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# Renewal of Historic Materials Using Vacuum Force Technology

*An Improved Method of Structural  
Repair and Restoration of Historic  
Materials*



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1998

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## **Preservation of Historic Materials**

**Stone, Marble, Terrazo, Granite, Flat Plaster, Plaster and Composition Ornament, Terra-Cotta, Ceramic Tile, Concrete, Masonry**

The exterior of a building may be its most prominent visible aspect, but its interior can be even more important in conveying the buildings history and development over time. The buildings spaces are comprised of individual materials that make up the walls, floors and ceilings and contain the architectural finishes and features that make up the buildings unique character. Renewal and rehabilitation of these materials, within the context of the Secretary of the Interior's Standards for Rehabilitation, calls for the preservation of exterior and interior portions or features of the building that are significant to its historic, architectural and cultural value. Modern techniques and materials now allow aesthetically sensitive stabilization repairs with less intrusive and more permanent results. Today, cracks can be repaired effectively and efficiently with no affect or change or defacing to the surface of the member. Delaminations of all sorts can be rebonded and structurally restored. These new processes, many with patents pending, limit the act of replacement to only those specific areas where there is disintegration or total loss of the original material. It is now possible to tastefully extend the life of existing materials indefinitely while preserving the quality of the historic fabric.

### **Background:**

There is an ongoing dilemma within preservation circles that often converge on interior restoration. Adhering to the Secretary of Interior's Standards to repair rather than replace historic features the preservationist is faced with a limited budget and a multitude of different materials. Each of these materials has its own personality and each has its individual requirements for knowledgeable specialist. While there is no way to eliminate or resolve this dilemma, modern repair technologies and materials allow more prudent uses of their services and can greatly decrease the orchestration normally associated with the project.

Deterioration of an array of materials can be caused from an array of problems. However, as an integral part of the building system, most will be subject to the typical problems of water intrusion, structural movement, vibration, and insensitive alterations. These problems result in common mechanical defects and deteriorations that are comprised of cracking, delaminations, spalling deflections and erosion. Each of these defects can be further segregated to more specific types; cracks for instance, can encompass hairline, structural and non-structural, surface or through cracking, active and inactive, map cracking, etc.. Or there can be combinations of defects such as map cracking associated with delaminations.

It is common knowledge that improper maintenance of historic buildings and materials can cause long term deterioration and often result in irreparable destruction. Yet, deferring the repairs is often the option selected. Sometimes a temporary solution is employed that is not adequate to protect the materials, do not penetrate to the cause of the problem are often only physiological protections that provide a false sense of well being. With the advent of modern materials and proven application technologies a variety of defects can be stabilized and restored with a handful of processes.

### **Repair Materials**

The use of epoxies, in conjunction with pressure injection, has been used extensively for the structural repair of concrete, stones and many other materials. Unfortunately, the very nature of the repair, in most cases, precludes the use of pressure in the performance of the historic repair. Also, in order to contain the epoxy in the fracture zone, it is necessary to seal the face of the fracture with a rigid curing, tenaciously bonding, epoxy paste material. Upon the conclusion of the pressure injection process, this material is most times required to be removed. The removal process requires grinding, which no matter how

carefully performed mars and defaces the fabric; or heating, which melts the paste and leaves residue in irretrievably the pores of the surface.

There are many other shortcomings with pressure injection and epoxy resin. Not the least of which is pressure injection's inability to fill dead end cracks and the establishment of pressure pockets that can extend internal damages. Plaster delaminations for instance would be out of the question using this technique.

Epoxy resins are viscous, typically 100 to 500 cps, and are inhibited from penetrating cracks much narrower than 0.004in. The components require precision mixing to assure cure after injection and most noteworthy, since the epoxy will not bond to itself a failed epoxy injection repair is considered terminal.

The vacuum permeation of acrylic resins, such as methyl methacrylate, are capable of overcoming these misgivings. Methy methacrylate (MMA) repair resins are very low viscosity (3-5cps, water is 1) and can be formulated for varying degrees of elongation. While meeting or exceeding the physical properties of epoxy resin, MMA penetrates deep into the concrete and routinely fills cracks as narrow as 0.001in. The resin can be applied at temperatures as low as -20°F. and will protect the member form abrasion, impact, moisture and chemical attack. MMA will stick to epoxy and has been used successfully by TECVAC, Inc. technicians to repair failed epoxy injection applications.

Micro Fine Cements have been developed that are composed of ultra fine particles that exhibit excellent penetrability, strength and durability. The size of the ultra fine particles (50% of the particle size is below 4 microns) allows the grout to penetrate into very fine cracks and fissures. Chemically activated, curing provides rapid hardening to high strength. After hardening by hydration, the installed grout acquires impermeability and exhibits  $10^{-9}$  cm/sec permeability in laboratory testing.

Vacuum technology allows a number of modern materials to be installed without compromise of the underlying and original fabric.

### **Vacuum Technology**

In the Magdeburg hemisphere experiment in 1657, German physicist, Otto von Guericke (1602-1686) pitted horses against a vacuum created by pumping air from between two fitted copper hemispheres. It took 16 horses to separate them. The vacuum power of the TECVAC, Inc. Processes will actually hold the weakened areas of disrepair and deterioration together and avoid any risk of augmenting internal damages or extending failures. While pressure only techniques force the material into the repair area the TECVAC Processes draw the material along using natural physics. Unlike pressure injection that forces moisture into the side walls of the fracture and compromises bonding strength, moisture and other deleterious materials are extracted. The enclosed fracture can be heated, or TECVAC , Inc.'s proprietary process of nitrogen introduction can be used to dry the zone.

### **Stabilization**

A vast number of architectural and structural maintenance and repair applications using the exclusive vacuum processes by TECVAC, INC. have successfully dealt with the problems of waterproofing, delaminations, bonding, joint sealing, micro cracking, void filling, porous and friable surface areas, and the deep sealing of an array of materials.



*Before and After TecBond™ Core Samples*

When the fracture or delamination networks or connects with imbedded items, such as reinforcing, the repair resins fill the micro cracking associated with the item and saturate the imbedded item as well. This action does not reverse the current corrosion but seals the imbedded item to stabilize and mitigate further deterioration.

A delaminated topping slab was rebonded with TecBond™. The repairs were performed on a second floor warehouse without displacing the commercial tenants below. Load testing after the repairs confirmed composite stability. Notice the thickened bond line of the topping to the structural slab. Low viscosity repair resins penetrate deep into the repaired materials.



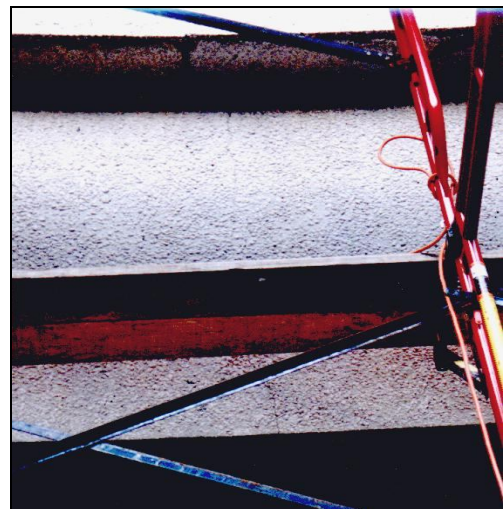
*Sealed Reinforcement*

### **Restoration**

Because TECVAC, Inc.'s Processes are unmatched in their ability to provide the deepest fill to the narrowest cracks, they provide a repair unparalleled in permanence: Construction Technologies Laboratories, an independent testing laboratory, performed petrographic analysis of vacuum repaired concrete. Their report found resin penetration into cracks as narrow as 5 micrometers (0.000195 in.). More importantly, the repairs can be employed for the finest and the largest of cracks with no residual affect of the historic fabric of the member. Not a sign of how the repair was installed.



*Before and During*



*After*

TECVAC, Inc.'s CleanSet™ application of structural repairs applied to beams constructed of exposed aggregate concrete left no sign of the repair on the surfaces.

All stone is porous, even the smoothest marble. When cracks or delaminations occur, vacuum technology and modern repair resins make deep penetrations and more permanent repairs.

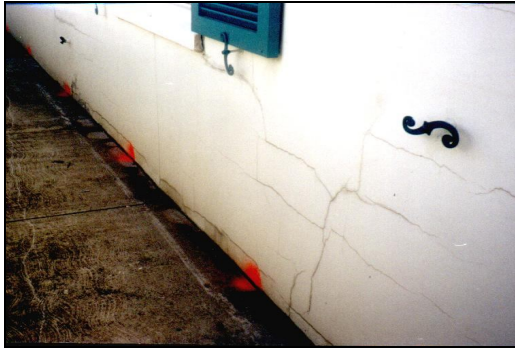


Using the CleanSet™ Process of vacuum permeation, the repairs can be performed with no telltale evidence left on the surface of the marble.

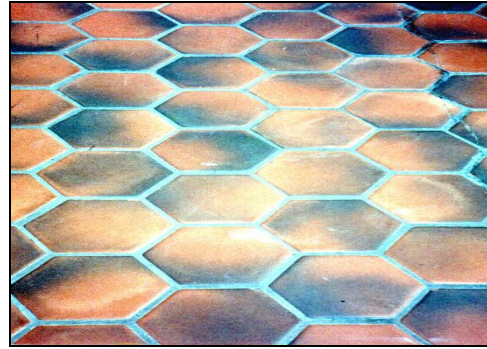
Ornamental cast of concrete, plaster or other materials can be treated for individual and discreet cracks with the CleanSet™ Process or, where material stabilization and protection is required the entire cornice, medallion coffer or sculptor can be sampled and treated with a wide variety of compatible sealers with the PermeNewal™ Process.



*Stucco finishes can be rebonded with little intrusion.*



*Floor tiles or the finest mosaics can be rebonded.*



Foundation repairs can often be completed by TECVAC with minimal excavation. This 15' deep pile that was deteriorating from Alkali Silica Reaction was repaired from the cap and the top three feet of the pile. The before and after core extraction was dramatic evidence of the effectiveness of the process.



Short, stubby and broken pieces from the before core extractions were notably sound in after extractions. Repair resins reached the very bottom of the pier and filled lateral cracks as deep as 50".



TECVAC Inc.'s PermeNewal™ Process allows the repair of large and diverse areas of defective concrete. Map cracking that is often deemed unrepairable can be repaired rather than replaced, surface deterioration can be mitigated and deep cracks can be positively identified, tracked for continuity and repaired.



While vacuum is applied to the enclosed system, repair resins penetrated the fractures and move completely across the column. TECVAC, Inc.'s proprietary process allows advance knowledge of crack paths and the ability to ascertain travel. The structural integrity is restored and the surface is waterproofed in the same process.

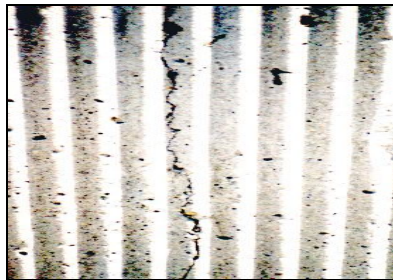


Once cracks are repaired using the TECVAC Processes, there is no further water or moisture penetration of the member.

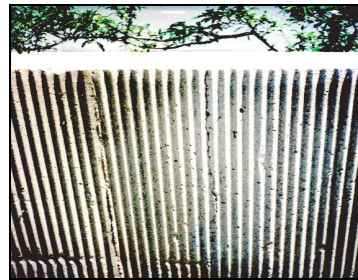


And depending on the results desired, the surface can be completely sealed from moisture

Intricate panels and detailed cornice work can now be repaired with lasting effects. The CleanSet™ Process can set up upon intricate surfaces and produce the structural repair necessary for long life of the member.



*Before*



*After*

The repairs can be completed quickly and efficiently, entirely absent the marring and disfiguration associated with the conventional means of repair. No grinding or abrasives of any form are utilized during the CleanSet™ Process of vacuum permeation injection.

## **Planning:**

When planning a structural repair, whether or not historic, it cannot be over emphasized that proper analysis leads to proper repairs. In order to perform the proper analysis the following steps should be utilized:

- Document Reviews
- Field Survey and documentation
- Materials Testing
- Analysis

Repairs should only be undertaken after the planning measures have be completed. Since the failure of the repair can lead to further and more serious deterioration, the temptation to resort to temporary solutions should be avoided.

## **Summary**

All historic materials are character defining features and are important contributors to the overall personality of the structure. Whether marble or stucco, concrete or plaster, each is vulnerable to the wear of time and exposure to the elements. In any condition, the materials have acquired significance over time, as part of the history and evolution of the structure. Each materials overall vulnerability should not be intensified with well-intentioned restorers who are unfamiliar with the modern materials and technologies. These modern techniques and materials are not suitable perhaps for every condition of every material but investigation and entertainment can often save the original material from destruction and replacement.

In severe cases, temporary stabilization measures should be employed. Particularly where exposed detailing is threatened with dislodging and falling. Whether interior or exterior, cornices, balconies, balustrades, urns, columns, buttresses, etc. can be effectively secured. The application of vacuum remediation will actually hold the piece or member together while the resins are put in place. Often, this remedial action can serve as the basis for a permanent solution. Where unstable pieces are often removed and/or destroyed TECVAC, Inc. can restore and save.

The universal application of TECVAC Inc.'s Vacuum Permeation Processes will contribute greatly to rehabilitation and repair. When you discover the granite or limestone building is actually glazed architectural terra-cotta instead, your repairs can go forward. Restoration and repair work is demanding and will not tolerate procrastination or halfway measures. Today's preservation work with modern materials and technologies should equal the spirit, attention to detail and ultimate preservation of the original make up which characterize everything associated with the materials.