FOXHALL SQUARE GARAGE POST-TENSIONED CABLE REPAIR AND REPLACEMENT

BY MICHAEL K. O'MALLEY

Foxhall Square is a large medical office building with retail space located in northwest Washington, DC. Parking for tenants and patrons of this facility is provided in a 325-space parking garage that is adjacent to the office building. The garage was built in 1972 and features post-tensioned construction in the parking deck slabs.

Due to the very high volume of traffic frequenting the medical office building and retail shops, there is heavy usage of this parking facility. Maintenance of the parking structure has been an ongoing process, and the building management company has performed structural repairs to the garage on an as-needed basis for many years. Repairs were focused on areas where public safety for pedestrian and vehicular traffic was the greatest concern.

While this approach was effective at addressing basic safety issues, the mosaic of repair efforts over time did not effectively serve the long-term health of the parking structure. After recognizing that parking revenue was being negatively impacted by the frequency of repair and restoration efforts and the increasing costs associated with performing the repairs, a long-term asset enhancement program was decided on for the garage.

EVALUATION

In the spring of 2007, the property management firm representing the building owner explored options for a long-term, low-maintenance solution to the ongoing garage repairs. An engineering firm was retained to perform a structural analysis of the parking garage and was also asked to provide input on how to expand the vehicular capacity of the parking deck.

As part of the project evaluation, the engineer was given a report prepared by another firm in 2005 that was based on a visual survey of the garage. That firm noted numerous locations in which post-tensioning cable hardware was visible overhead and on the slab floor. It noted that the cables appeared to be tensioned and identified 650 ft^2 (60 m^2) of spalled and potentially delaminated concrete. The recommendations in the 2005 report included replacing the exposed post-tensioned hardware, restoring adequate concrete cover to the spalled and delaminated concrete, and undertaking further destructive testing.

The engineer performing the structural analysis conducted his own visual survey of the garage, chain-dragging of the slabs, and an evaluation of selected post-tensioning tendons through destructive investigation. Several exposed cables were observed on the top parking slab and numerous instances of exposed cables on the soffit underneath were identified. The chain-drag investigation revealed approximately 800 ft^2 (79 m^2) of slab surface spalls and 120 ft (37 m) of soffit spalls.

During the investigation of the post-tensioning cables, potential replacement of cable hardware was considered. To demonstrate the ability to replace these components, a mockup of the replacement operation was constructed. The exposure of the tendons in the mockup phase revealed corrosion along the entire length of the cables and this condition now required complete cable replacement along the length of the bundle. Further testing was authorized and revealed that corrosion along the entire cable length was prevalent in every opening. Given this condition, complete cable replacement was recommended by the engineer. The owner had initially requested a 3-year phased schedule for the project; but as the first phase of the work progressed, it was discovered that a significant percentage of the cables were detensioned and the project schedule was accelerated to 2 years.

PROJECT EXECUTION AND CHALLENGES

Upon approval of funding for the structural repairs by the building ownership and management groups, the contractor proceeded to mobilize for the project per the phasing plan recommended in the report prepared by the project engineering firm. The building management was responsible for coordinating tenant and visitor notification regarding the impending project. To accommodate the high volume of pedestrian and vehicular traffic, a well-coordinated traffic control and parking plan was crafted between the parking operator, contractor, and building management firm. The parking operator

was directed by the building management to increase valet personnel because of the number of parking spaces that would be taken out of service on the garage roof level. A total of 15 valet drivers were staffed on site during the project.

A shoring plan was designed to support the upper level of the garage, and construction fencing and dust barriers were installed (Fig. 1). To maintain the owner's construction schedule, a crew of 20 workers was deployed to the site; they worked 6 days per week, 10 hours per day. Construction personnel were required to work during inclement weather, resulting in the physical challenge of laboring in the rain in addition to enduring long days through stifling summer heat.

The concrete demolition proceeded quickly, with openings made throughout the upper deck that exposed previous repairs and anchor locations (Fig. 2 and 3). While certain crews continued on demolition and slab openings, others were busy installing new cables (Fig. 4 and 5). A steady progression was maintained by using remaining personnel to install the intermediate stressing anchorage and splice chuck repair hardware for the upcoming cables that were slated to be stressed (Fig. 6 and 7). As the project moved forward and

Fig. 1: Temporary shoring and dust control measures

Fig. 2: Workers exposing tendons with small chipping hammers

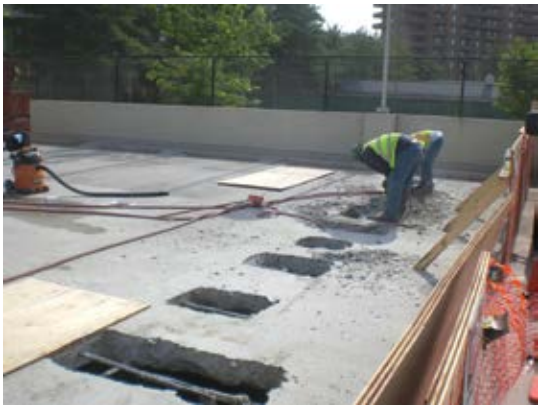

Fig. 3: Exposed anchor locations

Fig. 4: Newly installed cables

Fig. 5: Simultaneous operations

Fig. 6: Spliced cables

Fig. 7: Spliced cables ready for tensioning

Fig. 8: Tensioning new cables in stairwell

Fig. 9: Tensioning new cables on deck

Fig. 10: Newly stressed tendon

the full extent of the cable deterioration became evident, the owner contracted with a firm that specializes in corrosion mitigation to have it conduct a cable corrosion evaluation. The firm's findings validated the extent of the cable corrosion and the repairs proceeded as planned.

Stressing of the new post-tensioned cables (Fig. 8 and 9) was initially performed as planned; however, the project engineer had to make adjustments to the stressing tension after a few cable tendons ruptured during the tensioning operation. A completed stressing of an intermediate stressing anchorage with the wedges seated is shown in Fig. 10. Following the tensioning operation, concrete was placed in the repair cavities (Fig. 11 and 12). The newly placed concrete was finished to match the surface and texture of the adjacent concrete as closely as possible (Fig. 13).

The work items for the Foxhall post-tensioned cable repair project included:

- New cable installed: 67,000 ft (20,420 m);
- New end anchors: 1156;
- New intermediate stressing anchorages: 386;
- New lockoffs: 200;
- Partial-depth repairs: 1500 ft^2 (140 m^2);
- Full-depth repair: 5000 ft^2 (465 m^2);
- New reinforcing steel: 4500 ft (1370 m); and
- New area drains installed: three.

Some of the challenges faced during the construction process were:

- No as-built documents from previous repair efforts;
- Original structural drawings that were not entirely accurate;
- The building was heavily visited and noise restrictions allowed for only 4 hours of demolition each day from 7 to 9 a.m. and 5 to 7 p.m. Work was limited to the summer months and was completed in two consecutive seasons;
- Post-tensioned cable and end anchorage repairs were performed over a restaurant, requiring shoring and dust protection within the restaurant to be set up;
- Even though parking of vehicles was largely performed by valets, it became clear that when one of the ramps to the upper deck was closed, a flagman was needed to direct the one-way flow of traffic on the remaining single-lane ramp. This control was critical when a front-end loader had to use the ramp to move construction debris to the dumpster adjacent to the garage entrance; and
- Large planter boxes that ran along certain areas of the upper deck perimeter had to be removed completely, including the soils and all vegetation.

Fig. 11: Pouring concrete repair material

Fig. 12: Consolidating patch material

Fig. 13: Final surface of patch repair

COLLABORATIVE EFFORT YIELDS POSITIVE RESULTS

In a collaborative effort of commitment to meet or exceed the expectations of the owner, the project engineering firm and contractor emphasized and practiced open communication from the incipient stages of the project. Every attempt was made to turn challenges into opportunities to creatively work through the issue. This combined effort kept the project moving forward on schedule and to the satisfaction of the client. Considering the scope of work performed in the given time frame, the owner expressed appreciation for the site being closed for only a modest period of time and was grateful that the parking structure will be structurally sound for years to come and that the previous ongoing repairs are now a past headache.

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