

LOW-RISE CATEGORY

Plaza Deck Post Tensioning Repair, External Strengthening, and Waterproofing Rehabilitation

ALEXANDRIA, VA

SUBMITTED BY STRUCTURAL REHABILITATION GROUP, LLC



Fig. 1: Condominium building and elevated plaza structure over the garage

The Templeton of Alexandria Condominium is a 15-story cast-in-place concrete residential structure that features a landscaped elevated plaza deck (Fig. 1). The plaza deck utilizes a cast-in-place post-tensioned reinforced concrete slab constructed over a one-level garage structure. The garage provides approximately 23,000 sf (2137 sm) of on-grade parking located immediately below the elevated plaza structure. The garage utilizes a reinforced concrete structural slab supported by grade beams that span to caissons (deep foundations). The subject of this project is the elevated plaza structure over the garage (Fig. 2).

The elevated plaza structure previously underwent a renovation in the 1990s. At that time, the repairs included replacement of the waterproofing with a sheet-applied rubberized asphalt membrane system, repairing some of the post-tensioning cables at isolated locations, and installation of landscaping and hardscaping treatments.

In 2014, the Owner's original project goals were to implement targeted waterproofing repairs to isolated areas of the plaza that had been experiencing water intrusion over an extended period of time. The project goals expanded during the rehabilitation work to include strengthening the plaza structure to meet the Owner's desired future use and to update the appearance of the plaza's landscape/hardscape architecture.

EVALUATION

Based on the age and type of the post-tensioning system, the system was evaluated to confirm that it was functioning as intended prior to spending financial resources on a targeted and limited waterproofing repair program.

Visual inspection at the underside of the elevated plaza slab revealed various cracks, concrete spalling, grease staining, and electrical conduits that were compromised by water. The superimposed dead loads (SDL) in place at the plaza level (consisting of planters, pavers, soil, plantings and hardscaping) were measured (field verified) and determined to exceed the published design capacity noted on the original design documents. The structural drawings indicated that the original plaza structure was designed for a SDL of 50 psf (2.4 kpa) while loading estimates for portions of the plaza were as much as

300 psf (14.4 kpa). The following is a brief summary of significant findings from the survey work and analysis:

- The soffit of the post-tension plaza slab exhibited numerous areas of distress in the form of cracking and water leakage (Fig. 3); corrosion of embedded steel reinforcing, electrical conduits, and surface-mounted junction boxes; and leakage around drainage pipe penetrations;
- Discoloration of the concrete resulting from grease leaking from the un-bonded tendon sheath/covering; and
- 73 post-tensioning tendons were exposed, of which 13 were found to have lost post-tensioning force and 9 were found to have a partial loss of the stressing force.

The results of the investigation revealed that the loss in post-tensioning force significantly compromised the structure's load carrying capacity and the existing post-tensioned slab was not code compliant to today's standards given a number of deficiencies in the slab construction. As such, the structure was severely overloaded and the plaza and garage needed to be closed due to life safety concerns and shored to protect the public and workers.

EMERGENCY LOAD REDUCTION

The vehicular parking was closed under the plaza deck below the greenscaped and landscaped areas. Shoring was installed (Fig. 4) and a zero live load plaza restriction was mandated for the area, so the parking bays below the tennis court area could be reopened. The plaza level remained closed to pedestrians; however, pedestrian access at the garage level was restored in a defined walkway to accommodate building access.

When the emergency load reduction work was completed, it was revealed that the renovation performed in the 1990s included the addition of concrete topping materials to enhance drainage (Fig. 5). A network of troughs/trenches remained where the prior site walls existed. These troughs were problematic in detailing the waterproofing system, and the topping slab/overlay represented additional dead load on a deck that was already overloaded and under-designed. In evaluating the options to address the topping/deck profile issues, three remedial options were considered including removing all toppings down to the structural deck, leaving the existing topping in place and infill the trough/trench areas, and leaving the existing topping in place and prove by testing and analysis that the toppings were acting compositely with the existing structural slab. The topping slab pull off tests revealed sufficient adhesion to confirm that the toppings were well bonded and could be considered to be acting compositely with the structural slab.

STRUCTURAL, ARCHITECTURAL AND OPERATIONAL IMPROVEMENTS

The plaza deck analysis revealed a severely limited load carrying capacity. To restore the integrity of the original design, 69 post-tensioning tendons were repaired (spliced) or completely



Fig. 2: Bird's eye view of the plaza (planters, pavers, soil and hardscaping)

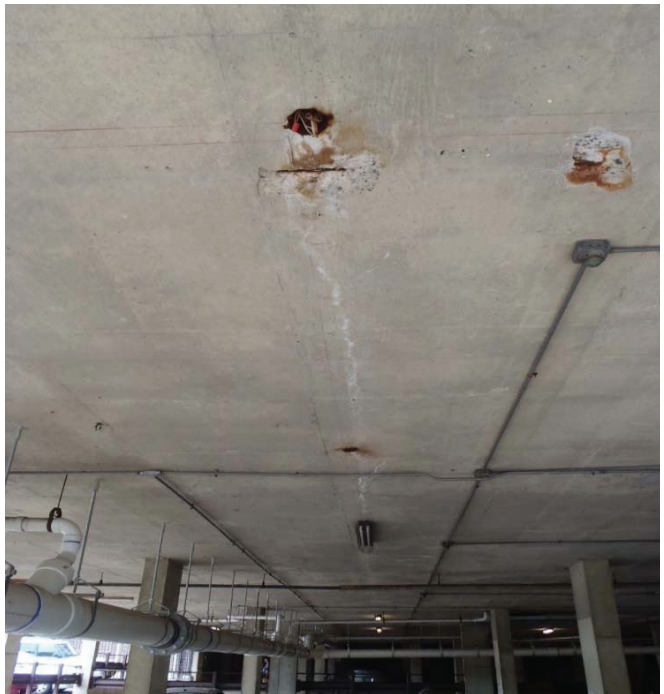


Fig. 3: Cracking of the concrete slab aligned with the electrical conduits at mid-span



Fig. 4: Shoring for plaza during the emergency load reduction phase



Fig. 5: Plaza demolition revealed topping slabs that overlaid the structural deck

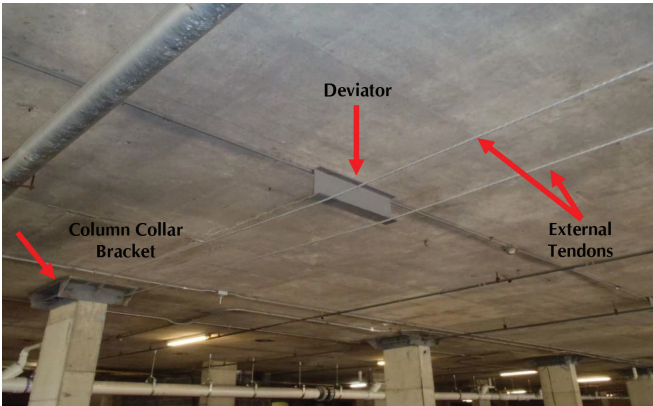


Fig. 6: Steel column collar brackets and intermediate deviators were installed

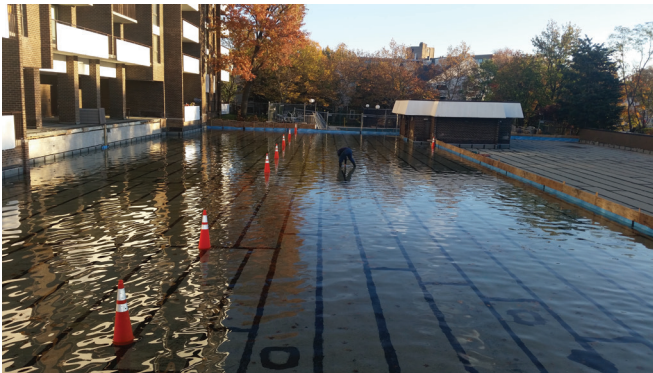


Fig. 7: Up slope hydrostatic water test performed to validate the waterproofing system installation



Fig. 8: Completed amenity space with hardscaping

replaced, and external reinforcing installed. The rehabilitated post-tensioned and externally reinforced slab was designed to safely support a live load of 100 psf (4.8 kpa) along with a SDL of 100 psf (4.8 kpa).

The use of external strengthening at targeted bays with longer spans facilitated the repurposing of the elevated plaza structure with increased capacity to accommodate the Owner's desired amenities and hardscaping/landscaping. Steel column collar brackets were installed to anchor the tendons and provide supplemental shear reinforcement at the column-to-slab connections. Mid-span deviators were installed to provide sufficient profile geometry for the tendons while maintaining head room in the garage space (Fig. 6).

The plaza deck was then covered with a reinforced hot rubberized asphalt membrane and the membrane was covered with an aggregate surfaced cap sheet as a protection layer (Fig. 7).

CONCLUSION

The project was a challenging plaza deck structural and strengthening rehabilitation. The Owner's initial desire was to perform targeted leak repairs to the plaza deck with the intent to defer the cost of a plaza waterproofing project for as long as possible. The pre-design evaluation revealed that the structure was not safe, requiring emergency stabilization and structural repairs.

The achieved results included a greatly extended service life, reduced future maintenance costs of the plaza deck/garage structure, and the opportunity to create an updated amenity space that will be serviceable and serve the building users well into the future (Fig. 8). The plaza has become an active and vibrant centerpiece for the occupants of the building, revitalizing the plaza into a meeting place and outdoor activity center for the community. ■

The Templeton of Alexandria Condominium Plaza Deck

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