

CLEANING GRAVESTONES: USE THE GENTLEST MEANS POSSIBLE

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It is most often in the spring, usually concurrent with pilgrimages to historic homes, that the "cemetery bug" bites. Well-meaning individuals and groups go for a cemetery-cleaning day, armed with chlorine bleach, scrubbing powders, and sometimes even machine-driven pressure washers. Although it gives everyone a fine feeling of satisfaction to attack old, darkened markers with vigor and elbow grease, sometimes, unfortunately, more harm than good is done. It comes as a big surprise to people who think of masonry as the most durable of materials to learn that the marble, granite and limestone of old grave markers is far softer and more porous than one would think. For this reason, the general rule of thumb in cleaning them is: "Use the gentlest means possible."

When you undertake a cemetery cleaning project, you must first determine what you want in the way of "clean": Remember that old, weathered stone does not have to look new. You probably want to remove harmful pollutants or lichen, but you certainly don't want to scrub until the surface of the stone erodes. (Or, worse, you would not want to blast the surface of a gravestone until you can no longer read the inscription!)

Approach each project, no matter what material the grave marker is made of, by asking yourself, "What is the gentlest means possible?" The harshest, quickest, or cheapest method is often not the gentlest. And, certainly, blasting with chemicals, sand, pecan shells, glass beads, or even water is not the gentlest means possible.

Make test patches of your proposed cleaning technique on an area of the structure that is least visible. Begin with plain water (at garden hose pressure) and a soft bristle brush. You will find that some foreign materials are removed quite satisfactorily with this simple approach – dark algae from a marble surface, for example.

Should further action be needed, the next step should be the slow and cautious addition of a mild detergent to the water. However, before any detergent is added, the stone surface should be thoroughly soaked with water, again at garden hose pressure. It takes time to thoroughly soak stone – thirty minutes minimum, and some sources recommend soaking a stone for 24 hours! The reason for the soaking is to make sure that the detergent is applied only to the surface of the gravestone; if not thoroughly saturated, the stone will absorb the detergent, making it impossible to rinse away.

It is very important to understand that acids are very damaging to marble and limestone, and chlorine bleach (such as Clorox and Purex) are very bad for almost all stone, including polished granite. Many people have totally lost the polished face of a fine granite marker by conscientiously scrubbing with household bleaches. If you feel you need something in addition to a mild detergent, use a dilute solution of ammonia: 1 part ammonia to 3 parts water. You can also try a photographic solution named Triton X, which is recommended by conservators as a gentle cleaner. Water and gentle scrubbing should do the job.

Keep in mind that a soft-bristle brush is all that is needed. Metallic brushes are entirely too harsh, and they also leave particles on the surface of the stone that can rust. Always watch carefully to make sure that none of the stone's surface is eroding as you scrub.

RESTORATION BRANCH TECHNICAL NOTES

THE CONSERVATION AND CLEANING OF HISTORIC GRAVESTONES

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"Why shouldn't old marble gravestones be cleaned with a high pressure power washer?"

"How can we repair our stones that were just broken by vandals?"

These are typical questions asked by churches, historical societies, and municipal governments throughout the state as they take renewed interest in their local cemeteries. Over the past few years there has been a sizeable increase in requests for Historic Preservation Office (HPO) assistance from groups responsible for the preservation of historic grave markers.

Statewide cemetery workshops, such as those held in Beaufort in 1990 and Chapel Hill in 1993, have revealed a nearly universal need for more information on the basic principles of gravestone conservation. This article provides caretakers of historic cemeteries with a comprehensive outline of the latest conservation practices. As always, readers are encouraged to call the HPO's Restoration Branch for more detailed information or an on-site visit. We also welcome hearing about your experiences with gravestone cleaning and repair.

Many of the following techniques were refined and put into practice by Lynette Strangstad, a leading gravestone conservator. Her authoritative book, *A Graveyard Preservation Primer* (1988) is a "must read" for anyone planning any type of cemetery preservation work. In his new book *Conserving Buildings*, the noted Canadian conservator Martin Weaver has included detailed specifications for cleaning and restoring grave markers. More information about these and other valuable sources is in the bibliography below.

The old saying "If it ain't broke, don't fix it" is certainly applicable to the cleaning gravestones. To the question, "Do gravestones need to be cleaned," the answer is simple. **Gravestones should be cleaned only if the dirt or soiling agent is actually harmful to the survival of the stone.** A second reason might be if dirt or growth has made it impossible to read the inscriptions.

It is not necessary to clean a gravestone to a perfect or "like-new" state. Not only is "total cleanliness" unnecessary but it will invariably result in some damage to the stone. The goal of any cleaning program should be to remove potentially damaging growth and improve the legibility of the inscriptions.

The First Rule of Cemetery Preservation: Do as Little as Possible

All conservators agree on this one issue: do as little as possible to achieve the desired results. The second rule is: use the gentlest, least damaging, and most reversible techniques available when conserving gravestones. Your goal as a caretaker of a historic cemetery should not be a perfect "restoration" but a long-term process of conservation to preserve the stones for future generations that may have more advanced techniques to care for the grave markers.

Cleaning: How Much Is Enough?

The most common questions involve whether to clean gravestones, and if so, how to clean them and how much. The answers depend on the amount of dirt and/or growth present on each stone. Most often, discoloration or dirt causes only insignificant harm, if any. Yet, cemetery custodians often believe they are not doing their job unless their monuments are kept sparkling clean through repeated power washings. Some well-intentioned monument repair and maintenance companies promote high-pressure water and chemical cleaning as one of their main services. At many cemeteries, scarce funds are spent on unnecessary cleaning instead of on critical repairs or improved security.

Know Your Dirt

What is the nature of the dirt or soil commonly found on gravestones? Most often it results from several forces, including air pollution, biological deposits, and weathering or deterioration. The most common form is what conservators call "microvegetation," a broad category that includes varieties of lichen, fungi, moss, and algae. This biological activity is most pronounced in damp, humid conditions such as those found in North Carolina's coastal areas.

The extent of biological growth can vary from stone to stone within a cemetery, depending upon shade cover or sunlight. The more porous stones, such as marble and sandstone, provide the best environment for growth and show the effects most obviously. Harder stones such as granites and slates are rarely affected by biological soiling.

Conservation experts continue to debate the degree of damage these biological agents can cause. All agree, however, that far more damage has been caused by misguided cleaning attempts than by the dirt and organisms themselves. Modern high-pressure cleaning is second only to vandalism in the damage caused to the state's historic cemeteries. This unnecessary damage results largely from ignorance of the principles of gravestone conservation.

According to Frances Gale, a leading stone conservator, the most common agents that soil or darken stone are:

Fungi. Fungi include molds, mildews, and yeasts and are usually green, brown or black in color. They are most commonly associated with staining and discoloration and are not thought to be responsible for physical damage to the stones; however, fungi are usually necessary for the growth of other organisms that could cause harm.

Algae. Usually green, brown or red in color, algae are commonly found on limestone and sandstone grave markers. In extremely damp situations, algae may take on a slimy and wet appearance that trap dust and soot. Algae tend to develop during very wet conditions and continue to hold moisture and dampness, which prevent the stone from drying out and accelerate moisture-related damage.

Lichens. Gray, gray-green, or orange in color, most lichens are a form of algae and fungus growing together. They form a strong, leathery mass that can be difficult to remove and can produce levels of acid that slowly damage acid-sensitive stones such as marble and limestone. Like other soiling agents, they tend to slow the drying of stone which increases the likelihood of moisture-related damage.

White marble shows this natural soiling far more dramatically than other common stones such as slate, brownstone or granite. Thus, most gravestone cleaning efforts in North Carolina and the Southeast are directed at marble. In the Southeast, soot, air pollution, and acid rain are not generally the problem they are in the large urban centers of the Northeast and Midwest.

Cleaning Techniques

Water Cleaning

The simplest and least damaging technique is to use water at a low pressure that floods the surface of the stone for at least six hours and up to 24 hours. This is best accomplished by setting up a simple system of mist-type nozzles that provide a uniform application of water over the front and back surfaces of the stone. A homemade jig or stand can be erected to support the sprinkler heads. Mist-type spray nozzles with a flow of from one to two gallons per minute can be obtained from most larger garden supply companies. Pressure is not a factor with this method.

The gentle, constant wetting action serves to loosen and even remove accumulated dirt and microvegetation.

If dirt or growth is still present after the stone has been flooded with water, scrubbing the stone gently with a soft-bristle brush may dislodge the soil. A combination of gentle brushing and continued rinsing is very effective. The goal of this soaking/brushing technique is to remove dirt with as little abrasion as possible. Any form of scrubbing invariably removes some grains of the stone, so it is important to watch the stone's surface closely to detect any erosion. If erosion is detected, cleaning should stop immediately.

A simplified version of water cleaning is to use water from a standard hose with a wide-angle spray nozzle. Spray the stone thoroughly to saturate it with water, then use a soft bristle brush to gently scrub the surface. Using the spray while scrubbing will help "float" dirt away. Do not use a sharp stream of water to remove the dirt. The only purpose of the water is to soften, dissolve, and wash away the dirt that is loosened by the scrubbing. Water under high pressure (greater than 60 psi) should never be used.

Caution: Water quality is also important for cleaning stones. The water used should have a low metals content to avoid staining. Well water with a high iron content should not be used.

Detergent Cleaning

If additional cleaning is required after the water methods have been tried, then gentle detergent cleaning methods are considered reasonably safe by conservators. As with all work on gravestones, approach the process carefully and follow all directions exactly. It is best to test the cleaning method on a small area of the stone (preferably on the rear) prior to proceeding with the entire stone. The use of detergents has not been proven safe for all types of stone, particularly the softest, most porous sandstones. There is always a slight risk of unforeseen effects in the absence of long-term test results.

Non-ionic Detergent Solution

This is the gentlest known detergent solution and should be used before resorting to the stronger ammonia solution. Use conservator-approved detergents such as Amway's LOC detergent or Triton-X, made by Rohm and Haas or Igepal and available from conservation supply houses. Photo-Flo, used by photographers to clean negatives during the development process, is also effective and commonly available in most photo supply stores. Use one ounce of detergent to five gallons of water.

Ammonia Solution

Use this solution for more stubborn stains or to soften and kill lichens. Mix one part plain household ammonia (not the fancy scented stuff) with four parts water.

Procedure for Detergent or Ammonia Cleaning

After preparing the detergent or ammonia solutions described above, saturate the stone to be cleaned with water using a hose or mist spray to thoroughly wet all portions of the stone. As many as fifteen minutes or more of gentle wetting may be needed to achieve complete saturation. This wetting-down process prevents the stone from absorbing the detergent solution, as would be the case with a dry porous surface.

Once the stone is saturated, use the detergent solution and a soft bristle brush to scrub the stone gently. Work from the bottom up to avoid staining and streaking. Use as little pressure on the brush as possible to produce acceptable results. Excessive brush pressure can erode the stone.

After washing, rinse the stone completely with clear water for at least fifteen minutes to remove all traces of the detergent.

Removal of Lichens

Many conservators still debate the need to remove lichens. Some argue that the removal does more damage than the lichens can do in hundreds of years. Others believe that the acids produced by lichens will, over hundreds or thousands of years, eat away the stones. Bearing this in mind, lichens should be removed only when they obscure the inscription or if they are taking over the whole gravestone. Otherwise, it may be wise to wait and see if some more effective lichen-removal techniques are developed in the future.

Tools for Lichen Removal

Water should be applied at low pressure to soften the lichens before attempting their removal. After the gravestone has been flooded with water for at least ten to fifteen minutes to soften the lichen, use small wood or plastic sticks or soft-bristle brushes to remove the lichen. Good results have been obtained using wedge-shaped wooden sticks approximately one inch wide, eight inches long, and tapering from three-quarters of an inch thick at one end to a sharp point at the other. Standard plastic putty knives or glue spatulas also work well. Use the wood wedges to pry off the lichens, taking care not to force off stone particles in the process. One part ammonia, diluted with four parts water, can be used afterward to help kill or at least arrest the lichen's growth.

Treatment for Lichens

To date, there are no sure cures for lichens. Some conservators recommend using formaldehyde as a fungicide on gravestones after cleaning off all visible lichen growth. This treatment has been used effectively, but its long-term effects are unknown. It should be used only in extreme cases and only on sound stones.

Repair of Broken Gravestones

The repair of broken stones should be undertaken only by a skilled craftsman/artisan trained in the procedures of stone repair and conservation. Repair is often a complicated, time-consuming process and, therefore, is not recommended for novices or volunteers. Only the simplest of breaks – a stone snapped in two with a clean joint line – should be repaired by nonprofessionals.

The following outline procedures are presented to inform those responsible for the care of historic gravestones about the repair of broken stones. For additional information, an assessment of your project, and a list of recommended stone repair craftsmen, contact the HPO's Restoration Branch at 919/733-6547.

Assess the nature of the break. Inspect each broken gravestone to determine answers to the following questions:

What kind of break is it? A simple, clean fracture or break that leaves the stone in two pieces is much easier to repair than a compound break that has left the stone in three or more irregular pieces. Most simple two-piece breaks can be repaired in the field; complex breaks usually require removing the stone for repair in a properly equipped workshop or lab.

What kind of stone is it? Marble, limestone, and dense sandstone can be repaired relatively easily. Rarer stones such as slate and soft brownstone require the services of a professional stone conservator and should not be repaired by amateurs.

How big/heavy is the stone? Large stones are difficult to handle. The heaviest ones may have to be listed by a hoist set up in the cemetery, a job best left to a professional. Smaller stones can be handled by two people.

Answers to the above questions will determine whether repairs should be attempted on a local level or performed by a professional stone conservator. Amateurs should not attempt repairs on stones that are very old, large or very heavy; made of slate or soft sandstone; or if the stone material is unknown. The Restoration Branch can help evaluate the condition of the gravestones.

Introduction to Gravestone Repair

The two broken fragments can be rejoined by pinning or doweling the sections together in the same way two boards are doweled together to produce a single larger member. Conservators presently recommend using threaded nylon rods as dowels and a high-modulus or high-strength epoxy or polyester resin compound as the glue. Holes are drilled in each of the stones for the nylon rods or dowels, which are glued into the holes of the uppermost piece of stone. Once the epoxy has cured to the top piece, the holes in the lower stone are filled with epoxy. The upper piece, with its nylon rods in place, is then carefully lowered onto the lower piece. The two pieces usually need to be clamped or supported firmly to hold the alignment for about twenty-four hours or until the epoxy cures.

Two decades ago, broken gravestones were repaired by using epoxy or polyester adhesives as the primary joining agent. The broken surfaces of the two pieces to be joined were smeared with glue and pressed together. Dowels or rods were initially used only for alignment. Later, conservators realized that the layer of epoxy in the joint could create a waterproof zone across the stone that altered or halted the natural movement of water and moisture in the stone. Because of possible harmful long-term effects of such a moisture barrier, conservators now recommend using the dowels or rods as the main anchors or ties rather than coating the joint with waterproof adhesives. Epoxy is now used sparingly in smaller areas to serve as a bedding compound between the two pieces. Leaving as much as half of the surface area of the jointing faces uncovered to permit movement of moisture from one fragment to another is currently recommended.

This technique replaced even older methods that employed Portland cement or cement with iron rods to join the pieces. Because iron rusts and expands within the stone, the repairs eventually fail. Later, stainless steel rods, considered an improvement over iron, were used but still posed a risk in high-moisture environments in stones that are in constant contact with the ground. Ceramic and Teflon rods, which resist corrosion, were tried with some success; however, epoxies have difficulty bonding with both materials.

Current research indicates that threaded nylon rods are the best possible choice for most applications. The nylon is extremely durable, while the threads on the rods tightly join the rods into the surrounding epoxy.

Following is a step-by-step description of how to repair a gravestone broken into two pieces. Compound breaks involving three or more pieces will usually entail more complete techniques that require the services of a professional. Do not attempt this repair process on stones of great age or significance.

Repair Techniques

Determine Number, Size and Position of Rods

Most stones with a single break can be repaired using three rods. Rods should be spaced approximately eight to twelve inches apart, depending on the width of the stone. The diameter of the hole to be drilled – and the rod diameter – is proportionate to the thickness of the stone. The hole diameter should not exceed one-third of the stone thickness. For example, if the stone is three inches thick, the drilled hole should be one inch or smaller, so that there is at least one inch of undisturbed stone on each side of the hole.

Threaded nylon rod of 5/16", 1/2", and 5/8" in diameter are the most common sizes used in gravestone repair. The small diameter is used for very thin or light stones, the 1/2" for most work, and the 5/8" for larger stones. Nylon rods are strong in tension and are somewhat flexible.

Set and Mark Alignment of Pieces:

Assuming that the lower piece of stone is still in the ground, have one person hold the upper or broken-off piece in its proper position on the bottom piece. If both pieces are out of the ground, then the lower piece must be secured in a vertical position using props and clamps. Check for true vertical using a level.

While one person holds the upper piece in place in the exact position desired to restore the stone, check to ensure that the joints fit together properly. Using a measure, mark the sides of both pieces with a soft pencil to indicate the position of the drilled holes as determined above. This will ensure that the holes and rods will be in proper alignment. Then remove the upper piece and transfer the alignment marks to the joint faces where the holes will be drilled. Double check all measurements to ensure alignment.

Drill Holes for Rods

Use a sharp, new masonry drill bit sized to provide a roomy hole to accommodate the epoxy adhesive; the drill bit should be 3/4", 7/8", or 1", depending on the diameter of the nylon rod. Drill with great care. Have an assistant on hand to help "sight" the drill to ensure a true vertical 90-degree hole; a drill level or drilling guide will be most helpful. Control the depth carefully so that all holes are approximately 3" to 4" deep; a depth guide is useful for this. Drill in short bursts, using a gentle pressure to avoid overheating. Withdraw the drill bit periodically to cool.

Clean out the holes thoroughly using compressed air. Use acetone (a good solvent for epoxy) to clean the dust from the sides and bottom of the hole. This can be done by making a homemade "Q-tip" out of a length of 1/4" wood dowel and some cotton or old cloth; dip in acetone and clean out the hole. Cleaning is a critical step to ensure a good bond between the adhesive and the stone.

Cut Nylon Rods to Fit Depth of Holes

After drilling, measure the combined depth of each pair of holes (top and bottom) to determine the lengths of each rod. Cut the rods to be 1/4" shorter than the combined depth measurement.

Epoxy Application

Use a high-strength epoxy such as Abatron's "Abocrete" or Sika's "Sikadur Hi-Mod Gel." Mix exactly as directed by manufacturer. Since the rods must first be glued into the holes in the top piece, mix only enough epoxy to fill all holes in one of the pieces at one time. This operation can be done with the stone in situ in the vertical position or, for difficult work, with the stone placed flat on a solid wood work table in a shop or lab.

Set the upper piece of stone in a true vertical position, with the drilled holes in the jointing surface facing up. Carefully fill the holes with epoxy to approximately one inch below the top to allow for the volume of the rod. Do not spill any epoxy on the outer faces of the stone. Clean any

spills with acetone immediately. Slowly insert the cut lengths of rod into the holes. Fill holes with epoxy up to top if needed. Check the alignment of the rods to ensure that all are standing in a true vertical position in all directions. If the rods will not stay straight, improvise a simple jig to hold them all in alignment. Allow the epoxy to cure to full strength before disturbing the stone.

Once the epoxy in the upper stone has cured (twenty-four hours), repeat the procedure for filling the holes in the lower stone, again remembering to fill to a level approximately one inch below the surface. Carefully apply some epoxy to the break surfaces to be joined, taking care to keep the epoxy back at least $\frac{1}{4}$ " to $\frac{1}{2}$ " from the outside face of the stone to prevent the epoxy from oozing out of the joint and staining the face. Remember, leave portions of the stone (as much as 50 percent) uncovered with epoxy so that moisture can move within the stone.

While the epoxy is wet, carefully lower the upper stone onto the lower piece with assistance from a helper to guide the pins to their holes. Use C-clamps or Jorgensen clamps with lengths of one-inch by four-inch boards to improvise a simple "splint" or backbone for each side of the stone to hold the top piece firmly in a vertical position for at least twenty-four hours.