

Hopkins House Concrete Repairs and Protection Systems Installation

Baltimore, Maryland

Submitted by Structural Preservation Systems

Built in 1968 near the campus of Johns Hopkins University in Baltimore, MD, the Hopkins House Apartment Building is an 18-story apartment complex. A five-level parking garage is connected to the apartment through a corridor.

The apartment balconies around the building were originally designed and constructed as conventionally reinforced concrete slabs, cantilevering from the building façade at an average of 6 ft (1.8 m). The balconies wrap around the building perimeter on every level with each apartment's balcony divided from the adjacent balconies with partition walls. Surface-mounted aluminum handrails run along the entire balcony perimeter. The bare concrete surfaces of the original balconies offered limited protection against the elements.

The parking garage elevated decks were waffle-slab design, providing rigid support for vehicle traffic.

Damaging Environmental Conditions

Since the building's original construction, minor repairs had been performed on the high-rise and parking garage structures. Because of damaging environmental conditions, including multiple freezing-and-thawing cycles and corrosive deicing salts, reinforcing steel corrosion and concrete spalling were prevalent throughout both the high-rise balcony and parking garage structures.

In 2004, the owner was preparing to undertake a large building rehabilitation, which included:

- Installation of new windows, balcony handrails, and divider panels;
- Interior apartment renovations; and
- Large-scale renovation of the building entrance.

Because the new balcony handrails and divider panels required anchorage into sound concrete decks, an investigation into the concrete structure was needed. The engineer performed a sounding and visual delamination survey of the parking garage



After the concrete was demolished in several balcony repair locations, significant reinforcing steel corrosion was visible. Many reinforcing steel bars within the cantilevered balcony slabs lost a significant amount of cross section due to rust. New reinforcing steel was spliced into the existing reinforcing steel layout

and balconies that confirmed significant concrete deterioration was present.

Oxidation of Reinforcing Steel

The primary cause of deterioration in both the balcony and parking garage was the oxidation of reinforcing steel, mainly caused by insufficient cover at several locations. In the parking garage, the combination of cracks through the waffle slab and ribs, along with the use of deicing salts, helped initiate and accelerate the corrosion.

Other causes of deterioration included settlement cracking throughout the parking garage and vertical masonry walls, freezing-and-thawing damage to both the parking garage and balcony decks, and dissimilar metal corrosion of the existing handrail base plates.

Repair and Protection Plan

The repair plan consisted of performing concrete spall, crack, and masonry repairs. The waffle slab parking garage configuration made the repairs more challenging than they would be on a conventional

flat slab. The repair contractor simplified these various challenging repairs by using premolded fiberglass formwork matching the dimensions of the existing waffle pans and ribs.

The protection plan involved the installation of a cathodic protection system in the parking garage. The selected method was a galvanic cathodic protection system using zinc anodes, designed to mitigate the new corrosion activity from occurring in the areas surrounding each concrete repair. Also included was the installation of a waterproof membrane coating system to protect the concrete. The team selected a traffic-duty polyurethane deck coating system for the elevated concrete decks in the parking garage and a



One of the parking garage full-depth slab repairs, prior to installation of zinc anodes for galvanized cathodic protection. At this phase in the repair, zinc anodes were attached to the reinforcing steel and wire mesh system along the perimeter of the repair area



Concrete repairs, pedestrian duty coatings installations, masonry repairs, new handrail installations, and new window installations were all performed during this project

pedestrian duty polyurethane coating for the topside of the balcony decks. To complete the balcony protection, the team selected a breathable acrylic coating to be applied to balcony soffits.

Successful Repair Process Execution

The balconies were repaired in six phases, with each phase strategically composed of multiple vertical tiers around the structure. Within each phase, the repair contractor performed:

- Removal of handrails and divider panels;
- Shoring installation;
- Demolition of deteriorated concrete;
- Repair surface preparation;
- Formwork installation;
- Placement of repair material;
- Coating surface preparation; and
- Top surface pedestrian waterproof coating and soffit coating installation.

The parking garage was repaired in 14 phases, where public and contractor safety was an important consideration for phase boundaries. Within each repair phase, the repair contractor performed:

- Shoring installation;
- Deteriorated concrete demolition;
- Surface preparation;
- Formwork installation;
- Installation of galvanized cathodic protection around the perimeter of repairs; and
- Placement of the repair material.

Because the balconies were continuous around the building and one work item included removal of the divider panels between apartments, the contractor was able to perform repairs horizontally in larger phases, thereby minimizing the daily use of the swing-stage work platforms. This new horizontal work sequence allowed the repair team to reduce the schedule by increasing the efficiency of the field crews performing the balcony repairs, while also improving safety by minimizing the use of swing-stage work platforms.

The repair contractor developed an innovative solution related to the parking garage access and phasing. The parking garage had narrow drive lanes, and the contract stipulated that the work be performed using only a small number of parking spaces. The original garage layout would have required many phases with the potential for hazardous conditions. Instead, an old abandoned garage entrance was identified by the planning team, so the repair contractor requested that this entrance be reopened to help reduce the garage repair phases and improve safety of all parties involved.

Overcoming Challenges

Many potential pitfalls were avoided by spending extra time planning and gathering information prior to construction. One issue identified early was the

extensive concrete deterioration seen in the garage and balconies, believed to have progressed since the original concrete sounding survey was performed. The repair contractor working with the owner and engineer decided to perform repairs in one tier of balconies first and then compare these repairs to those identified in the survey. This portion of the work became a test location for the entire balcony project, similar to a mock-up. Upon completion of this phase, it was found that the corrosion had progressed into larger repair areas at many locations. The repair contractor agreed to report on the comparison after the completion of each phase and to work with the engineer to prioritize repair locations. These early efforts were an important component in building the teamwork that would lead to a successful project.

Several logistical challenges arose throughout the Hopkins House project:

- New subcontractors arrived on site working adjacent to repair work areas, creating safety and coordination issues;
- Material mobilization in large quantities to each long balcony level was a challenge using swing-stage work platforms; and
- Storage and staging areas were very limited.

The repair contractor communicated daily with the owner and other subcontractors about coordination and safety concerns. They assisted the other contractors with their access to the balcony levels and coordination of their storage locations on site. A material hoist, brought to the site after the suggestion at a planning meeting, provided the opportunity to deliver construction materials to various balcony levels more efficiently and safely than the original process of using the swing-stage work platforms.

Another unforeseen challenge was that one level of the parking garage had significant water drainage problems, which led to the deterioration of a large portion of the slab. Over the years, a multitude of drains were installed as new areas collected water. The repair contractor corrected this issue by performing a large full-depth concrete repair at this parking level and then finished the concrete with a proper slope to the remaining drains.

Project Success

Even with all the preconstruction planning performed for this project, the project would not have been successful without ongoing planning and flexibility. The repair contractor held weekly progress meetings in which the project team reviewed safety, schedule, coordination, manpower and material issues. Also, because the site conditions continuously changed from those identified at the start of the project, the process of tracking the project's progress and refining the plan according to new information and changed project conditions was critical for success.



A large portion of the top level of the parking garage experienced deterioration due to poor drainage. This slab was repaired in one large deck repair and was finished with the proper slope to permanent drains, which allowed the contractor to eliminate several of the existing drains and improve the drainage of the top level parking deck



Concrete repairs using galvanized cathodic protection, protective traffic bearing coatings, and painting of columns, walls, and ceilings were performed in the five-level parking garage

Hopkins House

Owner

CW Properties Limited
Owings Mills, Maryland

Project Engineer/Designer

Century Engineering, Inc.
Hunt Valley, Maryland

Repair Contractor

Structural Preservation Systems
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Material Suppliers/Manufacturers

Vector Corrosion Technologies
Wesley Chapel, Florida

Advanced Polymer Technology
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