2006 ICRI Baltimore Washington Chapter
Outstanding Repair Project Award

George Washington University
Ross Hall Façade Restoration

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Outstanding Repair Project Award
Part I

Project Name:	George Washington University Ross Hall Façade Restoration
Repair Contractor:	Concrete Protection and Restoration, Inc. 6737 Dogwood Road Baltimore, MD 21207
Owner:	The George Washington University 2025 F Street, NW Suite 100 Washington, DC 20052
Architect/Engineer:	Hoffmann Architects 1001 Connecticut Avenue NW Washington DC 20036
Material Supplier:	Cathedral Stone Products 7266 Park Circle Drive Hanover, Maryland 21076

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Part II

1.	Project Name:	George Washington University Ross Hall Façade Restoration
2.	Location:	Washington, DC
3.	Contract Amount:	$2,634,089.00
4.	Project Duration:	3 years - May through September per year

Abstract

The purpose of this project was to investigate and repair the cast-in-place concrete façade of the Walter G. Ross Hall at George Washington University. The Walter G. Ross Hall was officially completed on July 1, 1973. The seven-story concrete structure houses the teaching and laboratory facilities for the student and administrative offices for the School of Medicine and Health Sciences, the School of Public Health and Health Services, and the Vice President for Health Affairs.

The exterior façade of Ross Hall indicated severe concrete distress, which posed structural as well as life safety concerns. Overtime the structural damage became visible on a majority of the façade elevations. Through field investigation and concrete testing it was induced, among other things, that the biggest cause of the deterioration could be attributed to poor concrete cover over the reinforcing steel. Due to the life safety issues, during the façade investigation, a repair contractor was put on retainer to provide emergency services for concrete removals to arrest any immediate dangers. Although these emergency measures were taken to lessen the present safety hazard, the Owner understood that if left un-repaired the concrete would continue to deteriorate and future hazardous and structural deficient conditions would result.

In order to protect the structure from further attack a detailed remediation program was designed and implemented which included removal of the deteriorated and unsound concrete, treatment and repair of reinforcing steel, and the placement of a repair material to match the existing architectural finish of the building. Other repairs included crack injection, tuckpointing, and caulking. Upon completion of the structural repairs, the surface of the building was treated with a mineral based coating to provide a preventative waterproofing for the unrepaired concrete areas, protection of the new repairs, and to give the building a uniform appearance.

The implementation of the recommended repairs was imposed to increase the longevity of the façade structure, prevent high future maintenace costs, and to greatly improve the aesthetics of the structure.

General:

The purpose of this project was to investigate and repair the cast-in-place concrete façade of the Walter G. Ross Hall at George Washington University. The Walter G. Ross Hall was officially completed on July 1, 1973. The seven-story concrete structure houses the teaching and laboratory facilities for the student and administrative offices for the School of Medicine and Health Sciences, the School of Public Health and Health Services, and the Vice President for Health Affairs.

The building façade under went a multi-year, multi-phase restoration and renovation project which included over 9,000 SF of concrete repairs and 150,000 SF of surface coating. The first phase of the project was started in May of 2004 with the third and final phase being substantially complete in August 2006.

A prominent structural/architectural firm located in Washington, DC was chosen for the assessment. After extensive inspections it was determined that the concrete façade failures were caused by corrosion of the embedded reinforcing steel. It was further determined, through the field investigation, that the cast-in-place concrete deficiencies were mainly due to poor concrete cover over the reinforcing steel exaggerated by the atmospheric conditions.

The building location, in suburban downtown Washington, DC, is situated at a major intersection which is frequented by heavy vehicular and pedestrian traffic. In this regard, because of life safety issues as well as structural concerns the Owner elected to implement a repair program to arrest the distressed condition of the building.

Field Investigation

Tell tale signs of concrete deterioration sparked the Owner's interest to consult an engineering firm to investigate, design, and implement a remediation program. Phase I of this program was to conduct a field investigation. A thorough field investigation and assessment of existing exterior building conditions was needed to provide the Owner with an invaluable planning tool in assessment of the damage. This in-depth investigation was conducted to verify and document the condition of facade, roofing, building sealants, window seals, and the structural systems of existing building. The field investigation work consisted of the following:

- Review of existing structural and architectural drawings
- Perform exploratory demolition in several areas of the façade to document the existing conditions
- Identify problematic or potentially problematic conditions which warrant further attention
- Identify and correct minor repair needs before they escalate into major repair items or costly emergency repairs
- Laboratory testing and analysis of building materials, and an in-depth review of original design and contract documents, information on previous repairs, and other historical data on the building.

- Preparation of a report of observations, findings, and recommendations regarding the causes and origins of the structural deterioration.

During the field investigation it was discovered that the façade exhibited delaminations and concrete spalls that posed an immediate life safety issue for pedestrian and vehicular traffic below. A repair contractor was summoned to participate in the investigation, on retainer, in order to provide service to remove any of the loose material encountered. This provided for an immediate cause of action to make the building façade safe for traffic below.

Concrete laboratory and field testing was conducted and the results indicated the following:

- Concrete strength were lower than what was specified in the original design specification
- Water cement ratio was high, above .50
- Reinforcing steel had improper coverage during original construction
- Carbonation of the concrete was evident at the level of the reinforcing steel
- Deteriorated caulk and mortar joints allowed for water intrusion

Recommendations and Specifications

As a result of the field investigation, concerns arose over the concrete strength being lower then the original design specification. However, after structural evaluation, design factors allowed for this lower strength at the building's designed usage. Furthermore, it was determined that the low strength mix was a direct result of the high water cement ratio used in the original concrete mix. The optimum water-cement ratio provides a mix that has sufficient density to provide the required integrity while maintaining workability. Higher water-cement ratios lower the concrete's density resulting in higher porosity of the concrete. A higher porosity allows water and atmospheric conditions to penetrate the substrate easier resulting in carbonation and ultimately in this case reinforcing steel corrosion.

Furthermore, exploratory demolition and visual observations indicated that the concrete cover over the embedded reinforcing steel was less than 1 inch below the exterior finished surface. Exposed reinforcing steel was observed at many locations on the façade exposed finished surface. Rebar ends, chair legs, and tie wire were on the exterior formed surface exposed to the elements. This coupled with the poor quality of the original concrete only enhanced the corrosion potential and aided in the deterioration of the façade.

Hindsight being 20/20, if during the original construction a more ridged quality control program would have been in effect a majority of deterioration could have been prevented. Most likely, during the initial construction, water was added to the concrete mix to make it friendlier to work with during installation. Also, poor coverage of reinforcing steel was

a result of poor workmanship during forming. The reinforcing steel placement and wooden forms were not coordinated to ensure proper coverage. The board forms exaggerated this condition by not providing a uniform surface exterior to the steel. The vertical recesses added to the situation because they are not accounted for in the formwork and their surfaces occur at the surface of the horizontal reinforcing. Therefore we can speculate that the board form finish irregularities made it difficult to achieve the proper concrete coverage in the field conditions.

Over time, the façade's cast-in-place concrete exhibited surface deficiencies due to the poor concrete quality and cover on the reinforcing bar. The reinforcing steel became corroded due to exposure to the elements, expanded and caused the surrounding concrete to crack and spall.

The delaminated concrete posed a life safety hazard to the pedestrian and vehicular traffic below. Emergency measures were taken to lessen the hazard, but the Owner knew if left un-repaired the concrete will continue to deteriorate and future hazardous conditions will result.

It was recommended, that in order to properly repair the façade the following should be performed:

- Delaminated, spalled and cracked concrete related to corrosion of the steel any unsound concrete around the reinforcing bar should be removed down to a sound concrete.
- The steel-reinforcing bar that is exposed should be mechanically cleaned to remove all existing rust and scale.
- Reinforcing steel should be relocated to provide, as a minimum, 1 ½" of concrete cover
- Once cleaned, the reinforcing would be treated with a corrosion inhibiting coating.
- New concrete patching material would then be installed in the areas of removal. New patching material should match existing formed board surface in color and texture.
- All mortar joints should be tuck pointed to make waterproof
- All caulking shall be removed and replaced to prevent moisture infiltration
- Repair the cracks in the concrete spandrels, fins and columns that do not have associated delaminated concrete, should be injecting with a high strength epoxy to seal these areas from future water entry.
- When the concrete repairs are complete, all surfaces of the building should be cleaned, and all exposed concrete surfaces of the building should be treated with a mineral based coating, to provide a preventative waterproofing for the un-repaired concrete areas, protect the new repairs and to give the building a uniform appearance.

From these recommendations specifications were developed and the project was competitively bid and awarded to a successful contractor.

Project Execution:

Upon award of the contract, the successful Contractor consulted a local material supplier to costum manufacture a repair mortar. Specifically this mortar needed to match the design strength, existing color, and texture of the facade, and could be hand applied and sculpted to recreate the board finish. The basic design criteria set forth for this material was the following:

- Single component: Mixes with water only, improving quality control and consistency of application
- Compatible Formulation: Compatibility of physical properties to ensure that the repair material and substrate react to the environment in the same way
- Tenacious Adhesion: Strong bonding capabilities without any bonding agent
- Single Layer Build-Up: Resulting in faster application
- Factory Controlled: No field chemistry resulting in product variation
- Custom Color: To match existing color and texture
- Highly Resistant to Carbonation: Superior long term embedded steel protection

After a many mock-ups and on-site field applications, the custom material was chosen and manufactured for this project. Prior to installation, the material manufacturer worked closely with the Contractor's personnel to conduct on site training classes. The training included application procedures and finishing and texturing techniques to duplicate the original form lines. Key personell from the structural/architectural engineering firm, to enhance their ability to properly inspect the finished repairs, also attended training.

Upon completion of the concrete repairs the Contractor installed a mineral based coating system. The potassium silicate coating was chosen to form a chemical bond with the concrete structure yet allow the cast-in-place structure to breath and be permeable. The coating system chosen is high in pH to protect the reinforcing steel and concrete from carbonation. This coating system not only provided for an aesthetically pleasing finish to the façade but also provided protection of the areas did not require repair.

Furthermore, masonry infills were tuck-pointed and all building sealants were replaced. This was to ensure that the concrete structure was as watertight as possible.

Complexities

Although the nature of the concrete repairs and the theory of how to repair were quite elementary in respect to the science of concrete repair, there were several obstacles which made this a highly difficult project and the were as follows:

- Active school facility in busy downtown Washington, DC
- Work schedule and work hours were limited to slow summer months therefore making it a multi-phase, multi-year project
- Noise producing work was restricted to certain time frames on different sections of the building.
- Access was difficult and different forms of scaffold was required to maintain access to building entrances and loading dock
- Building was occupied by very difficult high profile client
- Selection of repair material to meet performance specification and to allow for color and texture match by having the ability to be sculpted to match the existing board finish

The Contractor was able to meet and exceed the Owner's expectation by staffing the crew with an experienced project management team, which welcomed these challenges and worked together to solve the details. The schedule was very fast paced and complicated by the occupancy of the building that has many different uses and needs. There was an expectation by them to have no disturbances during their workday. The Contractor had to accommodate these needs and work with the client while maintaining schedule and cost.

Conclusion:

This project was a perfect example of the importance of a Repair Contractor, Engineer, Material Manufacturer and Owner working together to provide a durable, economical, and quality repairs. Through communication, innovation and strategic planning the project was a success from the beginning to the end. It was the commitment of the Contracting, Manufacturing, and Engineering team to furnish the Owner with accurate solutions to complex restoration problems by providing the highest technical support offered by a repair team. Dynamic design details and innovation demanded that the Engineer and Contractor deliver to the Owner a level of service and technical assistance that far exceeds industry standards.


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