TECHNICAL REPORT

PermeJect™ Permeation Injection Using The CleanSet™ Process

An Improved Method of Structural Repair for Concrete, Masonry & Stone

Smithsonian Institute
Hirshhorn Museum of Art Building

TECVAC, Inc. ¤ 39482 Rickard Road Lovettsville, VA 20180
Office 703.742.9186 ¤ FAX 703.742.9231

CleanSet™ Technical Report

Repairs To Beams At The Hirshhorn Museum Of Art

Background

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 in the building. It was later concluded the cracks, located in the structural beams were, in fact, passing water into the building and eroding more and more each year. Not only were these cracks believed to be saturated, they also posed a threat of spalling away large areas of facia concrete due to freeze thaw cycles. Superficial patching of the defects were performed, however, these restorative efforts were more concerned with aesthetics and fabric preservation than the ongoing deterioration of internal 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 and totally eliminated any form of pressure injection repairs because of the cleaning required in preparation of the repairs. Besides, 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.

While sealing other surface cracks on the garden walls with a concoction of latex, fine sand and coloring to match the surfaces, our technicians suggested a test; a test to vacuum induce structural repair materials into the cracks without the kindred marring of the surface. An obscured portion of a garden wall was selected for testing late in the summer of 1993 with certain ground rules established that included no abrasives, no power washing and no residuals of any kind.

Impact-Echo testing revealed the massive block of concrete chosen (3'x3'x6'), to be riddled with cracks and voids and nearing total deterioration; a perfect candidate.

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 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. 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, the repair material slightly stained the surface concrete. Although the leaks 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.

Development

In early 1998, after several weeks of R & D testing, technicians have determined 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 thermal changes, 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.

Outcome

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.*"

Our 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.

Conclusion

The CleanSet[tm] set-up method for the PermeJect[tm] Permeation Injection Process has been successfully tested and applied to the cracks in structural beams of the Smithsonian's Hirshhorn Museum of Arts Building in Washington, DC. 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 used remain upon the repaired surfaces after completion.

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