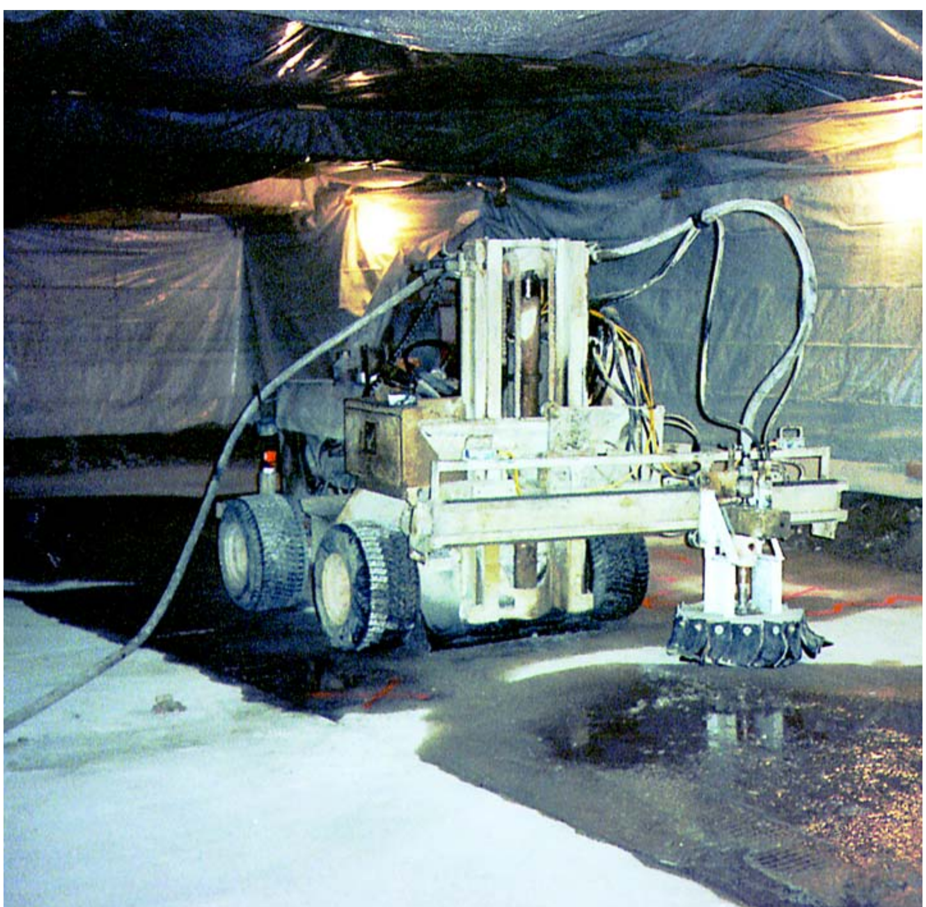
Challenges of a Chloride-Laden Parking Garage Repair

By Greg Neiderer

A 1500-car garage occupies all three subterranean levels of Building 10, a 15-story medical research facility on the National Institutes of Health (NIH) Bethesda, Maryland, campus. Building 10's central location and high density make it a prime parking location for employees, visitors, and patients.

The garage, built in 1979, was identified as needing repairs in 1992. Completing repairs prior to occupying an 850,000 ft^2 (79,000 m^2) horizontal hospital addition was a key goal because the garage would become the primary entry for patients and visitors. Investigation by the original parking consultant identified that 2/3 of the garage floor slab was chloride contaminated within the top 4 in. (10 cm). Further investigation also identified that the remaining slab was contaminated full depth because a salt-laden accelerator was used in the original concrete mixture.



Remote-controlled Hydrodemolition Robot

A Team Approach

The technical issues of approaching the repair posed many challenges. In 1995, NIH sought advice and guidance from a new engineer and parking consultant team. The local design engineer's key strength was an in-depth knowledge of Building 10's logistics, as well as the NIH site and procedures, while the parking consultant provided technical expertise. This team completed the original repair oversight; completed the fully contaminated slab investigation, design, and construction; and formulated the design of upgrades.

Construction of the original repair started out well, but by the winter of 1997, the contractor had fallen behind schedule. Attempts to resolve the resulting contractor-owner dispute failed, and the contractor left the site in the spring of 1998. At this point, NIH felt that only a more integrated team approach would deliver the project on time and budget.

To meet this goal, both a construction manager and a structural repair subcontractor were hired. The team scrutinized the original design, suggested a number of minor technical changes and modification of phasing restraints, and fostered genuine team building. This reduced the schedule from 30 to 17 months and greatly reduced the costs. Construction restarted in the fall of 1998.

Phasing Concerns

The garage is primarily a long and narrow rectangle, 1400 x 120 ft (425 x 37 m). One entrance at Level P1, one entrance at Level P3, and one set of internal ramps provide all vehicular access. This layout complicated phasing because circulation could easily be blocked without detailed phasing logistics. The length also complicated concrete placement and hydrodemolition wastewater transport.

The repair proceeded from top to bottom in vertical sections. As demolition occurred, water and debris dropped to the lowest level, P3, where small front-end loaders could transport the concrete debris and the hydrodemolition water collected for the wastewater treatment system. As each level was completed, it was returned to service and construction would move horizontally across the garage to an adjacent phase.

Communications Through Phasing Changes

When repair started, the total car capacity shrank from 1500 to nearly 1100. As repairs neared 70% completion, the expansion began and capacity dropped to 900. Early in the project, NIH hired a parking operator to valet park patients throughout construction. The valets increased capacity by 120 cars and helped confused patrons.

As repair and expansion continued, the engineer created phasing plans and car counts for each phase change. NIH and the parking operator used this information to proactively adjust to changes. Staff was informed of changes through both email and posters. Patients were informed and guided through changes by the valet staff. Phase changes occurred over weekends to ease the transition. On the Fridays before a change, flyers were placed on windshields. On the Mondays after a phase change, a larger valet staff was on site.

Environmental Controls

Vibration, normally an inconsequential issue, was paramount because microsurgery on nerve tissue occurs within Building 10. Vibration-generating activities were stopped during scheduled microsurgery, and a formal shutdown procedure was instituted to allow surgery teams to halt construction during emergency operations.

Vibration, noise, and dust concerns resulted in selecting hydrodemolition for concrete removal. Jackhammering was scheduled only during off-hours to address small areas unsuitable for hydrodemolition. Large diesel engine-driven pumps raised the hydrodemolition water pressure from 70 to 20,000 psi (0.48 to 138 MPa) and it easily cut the 5000 psi (34 MPa) concrete. The pumps and engines were placed in a corner of the lowest level in the garage and surrounded by two sets of masonry walls to reduce noise. The diesel engines' exhaust and fan-cooled radiators were placed 100 ft (30 m) away, above grade, in a small enclosure that blended into the campus.

When jackhammers were used, the slab was watered to reduce dust. Sandblasting contained grit and water to reduce dust. Temporary building fan changes insured negative air pressure in construction zones so dust would not enter the building. These fans also contained replaceable filters.

Stringent wastewater limits require an enhanced pretreatment system for hydrodemolition wastewater. The selected system monitors the pH and automatically adjusts the acid dosage to neutralize the varying caustic content of effluent. To eliminate concerns of using concentrated acid in a below-grade garage, the contractor used mildly acidic carbon dioxide gas through a bubbling diffuser in the settling basins—a construction first. This process combined with the use of up to six particle settling basins exceeded the pretreatment requirements for the 18 million gal. (68 million l) of wastewater.

Exposed top steel after hydrodemolition

Cleaning of steel after hydrodemolition

Shotblasting of column area inside containment before receiving coating

Column area after concrete repair receiving coating

Upgrading Waterproofing

Surface water control was a two-prong upgrade of better drainage and strategic traffic topping installation.

The original repairs consisted of replacing in kind the top 4 in. (10 cm) of the 10.5-in.-thick (26.7 cm) two-way, mildly reinforced slab. The first upgrade enhanced drainage. The perimeter of each 30 x 30 ft (9 x 9 m) square bay was thickened by 1.5 in. (3.8 cm) and then sloped to the original surface at the center. This created drainage basins, and then new floor drains were installed at the low point of each basin, which virtually eliminated ponding problems prevalent in the original construction. Structural analysis confirmed the slab could accept the additional concrete weight because actual concrete strength was higher than the design strength.

This structural system inherently cracks, and the areas near columns have high concentrations of microcracks and embedded steel near the surface. The second upgrade consisted of installing 10 x 10 ft (3 x 3 m) squares of traffic topping at columns. By coating around the columns, this most vulnerable area was protected at a greatly reduced cost.

Upgrading Lighting

The existing lighting system consisted of high-pressure sodium fixtures with fluorescent fixtures for emergency lighting. A survey confirmed the lighting did not meet current standards. A new metal halide lighting system replaced the current system, where average floor surface light levels almost tripled from 5 ft candles and color rendition improved, yet power usage remained constant.

Upgrading Vehicle and Pedestrian Flow

Because patients and their caregivers are under significant stress, inattention of both drivers and pedestrians in the patient parking areas is a concern. To address this concern, a 5-ft-wide (1.5 m) pedestrian aisle was striped in front of cars, eliminating pedestrian/vehicle shared pathways. Two-way traffic in the patient area was converted to one-way to reduce traffic conflict. The 90-degree striping was rotated to 75 degrees to ease turns into stalls. There was no loss in parking capacity because the column grid accommodated the changes. Two-way traffic remained in the employee area to retain the shortest routes between exits and parking spaces.

Upgrading Signage

A new signage package helped patrons identify the new traffic flow, locations of main circulation routes, ADA accessible parking, and exits. Vehicular signage remained the responsibility of the parking consultant, while signage for pedestrians was transferred to an ongoing upgrade program to provide a seamless transition into the building. Signage was nearly doubled in the patient parking area. Shapes and color now subdivide patient parking areas to ease finding of cars.

Architectural Improvements Mockup

NIH was committed to making parking friendlier. Prior to committing to a comprehensive upgrade, however, a large-scale (20,000 ft^2 [1860 m^2]) mockup of new light fixtures, new signage, revised striping, and painted ceiling and columns were installed for review. The mockup permitted both a patient advisory group and clinical staff to comment on an actual installation before completing the design. These groups provided positive comments and suggestions that were incorporated into the final package. The location of the mockup was the patient entrance, so this improved area was of immediate benefit.

Communication Through Models

The parking configuration is patients on the lowest level, P3; general employee parking on P2; and restricted employee parking on the upper level, P1. The expansion design team will relocate patient parking to P1 for a more pleasant transition into a new, open lobby when the expansion is complete in 2003. At that time, the parking groups will move between levels and internal circulation will be modified. To address these changes, a series of meetings refined each group's new location. To facilitate discussions, a color-coded, three-dimensional model was created to permit team members to visually grasp the new locations, understand the physical constraints, and quickly reach consensus.

Corrosion Control in the Fully Contaminated Slabs

An issue raised by the original parking consultant was the possibility of hydrodemolition "wetting" the slab for extended periods and accelerating corrosion in the full-depth contaminated slab. A 1993 to 1995 study by an independent corrosion consultant electronically monitored the bottom mat of rebar corrosion on a 2000 ft^2 (185 m^2) test patch. Corrosion accelerated for the first 11 months before dropping to a practically negligible rate. Based on this study, the repair design for the fully contaminated slab was permitted to mimic, where

Column area before concrete spall repair

Column area after concrete repair

possible, the repair already underway elsewhere in the garage. This greatly simplified the purchasing of construction through an extension of the existing contract.

Shifting Construction to Minimize Impact

Hydrodemolition started too slowly to meet the schedule, with concrete removal rates of 75 ft^2 (7 m^2) per h. The subcontractor extensively modified his equipment to operate two hydrocutting heads (instead of one) and to accept six pumps (instead of two) and increased removal to 200 ft^2 (18.5 m^2) per h. Enhanced removal rates increased the need for hose, water treatment, and debris removal—all of which were met.

Concrete pours started each day at 3:00 a.m. and were completed by 6:30 a.m. to minimize impact on campus. Debris removal also stopped during peak traffic periods to reduce congestion. The repairs proceeded in alternating strips that reduced forming, rebar placing, and slab profiling effort and schedule. The repair subcontractor worked two shifts (10 h each), 6 days a week, for 15 months, shaving 2 months off the target schedule.

Maintaining Critical Delivery Pathways

The garage is used as a travel route for a lab that creates medicine with a 30-min life span. After creating the medicines, delivery time to patients is critical. Construction phasing addressed this issue by splitting phases at the travel route when practical. When impractical, a 5-ft-wide (1.5 m) tunnel of marine quality wood and heavy shoring permitted travel while jackhammer repairs proceeded overhead.

Maintaining Fire Safety

During expansion, several fire exits would be closed for months. To ensure safety, these exits were rerouted within fire-resistant corridors through the garage. Repair phasing along and above this path was modified. Portions of the repair were accelerated to complete work before corridor installation. Other portions were transferred from the repair team to the expansion team because extensive structural modifications were required by the expansion.

Access Control

Vehicular access control for employee parking did not exist at the beginning of the repair project. Employee parking was monitored by hangtags. A simple pay-upon-exit cashier booth regulated the visitor and patient parking. Movable fences that prohibit vehicular flow separate the groups. A vehicular access system of magnetic cards for employees was considered but delayed for implementation of a campus-wide access system that is envisioned to include both parking and building access.

Costs

Construction cost before 1998 totaled $3 million. Costs for the remaining structural repair dropped significantly from $20 million to $9.9 million during the 1998 value analysis. This resulted in a cost savings of over $6700 per parking space. This occurred while working beneath a sensitive medical research facility, restarting and accelerating the construction, and changing phasing to accommodate the horizontal expansion.

NIH Parking Garage

Owner
National Institutes of Health
Bethesda, Maryland

Parking Consultant
Walker Parking Consultants
Wayne, Pennsylvania

Engineer
Cervantes and Associates
Fairfax, Virginia

Construction Manager
Bovis Lend Lease
Bethesda, Maryland

Repair Contractor
Restoration East
Baltimore, Maryland

Parking Contractor
Colonial Parking
Washington, D.C.

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