only one set of holes. Larger width draperies may need two or more sets of holes.
2. Drill each hole slowly and carefully, holding that collection cup below the drill bit to catch the calcite powder. When all holes have been drilled, you're ready for the next part.
3. Make sure the surfaces and the drill holes are as clean and dry as possible.

The Epoxy

One of the tools in reattaching stalactites is a mixture of a two-part epoxy adhesive. The two parts of the epoxy consist of a base and an accelerator (hardener). The two parts are in the liquid state, but when mixed, they react and eventually form a solid compound. The "worklife" of the mixture is the time that, after they are mixed, they remain in the liquid state. During this worklife period, the mixture can be applied to surfaces to be bonded and "worked" into place. The worklife ends when the mixture is somewhat stiff and is not sticky to the touch. The total curing time usually extends for a considerable period after the worklife period has ended. The epoxy I use most often for repair of stalactites in the Ozarks is a two-part translucent liquid manufactured in Springfield, Missouri at a local 3M plant. It has an approximate 10-minute worklife, which is sufficient for mixing and applying to most stalactite sur-

faces. Its total curing time is a few hours. However, for particularly challenging repairs that may require a longer worklife period, I use a two-part translucent epoxy with a worklife of 70 minutes. I also use a gray two-part opaque epoxy with a 90-minute worklife and a green two-part opaque epoxy with a 70-minute worklife.

Mixing the Epoxy

I apply the necessary quantities of both parts of the epoxy to the bottom of a small mixing tub following the manufacturer's recommended mixing ratio. I use small plastic butter cups or yogurt cups and wooden tongue depressors as my mixing tools. Use only what you think you will need for the repair. If you are using an epoxy with a relatively long worklife (one hour or more), you can mix enough epoxy for more than one repair. However, if your epoxy's worklife is short, such as 10 minutes, you will want to mix only enough epoxy for one repair. I mix the epoxy thoroughly—you want to make sure it is totally mixed so that it will cure throughout the application and cure when it is supposed to cure. Incompletely mixed epoxy may result in an inconsistent or incomplete cure and less bonding strength.

Applying the Epoxy to the Stalactite

I apply an adequate amount of the mixture to both surfaces to be bonded. Using the tongue depressor or a gloved finger, I spread the epoxy out and make sure it is sticking to the surfaces throughout each surface. Ideally, when the pieces fit perfectly, there should only be a paper-thin coating of epoxy on each surface. Any thicker than paper-thin will result in an excessive amount of epoxy that will ooze out of the stalactite. For Method A repairs, epoxy is inserted into the drill hole, too. In some cases, minor voids resulting from minute missing pieces can be filled with "excess" adhesive.

Joining the Broken Piece to the Stalactite Base

When the epoxy is spread completely, the two pieces are then joined. I slightly rock (jiggle) the piece to be bonded against its base to squeeze the epoxy enough to fill all voids within the surfaces being bonded and to squeeze out any excess epoxy.

For Method A repairs, the threaded pin is inserted until it is completely within the confines of the stalactite (none of it protrudes beyond the stalactite). A screwdriver is used to force the pin against the adhesive.

For Method B repairs, a cut piece of wire is bent into a horseshoe shape, inserted into the set of holes; the ends are twisted tightly together to make an effective "clamp." If there is more than one set of holes, do this for each set of holes in the repair. The wire will hold the repair in place indefinitely.

I use a good plastic spring-loaded clamp. When applied, it holds the stalactite repair tightly in place (giving your arms a needed rest!). The clamp is allowed to remain in place until the epoxy is hard to the touch. The pin, or wires, will continue to hold the repair in place indefinitely.

The tighter the fit, the stronger the bond. Toward the end of the worklife period, I use a tongue depressor or a gloved finger to wipe away any excess epoxy that has oozed out of the cracks. The excess epoxy is ready to be removed when it has the approximate consistency of "used" bubble gum.

Masking the Crack and Color Matching

Most of the time, there will be an obvious crack showing after the initial repair. This can be masked by either applying a mixture of calcite powder (obtained by collecting falling powder when drilling holes),

dirt and water or epoxy until there is an approximate same color as the stalactite and rubbed into the crack to fill the crack (again, using a tongue depressor or gloved finger). If the color match is good enough, the crack marking the original break will be somewhat difficult if not impossible to see. The color matching material is also applied to Method A hole(s) to hide the drill hole. Do not fill the holes in Method B repairs, as you may want to eventually remove the wires (THEN fill the drill holes).

If a stalactite is dry (dormant), it is possible to color match without epoxy. If the speleothem is active and growing, color matching may be unnecessary—new calcite growth will eventually cover the crack of the former break.

When new calcite growth has covered the Method B stalactite, it might be appropriate to cut and remove the wires—their job is done! For Method A stalactites, the pins are hidden inside the stalactite, are a permanent fixture and won't ever be visible.