

Strong Communication Key to Successful Garage Repair

By Craig Kobza and Ron Petsch

The Orange Street Parking Garage is a precast concrete structure that provides approximately 720 parking spaces for commercial tenants in Lakeland, Florida. The five-level structure, owned by the City of Lakeland, is approximately 30 years old and encompasses one city block with approximately 250,000 ft² (23,225 m²) of space. A preliminary assessment of the structure indicated that extensive work was required to repair and rehabilitate the garage. The owner required that the garage had to remain fully functional throughout the entire repair process. This provided challenges that required unique and innovative solutions. It became apparent prior to construction that scheduling and collaboration between the owner, engineer, contractor, and more than 700 patrons would be critical towards achieving a successful end product.

The overall plan dimensions of the garage are 180 x 360 ft (55 x 110 m) with a typical bay spacing of 20 ft (6 m) in the north-south direction and 59 ft (18 m) in the east-west direction. The center bay is at a constant elevation while the two exterior bays slope to create the elevation change between the levels forming a single helix-type circulation system. Traffic flow within the garage is one-way with angular parking spaces.

The structure is comprised of both precast and cast-in-place concrete elements. The cast-in-place stair and elevator towers and various shearwall elements are located at various locations throughout the structure. The six stair towers and two elevators are situated around the perimeter of the structure. The columns, spandrel beams, and double-tee beams comprise the precast elements of the garage. Three bays of double-tee beams (59 ft [18 m] in length) span between the spandrel beams (20 ft [6 m] in length) supported at each of the column locations. Precast columns have dimensions of 24 and 36 in. (61 and 91 cm). Special connections were used between the rigid shearwall elements and some of the double-tee beams to provide rigidity to the overall structure. A topping slab was placed throughout the structure as the wearing surface. Two pedestrian bridges provide access to the structure from adjacent buildings while four elevator and stair towers provide access to the ground level.

Assessment and Repair of the Structure

In 1999, the City of Lakeland retained the services of an engineering firm to perform a condition

assessment and structural evaluation of the structure. The recorded damage and deterioration noted during this phase of the project consisted of:

- Extensive spalling of the concrete;
- Numerous cracks in structural and non-structural members;
- Inadequate precast bearing and damaged bearing pads;
- Failed joints and sealants; and
- Lack of a traffic coating system.

Concrete damage, especially at many of the tee stem bearing locations, was noted. Several factors contributed to the corrosion and deterioration, such as inadequate concrete cover, exposure to the elements, embedded conduit, and inadequate maintenance. Core sampling and testing of the in-place concrete were performed to allow the engineer to provide the most cost-effective methods of repair.

After a review of the condition survey, the city elected to move into the next phase of the work, which consisted of the formulation of a complete repair and rehabilitation plan for the garage. A detailed investigation was performed by the engineer to evaluate the most cost-effective methods of repair because the garage had to remain operational during the repair process while numerous areas were being restored. The most severe damage and highest concentration of deterioration was located near the top level and at locations near shearwall elements and along the main expansion joint of the structure.

The contractor prepared a schedule that required development of a well-designed work and traffic control plan. Repairs were orchestrated in such a manner as to provide the maximum number of parking spaces with minimal closure during the construction process. Partitioning of the garage was accomplished by grouping methods of repair such as spall repair, crack injection, CFRP installation, bearing pad replacement, and the application of coatings and sealants. Extensive amounts of tee beam stem and flange restoration were required, and the primary expansion joint was repaired using an epoxy nosing and flexible sealant allowing both horizontal and vertical movements.

An issue of great concern was the amount of jacking and shoring that was required while the garage was still in use. To remain on schedule, the contractor had to work in multiple areas concurrently, using innovative techniques of jacking and shoring while vehicles and people traveled in and out of

the work zone. This addressed safety as well as logistical concerns. The contractor used sophisticated hydraulic jacking equipment to incrementally raise the precast concrete to allow repair of the tee stem bearing locations and replacement of the deteriorated bearing pads. The loads exerted by the hydraulic jacks induced forces in the members that could be monitored allowing a safer and more controlled system. The system was continuously monitored by the engineer during this process to ensure that overloading and subsequent cracking of the precast members did not occur. New bearing pads were designed to accommodate the loading and allow movement and rotation at the ends of the tee members. Many of the precast members required the release of welded connections prior to jacking. Extensive amounts of effort by the contractor ensured the facility was safe for users during the construction process.

Strengthening with Carbon Fiber-Reinforced Polymer

Due to severely spalled stems caused by inadequate reinforcing steel at the bearing locations of the double tee beams coupled with the existing cracks, carbon fiber-reinforced polymer (CFRP) reinforcement was used to strengthen the deficient areas. After the engineer performed an analysis of the bearing conditions for shear considerations of the existing members, a CFRP wrap system was designed to strengthen approximately 20 tee stems. The surface of the area receiving the CFRP was prepared per the manufacturer's requirements and all cracks were epoxy injected prior to installation of the CFRP. The CFRP was applied in multiple layers that wrapped the stem in the vicinity of the bearing points. This system provided the retrofit necessary to accommodate the stresses at the bearing locations due to the loading conditions and allowed an economical solution to an otherwise costly repair.

Scheduling and Team Collaboration

With the exception of the specific work areas, all areas of the garage needed to remain operational during the repair process. Only a limited number of parking spaces are available in downtown Lakeland, hence, vehicles could not be easily relocated to other parking facilities—use of every space within the garage was critical.

Project specifications required that the contractor formulate a work and traffic plan that enabled the repairs to be performed while the garage was occupied. This would require altering existing traffic patterns and restricting the use of many areas of pre-assigned parking locations. To aid in accomplishing this complex task of repair, the



Fig. 1: Expansion joint requiring repair

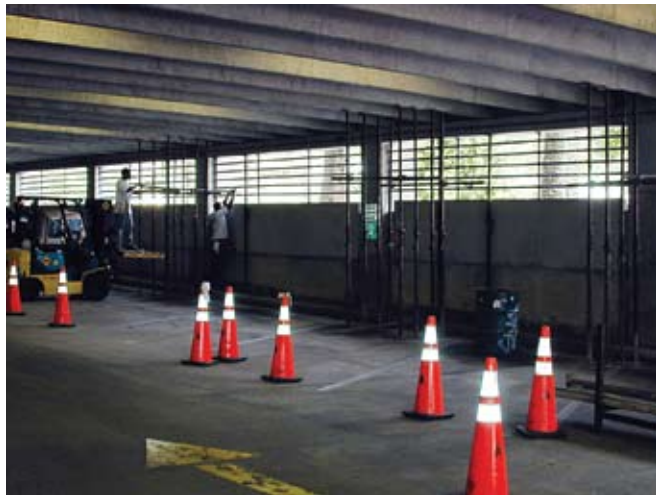


Fig. 2: Shoring of damaged double tee beams



Fig. 3: Jacking equipment used to raise double tee beams during bearing pad replacement

contractor strategically scheduled selected work, created mapped directional plans, and incorporated the use of a web-based communication management system to allow the designer, owner, and patrons of the facility to obtain and exchange information with regards to the repair process during construction.



Fig. 4 (top inset): Beam repair in progress

Fig. 5: Completed beam repair



Fig. 6: Concrete cutting and removal at top level

This also allowed the owner and patrons to be more engaged during the construction process. This resulted in many positive aspects:

Project Team Collaboration

Collaboration between the owner, engineer, and contractor occurred through the use of the web-based communication management system. This resulted in:

- Instant sharing of updated drawings and design information;
- Reduced shipping and document management costs; and
- Tracking progress and assignment of tasks while keeping the owner informed.

Patron Involvement

A public access website enabled patrons to obtain knowledge regarding all aspects of the project. Information available included:

- Parking schedules and traffic plan;

- Current site and project information;
- Downloadable meeting minutes for project information and a better understanding that provided increased project accountability;
- Automatic e-mail notification of changes to the website, changes in parking plans, and updated traffic floor diagrams;
- Steps of the jacking and shoring process explained the need to have areas appearing to have no work in progress unavailable during these stages of construction;
- Project images showed progress and intricacies of work being performed; and
- Safety issues were publicly addressed while also allowing patrons to voice concerns and submit direct questions to the project team members.

The addition of the web-based communication management system brought new information and management opportunities to this challenging project. The project team was able to update the public and project information instantly and easily. This ensured that all available parking spaces were used during the repair process and created a safer working environment for both the on-site contracting personnel and patrons of the garage.

Complete Success

A unique retrofit project to a facility that could not be shut down during repair was successfully accomplished using innovative repair techniques and utilization of a web-based communication management system. The application of CFRP and the use of sophisticated jacking methods during the repair process created cost-effective solutions. Completed within the allotted time, the parking garage was embraced by the owner and patrons of the garage with the learned understanding that they played a role in the successful completion of the project.

The satisfaction of the owner was accomplished by keeping the city continually updated with the progress of the repair and rehabilitation of their facility. The engineer and contractor were able to share and view information in a way unlike previous repair projects allowing for the most efficient allocation of time and resources. Overall, the cost savings, customer satisfaction, and effective means and methods were gained through the use of innovative repair techniques and the unique web-based communication management system.

Craig Kobza is the founder and owner of Aerial Restoration Contractors, in the restoration and repair business for over 24 years. Ron Petsch, also of Aerial Restoration Contractors, is a certified general contractor. He is also a charter member and a Past President of the ICRI Florida West Coast Chapter, and is an active member of several ICRI committees.