THE VERSATILITY AND SUPERIORITY OF NEGATIVE FORCE VACUUM SITUATION OF MODERN REPAIR RESINS for IN-SITU STRUCTURAL/NON-STRUCTURAL REPAIRS OF CONCRETE, MASONRY AND STONE

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ABSTRACT

Most, if not all, common defects in concrete, masonry and stone begin with and are ultimately associated with cracking. While some cracking may not threaten the structural integrity or even diminish the structural performance of the member or structure, they allow moisture penetration that will contribute greatly to the related problems of delamination and spalling. By closely situating the repair resin into the micro fractures, the useful life of the repair will be greatly extended.

Commonly used methods of repair include routing and sealing with sealant, pressure injection of epoxy or polymer fillers, application of surface coatings or overlays and/or removal and replacement patching. It is very difficult to employ these conventional techniques to repair members with irregular surfaces. Moreover, structures with historical significance for instance, or with intricate architectural designs and finishes often leave a changed and unacceptably altered appearance of the repaired member.

Unlike conventional pressure methods, which “push” the materials along the repair zone, negative force methods “pull” the material into the zone. The application of negative pressure will withdraw air and moisture from the repair zone prior to the installation of appropriately selected repair resins. Using this technology, there is no compression of the liquid repair resin. Consequently, the inherent tendency to “burst” the damaged or deteriorated member, so characteristic of conventional pressure methods, is totally eliminated using vacuum technology.

This paper presents an alternate approach to the more permanent repairs of concrete, masonry and stone using vacuum technology to position ultra-low viscosity resins into voids, cracks and interconnecting crack networks. Case studies will demonstrate how vacuum repair methods can provide superior in-situ repairs and can usually be accomplished without significantly altering the surface appearance of the repaired member or structure.

Key Words: Concrete, Repair, Rehabilitation, Vacuum Technology, Masonry, and Structures

1.0 INTRODUCTION

In-situ restoration of deteriorated concrete is being performed using unique methods of vacuum application. The current use of vacuum originally evolved from methods developed in Europe in the early 1970's. The proprietary vacuum processes are now in a second generation of applications and improvements. These new and improved processes are also applicable to stone and masonry applications and have demonstrated a fundamental superiority over the accepted conventional methods:

- Vacuum processes withdraw air from the void prior to the installation of repair materials
- Moisture is removed so there is no residual water
- Compression stresses at the ends of voids are eliminated
- Thermal expansion of arrested air is eliminated
- Vacuum will actually hold broken and disrepaired pieces together during the processes
- And, there is obviously no danger of internal damage from induced high pressures

Concrete deterioration takes many forms but can usually be associated with improper design and/or improper installation. After all, a concrete block of 1,000 psi design strength will last forever if properly cast and stored. Whereas a concrete block of 4,000 psi concrete exposed to creep or other severe condition could fail shortly and provide a much shorter useful life. So, in the broadest sense, the durability and longevity of concrete in specific configurations is directly dependent upon the designers who depict and specify, and the contractors who cast the members.

This arguable conclusion is more than often the basis of the of the overall repair program. There are no details of cause by which the specific repairs should be founded. Consequently, the key outcomes of the finished work are never achieved. With proper analysis, the repair methods employed will necessitate the restoration of structural integrity to the members and, if economically feasible, the repair method will subsequently provide extended serviceability to the individual members and the entire structure.

Prior to the implementation of any rehabilitation program, it is therefore necessary to conduct a thorough examination of the causes associated with the deterioration or defect of the member or structure. This cause and affect evaluation will produce conclusions patently necessary to produce a suitable and long lasting repair. From the simplest patching, to complicated structural rehabilitation, it should be important to understand that *proper analysis will produce a proper restoration effort.*

Selecting the repair system involves the consideration of the following criteria: (a.) economics; (b.) disruption of the repairs to the faculty and student body; (c.) ability of the method to be applied to the existing structural member conditions, and; (d.) consideration of the remaining structural service life.

With that in mind, and without giving further description of causes, the most common problems encountered with concrete are most likely associated with reinforcement corrosion, freezing and thawing cycles, improper placement and curing, and/or chemical attacks. These problems host a battery of offending conditions including cracking, spalling, leaking and/or delaminations. Despite proper analysis, conventional restoration methods often produce inadequate results. More than often, conventional methods patching and crack repairs fail to provide long term solutions. There are methods however, based on vacuum processes, which provides superior restoration results for each of these resultant conditions. Additionally, inherent necessities with the application and removals of preparation materials cause conspicuous evidence of the repairs to the member. Architectural finishes are defaced and destroyed with conventional methods of pressure injected epoxy.

This paper will highlight each of these conditions, but will primarily focus on the vacuum process used to restore structural integrity associated with cracking. Although the work often only involves just a few steps, the vacuum injection/impermeation methods are not simple. Specific requirements of each project require specific applications to achieve a more permanent and complete restoration. The basic steps of the vacuum processes include:

- The object or member is enclosed
- A low pressure zone is created by applying a vacuum source to the enclosure
- A suitable impermeant repair resin is introduced into the enclosed system

2.0 THE VACUUM METHODS

The methods are fundamentally based upon first creating a partial vacuum within the concrete and then introducing a repair material into the matrixes of concrete, masonry and stone. The process treats five basic conditions with four basic repair methods: (a.) Vacuum installed polymer patching materials to replace removed or spalled areas (b.) Vacuum injection/impregnation of individual and discreet cracks to strengthen and increase structural load capacity of the member (c.) Impregnation flushing to impregnate surfaces and completely fill multiple and intimately spaced cracks in a wide area (d.) Vacuum injection/impregnation of member areas, identified as delaminated, which eliminates the requirement of removing the delaminated material and to bring the layered members back into composite, and, (e) Vacuum induction of expansive repair materials to stop leakage. (Ref 1) Using vacuum enables these processes to be applied without detriment to the underlying surface fabric.

Using the vacuum processes and the appropriate repair resins, the processes will fill cracks, including interconnected cracks, voids and networks within the concrete matrix down to the micro level. Upon curing, the acrylic repair resin bonds the fractured and fissured matrix into a monolithic structural member of sufficient strength to exceed most design strengths. Partial vacuum creation, and repair resin introduction, is achieved by adhering vacuum source and introduction porting devices onto the fracture or surface being repaired. By means of special tubing, the porting devices are connected to the vacuum source and the partial vacuum pressures are applied to the enclosed system. The repair resins are introduced, while maintaining the negative pressures, to fill the major cracks, interconnected cracks and voids and micro cracks. The matrixes of concrete, stone and masonry, including the walls within fractures, are impregnated with the repair resin materials.

Moisture is evacuated from the matrix's fracture wall surfaces along with any deleterious gases and/or materials. Where excessive moisture is encountered, heat can be introduced into the enclosed system. The drying process can be monitored by using in-line hydrometers installed in the special vacuum tubing. Previous experience has recorded 95% humidity in enclosed zones. Effluence readings were recorded at 3% humidity.

The vacuum process offered the following advantages over conventional pressure injection methods:

- Repairs can be completed in a relatively short period with no sacrifice to the quality of the repair.
- Repairs can be completed within the price perimeters of most budgets and are competitive with conventional methods of repair.
- Efficient and complete filling of existing fractures, interconnected fractures, voids, and the complete filling of micro fractures and connected networks.
- Total elimination of pressure pockets insures and facilitates deeper fill of repair resin.
- Evacuation of moisture from the interior concrete matrix of the fracture.
- No possible extenuation of the damage due to absence of applied pressures.
- Ability to introduce ultra-low viscosity materials into the fracture areas that would pass by and bond to the repair materials existing in the fractures.
- Improved bonding due to the lack of bubbling normally associated with pressure introduction of low viscosity, low specific gravity repair resins.
- Susceptibility of continued reinforcing corrosion is significantly diminished because of the evacuation of, and sealing out of, moisture from the treated concrete matrix.

3.0 VACUUM REPAIR MATERIALS

3.1 Methyl Methacrylate (MMA)

This low viscosity, high strength material was particularly developed with special modifiers for the of vacuum injection processes.(Ref 2) It is noted for its ultra low viscosity (5-15 cps) highly rated physical properties, flexibility, and its superior bonding and wetting properties. The material is not temperature sensitive and is easily mixed and modified for specific field conditions. Unlike epoxies, MMA is favorably forgiving when not mixed “just right” and will easily bond to previously cured MMA or epoxy. The vacuum installation of MMA can be used to repair shallow level epoxy repairs.

The odor of the monomers, and toxicity commonly associated with all polymer components, required the usual precautions for handling. Foremost with the use of MMA was the proper and adequate ventilation of the emitted vapors (Ref 4.). The technicians employed high volume air moving exhaust equipment that totally exhausted the vapors from the work area to the outside.

The basic monomer of the repair material is methyl methacrylate (MMA). MMA is a slightly amber liquid that looks like colored water and is about the same viscosity. It has a sharp odor that can be detected by smell in as little as one part per million. (Ref 4) An inhibitor is added for longer storage times.

Inhibitors are additives used in MMA to prevent premature polymerization, that can be caused from excessive temperatures, contaminates, etc.. The two most common inhibitors are methyl ester of hydroquinone (MEHQ) and hydroquinone (HQ). These inhibitors and promoters are normally added to the monomer by the acrylic manufacturer and require no field mixing or attendance to whatsoever. Promoters are used in very small quantities to increase the decomposition rate of the initiator, which will result in faster curing of the polymer. The general preferred promoter used is dimethyl-para-toluidine (DPT), a liquid with the same viscosity of the MMA.

The initiator is added to this mixture of MMA, MEHQ and DPT that initiates the polymerization process, or curing of the repairing resin. Benzoyl Peroxide is a white powder or liquid that readily dissolves in the MMA. The amount of initiator added to the MMA is directly related to the time desired for curing the polymer. Increased amounts of initiator will result in more rapid polymerization of the monomers.

Physical properties of the cured materials generally range in the area of 10,000 psi compressive strength, 7,000 psi tensile strength, 4,000 psi flexural strength and 700,000 psi modulus of elasticity.

3.2 Expanding Vinyl Ester Gel

These low viscosity gels are water-soluble acrylic monomers. It is used for the injection and sealing of joints and cracks against water leaks. Due to its ultra low viscosity it has a very low flow resistance Therefore, it is able to permeate into the smallest of hairline cracks and capillaries, sealing them reliably and permanently.

Because the polymerized material will swell to double its volume, dimensional changes will not affect the seal. The resins are solvent free and during the hardening (polymerization) stage, the monomers link together to form long chains. These chains are themselves cross-linked to form a three dimensional network, or a single giant molecule.

There are, however, small side-chains combined with the molecule which have a water-soluble character. When the side-chain comes into contact with water, the side chains dissolve in the water, but the whole molecule doe not because of its size. The material will take up the water and swell while retain its external shape. Like the solution of common salt in water, the process is purely physical and is therefore reversible. Because of this unique property, the material will retain its self-healing properties even when in a dry condition.

The swelling and re-swelling is dependent upon the availability of water. After a period of dryness, a wet or damp environment will bring the material will transform into a state of equilibrium. Moisture within concrete will keep the material in a swelled state.

4.0 APPLICATIONS AND EXAMPLES

This section deals with the actual applications of the methods described above to demonstrate the actual successful uses. The projects are selected to cover different regions of the world. It is felt that these examples will help the reader to appreciate the universal nature of the process. The examples are:

4.1 Hirshhorn Museum of Art Building

Smithsonian Institute
Washington, DC

The Hirshhorn Museum of Art Building is a concrete structure located within eyesight of the U.S. Capitol. Because of its close proximity to the Capitol, the relatively young building, and associated garden walls, are designated historic. This designation caused considerable concern when, in 1993, certain cracks in the building and wall structures began to enlarge. The building cracks were believed to provide the source for leaking water into the building that caused unsightly staining and damage.

It was later concluded the cracks, located in the structural beams were, in fact, passing water into the building and eroding wider and wider each year. Not only were these cracks believed to be saturated, they also posed a threat of spalling away large areas of facia concrete during the freeze thaw cycles typical to the region. Superficial patching of the defects had been performed on a number of occasions, however, these surface applied restorative efforts were more concerned with aesthetics and fabric preservation than the ongoing internal deterioration of the concrete materials. Sandblasting, water blasting or any other form of abrasive, chemical or pressure cleaning was prohibited because of the requirement to preserve the historic fabric of the exposed aggregate surfaces. This limited most repairs methods and totally eliminated any form of pressure injection repairs. Pressure injection methods require aggressive methods cleaning in preparation of the repairs. Moreover, pressure injection requires a tenaciously bonding sealer material that confines the pressurized repair resin (usually epoxy) and requires high heat or grinding to remove the material upon the completion of the repairs. In either instance, residue of the material and/or marring of the surface cannot be avoided. Removal is conspicuously evident on the adjacent surfaces upon completion of the repairs.

Other attempts to seal surface cracks with a concoction of latex, fine sand and coloring to match the surfaces had been mildly, but only temporarily successful. Conventional pressure injection with epoxy material was first considered. However, and aside from the fact the surface materials required were totally unacceptable, previous attempts at repairing fractures by this means have been totally disappointing. The viscosity of the epoxy repair material prohibits deep penetration in all but the largest part of the fracture. Epoxy has been found to penetrate only to a shallow depth; sometimes just below the surface of the member. The fractures radiating from the main fractures can be totally void of any repair material. Where the epoxy can penetrate to any degree, moisture contained within the crack will prohibit any form of bonding. Another problem is the inability to re-inject the cracks because fresh epoxies will not adhere to cured epoxies. Where the previous repairs are only partially filled with epoxy, and unbonded to the fracture wall, the existing material will block the flow of new repair material and, more importantly, form a relief at the existing epoxy/new epoxy joining line. The entire repair will be rendered ineffective. Therefore, an alternative means of in-situ repair was preferred and desired.

A test was suggested; a test to vacuum induce structural repair materials into the cracks without the kindred marring of the surface. This process touted vastly successful outcomes under a wide range of applications and conditions. By creating a partial vacuum in the concrete, repair resins could be introduced into the fracture resulting in a more complete and permanent repair of the member.

An obscured portion of a garden wall was selected for testing but with the condition that certain ground rules would be established. These rules included that no abrasives and no power washing would be allowed for the preparation and most importantly, no residuals of any kind would be left on the surface of the member when the repair was concluded.

Impact-Echo testing revealed the massive block of concrete selected for the test (3'x3'x6'), to be riddled with cracks and voids and nearing total disintegration. At the conclusion of the test, the outcome would be readily measurable.

A specially formulated sealing material was heated and applied to the mouths of the extensive fractures ranging in width from 0.25in. to 0.005in.. Access openings were maintained along the fracture lines by mounting plastic porting access devices on and along the surface of the cracks with the same heated sealant. Setting up one day and performing the actual injection the next proved to be a mistake. A special means of establishing continuity along the sealed crack line revealed the heated sealant had debonded from the surface. This condition would not contain the water thin viscosity methyl methacrylate repair materials. It was established that the thermal stresses caused from day and night temperature differentials, combined with the low bond strength of the sealer material, necessitated a continuous start to finish operation and a repeat application. The sealant was removed and reapplied the next morning.

After the sealant was re-applied, continuity testing confirmed the adhesion of the sealant to the face of the cracks. Vacuum was applied to the enclosed system and the repair resin was introduced. This induction continued until the crack was full as evidenced by refusal. However, during the injection process, the surface sealant debonded in a number of "spots" that require immediate remedial actions. Upon conclusion of the repairs, the sealant removed easily with no residue.

While Impact-Echo testing later revealed solid mass, attested the cracks had been completely filled, in a number of areas, the repair material slightly stained the surface concrete. Although the leaks of the repair resin had been quickly stopped, the light amber color of the resin was evident on the surfaces in the areas where leaks occurred. This put somewhat of a damper on the excitement of the originally anticipated outcome.

After several weeks of R & D testing, technicians determined that the sealing material used earlier was simply lacking the bond strength to contain the repair resin. Not only was the sealant unable to resist the minor expansion and contraction associated with overnight thermal changes (yawing), the adhesive ability was further reduced by environmental foreign matter deposited on the surface of the member. Sealants of a different formulation were applied at slightly higher temperatures on a number of different materials. The surfaces were left un-cleaned, cleaned with a mild detergent and water and, lightly brushed with just water. With the change in sealant formulation and additional heat application, the results of lightly brushing with plain water proved to provide lasting adhesion during the induction of resin and removed easily with no leaks, residual staining or residue.

The Smithsonian awarded a contract to repair the defective waterproofing and repair cracks in the structural beams at the Museum of Art Building.

The specifications required "*repairing of cracks in structural concrete by permanently rebonding the concrete by vacuum grouting*…". Among other items, "*The Contractor must demonstrated that crack repair method will result in repairs that are visually acceptable to the Smithsonian. Cracks should be no more visible after repairs than are unstained cracks prior to repairs*."

The specifications also required a mock-up to be performed in an area designated and acceptable to the COTR. "*Prior to the start of the work, the Contractor will complete a field mock-up using specified materials and technique on a crack in the spandrel deck beam to be selected by the COTR, in an area that is designated on the drawings to be repaired. Mock-up shall address all aspects of the crack repair process, including restoration of concrete surface. Mock-up shall be performed until crack repair is visually acceptable to the Smithsonian, and meets other specified requirements.*"

Technicians performed the mock-up and it was accepted by the COTR on the spot. The adjacent surfaces along the crack line remained in their original pristine condition during and after the repairs. The process was repeated on the total of the cracks, exceeding 240 lineal feet, with no evidence of the repairs visible.

The CleanSet[tm] set-up method for the PermeJect[tm] Permeation Injection Process has been successfully tested and applied to architecturally sensitive members. CleanSet[tm] leaves no negative impact on the surfaces of the member and will not alter the fabric during the course of the repair. Nor does any sign of the method remain upon the repaired surfaces after completion.

This method can be used in any instance where the repair of individual structural cracks requires maintenance of sensitive aesthetics and/or complex surface contours.

4.2 Delaminated Topping Slab
Second Story Warehouse Floor
College Park, MD

The second story of a warehouse facility was used to store and distribute aluminum siding, windows, kitchen equipment and other items incidental to residential construction. The floors of the facility were constructed of a three-inch-thick topping slab installed in composite over precast concrete double T's. Because of the transient nature of the materials, a great deal of heavy forklift traffic was required to move the materials in and out of the warehouse. When large chunks of concrete began to fall from the bottom of the precast panels, the topping slab was discovered to be delaminated.

Although arguable, it was preliminarily determined that the tenant had exceeded the designed weight restrictions and had overloaded the floor. This had caused the topping slab to ripple across the double T's and delaminate. This condition, in turn, imposed forces on the double T's and caused cracking and delaminations of the T's and stems. Representative areas of floor were chain dragged and confirmed to be delaminated. Initial recommendations indicated the only method to restore the composite action of the floor was to entirely remove and recast the topping slab; over 120,000sf. This repair endeavor would necessitate the temporary displacement of the tenant, but more disruptive, it would also require the temporary displacement of the tenants below. Needless to say, no one was happy with this situation, including the owners of the property who were ultimately responsible for what was deemed to be an unsafe condition.

It was agreed that the floor was not totally debonded. There were areas where the topping maintained its original design. However, to facilitate even partial removal, all of the tenants would have to be displaced. It was surmised that if the tenants had to be displaced, then the entire topping would have to be removed and replaced. Using only lightweight hammers this would not only be a gruesomely slow operation but, at the very least, would also put the double T's at risk during the demolition. Moreover, this was to be an incredibly expensive ordeal, as suggested by the consulting engineers. 250,000sf of new warehouse space would have to be secured, the contents of 6-7 light commercial businesses would have to be moved, the work would have to be completed and finally, the tenants would have to be moved back into their original spaces. Hence the positioning for responsibility and liability and the entertainment of alternative methods of repair.

Epoxy injection of the delamination was suggested, but this method is not totally effective. Pressure used to install the epoxy resin actually tends to extend the delamination process as it moves the materials along. Iowa DOT testing of topped bridge structures revealed some effectiveness with this method. However, the one thing no one wanted was to risk massive disruptions with no resolve, or only temporary resolve, of the problems.

Impact-Echo testing is a method of non-destructive testing of concrete, masonry and stone. (Ref 5) While this method of testing will reveal many internal defects, including honeycombing, linear fractures and crack depths, in this instance, there was a necessity to identify the void areas between the topping slab and the double T's. This method, unlike common chain dragging, would precisely map the areas of delamination throughout the warehouse with little disruption to the tenant.

First, a 3'x3' grid pattern was laid out on the warehouse floor and transferred to the original floor plan drawings. At each of the grid points, a "shot" was taken with the Impact-Echo equipment and identified as sound or deficient. When all of the grid points were tested, the information was produced as a color-coded diagram of the entire floor. Unlike the area anticipated, the Impact-Echo testing revealed under 35,000sf as delaminated. The testing team also suggested an effective method of repair; a method that could be performed in-situ and would not require the displacement of tenants. With proper load testing confirmation, vacuum permeation, rather than removal and replacement or pressure injection, could prove a real value. This method, coupled with extremely thin acrylic repair resins would produce an effective method of repair, able to withstand confirmation testing.

With the areas of delamination identified, the double T panels were inspected from below. Areas where the repair resin was suspected to leak were sealed and cracks within the deck and stems were identified for repair.

When the areas beneath the delaminations were secured, tiny holes were drilled into the topping to intersect the delamination fracture zone. Vacuum was applied to the sealed zone and the repair material was introduced. The vacuum power was used to draw the materials into the fracture and along the zone to the perimeter of the areas. Spot core drilling was performed to confirm the rebonding and completeness of filling. Later, load testing by an independent testing agency confirmed the restored composite action of the topping and double T's within the entire area.

The power of vacuum forces have been known since the mid 1600's. Otto von Grericke pumped the air from two fitted brass hemispheres and harnessed it between two teams of eight horses on either side. Riders kicked and whipped the teams, but could not part the vacuum secured hemispheres. Tecvac, Inc. has harnessed this powerful force in the repair and restoration of concrete, masonry and stone.

In most cases, the work can be performed with little disruption or intrusiveness. The work was performed during off-hours at night with no disruption to the tenants daily operations. Some of the stored materials required moving to another area of the warehouse while the work was performed, but required no displacement. Nor were the tenants below displaced and the entire work was completed within 45 days.

4.3 Leak Repairs
Ronald Reagan International Airport
Washington, DC

A pedestrian tunnel linking a parking structure with the main terminal facility at Ronald Reagan Washington National Airport was scheduled for completion in the Fall of 1998. Shortly after the parking structure was completed in 1991, several hundred lineal feet of cracks developed in the 30” thick concrete floor of the future tunnel link constructed 25-30 feet below grade. Wall cracks also developed, but the major source of intrusion was generated from the floor. For some time after each rainfall, these cracks allowed the natural high water table to flow up through the floor and into the areaway. Now nearing completion linking, the floors are to receive a terrazzo finish and the leaks were required to be repaired by the general contractor.

The general contractor performing the completion work, and the overseeing engineer sought a long term solution and a five year guarantee. After several weeks of soliciting contractors to perform the repairs, the general contractor located a company willing to perform the repairs and provide the guarantee required by the contract.

Unlike the conventional method of pressure injecting expanding polyurethane into drilled holes, the company employs the TecSeal™ Process of leak repair. This process utilizes vacuum technology that sets up a negative pressure zone within the fracture. Then, a thin expanding acrylic resin was introduced through surface mounted porting devices.

Examination of the cracks within the tunnel posed two problems: (1) the cracks were very fine and ranged form 0.005in to 0.010in in width and, (2) the thickness of the slab, some 30”, was complicated with grade beams and expansion joints. The fractures were notably fouled with efflorescence deposits resulting from the long period of leaking.

The efflorescence was removed by abrasive blasting and the mouths of the fractures were opened in the process. Surface mounted ports were installed along the crack line and the entire length and offshoots of the singular fracture was sealed. The ability of the fracture to accept resin was then tested by applying negative demand on the enclosed fissure. Each port along the length was tested for evidence of the demand and identified. While maintaining the negative demand, water-thin vinyl ester repair resin was introduced into the tightly sealed system.

Only minimal lengths of the wall cracks required drilling access holes. Because of flow and configuration, holes were drilled at 45° angles to intersect the fracture at 5”-6” depth. Ports were installed into the drilled holes and spaced along the length the crack. The entire length of the crack was then sealed. By applying negative demand to the enclosed system the repair resin was introduced deep into the fissure and the flow was arrested.

Upon completion of the tunnel, the pumps used to facilitate the construction were disconnected and removed. The cracks treated with the TecSeal™ Process are completely dry and there is no evidence of water intrusion.

The TecSeal™ Permeation Leak Repair Process has been successfully applied to the leaking cracks in the floors and walls of the Pedestrian Tunnel at Ronald Reagan Washington National Airport. With the exception of a few lineal feet, the entire task was completed without the necessity of drilling. By applying negative demand, the TecSeal™ Process intakes repair resin deep into fracture zones and can eliminate unsightly member destruction by drilling.

This proprietary method of delivering repair materials into leaking cracks has a number of advantages over conventional pressure methods. Conventional pressure injection of resins are poorly suited to deliver materials into fine cracks. Attempts to do so by increasing delivery pressure often damages the member and exacerbates the problem. Interconnected fractures are pressure locked and receive little resin and internal shears can separate large areas of delamination with dangerous consequences. Rather than fight the flow, TecSeal^{tm} entices the resin along and into the finest of hairline cracks and interconnecting cracks.

The vinyl ester repair resin used for the TecSeal^{tm} Process contributes substantially to the success of the repair and has a number of advantages over polyurethanes which are typically used for this sort of work. Low viscosity (1cps) and low flow resistance, vinyl ester penetrates into the narrowest cracks and capillaries to seal reliably and permanently. Because the resin does not chemically react with water, there is no foam layer or resulting reduction of adhesion that accompanies polyurethane. Most importantly is the ability of the vinyl ester to self-heal after dry periods. Unlike polyurethane, the cured gel will re-swell when contacted with water and reestablish equilibrium.

The TecSeal^{tm} Permeation Leak Repair Process can be used in any instance where it is required to stop leaking or seeping water flow. The process can be performed at temperatures as low a +40°F and will maintain a strong resistance against constant hydrostatic pressure.

5.0 CONCLUSIONS

Vacuum induction and impermeation processes of repair offer superior methods of repair for concrete, masonry and stone. These processes allow ultra-low viscosity repair resins to penetrate deep into the member being repaired and will completely fill interconnected cracks and voids.

When considering the limiting qualities of most conventional repairs, these proprietary repairs provide the new age technology to situate modern repair materials into the deteriorated or damaged matrix on a microscopic level. Pressure only methods force the materials into the repair area and are severely wanting in a number of ways; i.e., (a) there is little access to fine cracks below 0.003in. (b) low level filling caused from compression pockets (c) entrapped moisture inhibits curing (d) internal damage is caused at the ends of the cracks from liquid pressure build ups (e) residual marring and defacing of the member upon completion of the repair.

The vacuum processes leave no residual marking and draw the material in using the nature of physics. The matrix can be dried and confirmed to receive repair resin prior to actual introduction. The vacuum repair processes result in an observable level of fill and rebonding unattainable by any other means.

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