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LOWER LOCKS PARKING GARAGE VISUAL INSPECTION REPORT

UNIVERSITY OF MASSACHUSETTS –LOWELL
FELIX GARCIA
SASHA SOSA
JOSEPH RIPLEY
QIXIANG TANG

BACKGROUND

As part of UMass Lowell's Service-Learning Program, students in Team 2 have been asked by the City of Lowell to assess the condition of the Lower Locks parking garage, located at 90 Warren Street in Lowell, MA. This report provides a detailed description of our team's findings during the initial visual inspection.

The Lower Locks parking garage is a five level concrete structure comprised of both cast-in-place and prestressed concrete. The garage was constructed in the mid 1980's. There are three stairwells located in the parking garage, two along its south side and one along the north side. An elevator is located near the UMass Lowell student entrance.

The first level is reserved for UMass Lowell student parking only, while the other levels are open to the public. Students have access to the parking garage by going the lower entrance located across from the University's Inn & Conference Center. The public gains access to the parking garage through the entrance off of Warren Street.

AVAILABLE INFORMATION

During the visual inspection, our team used plans of the Smith Lot Parking Garage, currently named the Lower Locks Parking Garage, provided by the city of Lowell. Plans were created by Engineers Design Group, Inc and dated 1983. City of Lowell Parking Director, James Troup, was our main contact during the initial inspection.

VISUAL INSPECTION FINDINGS

Representatives from Team 2 conducted a field investigation of the Lower Locks Parking Garage on February 13 and February 22, 2013. A visual inspection was performed in order to identify and prioritize defects with the parking garage structure. Typical defects observed were concrete cracking, spalling and staining of the columns, cast-in-place slabs and beams and prestressed double tee beams. Other defects included joint deterioration and drainage issues. Melting snow made the inspection of joints and drains very effective as team members could observe leaking joints, drainage issues and note any ponding areas. Although many defects were observed in multiple locations, the following defects were considered most critical to the overall structural health of the parking garage and are arranged in order of importance. Refer to Appendix A for Photograph locations.

A. CAST-IN-PLACE CONCRETE SLAB

This defect is on the ceiling, located at north part of level 1. It is about one meter in length and half meter in width. As it is shown in the photo #3 and #59, the presence of water has corroded the reinforcing steel and the concrete has spalled. Reinforcing bars are now exposed to air, and section loss to the reinforcing bars was observed.

Photograph 3 – Corroded Reinforcing and Spalled Concrete, Bottom View.

Ponding water on levels above continually makes the concrete surface moist which continues to aggravate the situation. Therefore, this defect was determined to be the most critical to the health of the structure.

Photograph 59 - Corroded Reinforcing and Spalled Concrete, Side View.

B. BEAMS

Several defects in the prestressed double tee beams were observed. Photo #36 shows the bottom of the double tee beam web near column C3-8 located on level 1. An obvious crack has developed across the whole section, and rust can be seen on it.

Photograph 36 - Cracks in Prestressed Beam Web, Bottom View.

Photo#37 shows the side view of this beam. Very wide cracks can be observed at the end of the beam. The boundary condition of this beam's bottom part is the free end, so the defect is not due to mechanical stressed and is likely caused by the expansion of the rusty reinforcing bars.

Photograph 37 - Cracks in Prestressed Beam Web, Side View.

The prestressed beam web in Photograph #40 has the same defect as the prestressed beam web at column C3-8 located on level 1 (Photograph #36and #37). Its concrete has already spalled and the reinforcing is explored to air. This beam is near Column B-16 on level 1 of the parking garage.

Photograph 40 - Cracks in Prestressed Beam Web, Bottom View.

C. COLUMNS

A visual inspection of the garage columns determined that multiple columns are in bad conditions. The columns in critical conditions are columns that are adjacent to heavily corroded drain pipes and metal protectors. These columns are subjected to a combination of chemical and physical attacks. The metal protectors were screwed into the concrete and due to the corrosion of the drainage these columns were exposed to high levels of moisture, rust and deicing chemicals. The screws in the concrete allow large amounts of moisture to penetrate the columns, freeze and increase the area of the cracks thus, increasing the permeability of the concrete. The concrete is exposed to deicing chemicals, which could increase the crack, expansion, softening, and disintegration of the cement paste (photos 71, 30).

Photograph 71 and 30 – Typical Column Cracking Due to Physical and Chemical Attacks.

D. PONDING WATER

Ponding water was observed on level three of the cast-in-place portion of the parking garage. This portion of the parking garage is not covered and is therefore susceptible to collecting precipitation. Unlike the prestressed double tee beams, the cast-in-place portion of the parking garage is not cambered and has a negative deflection under the dead weight of the slab, which causes the ponding water. (Photograph 16) While this defect is not immediately critical to the structural integrity of the parking garage, efflorescence was noted on the bottom of the slab (ceiling of level 2) indicating that water has leached through the slab.

Photograph 16 – Ponding Water on Level 3 Cast-In-Place Slab.

The presence of this ponding water in addition to de-icing chemicals has created cracking along portions of the third floor cast-in-place slab. (Photograph 17) A temporary repair was made in an effort to waterproof this crack. The caulking used appears to have prevented further leaching of water through the slab at this location.

Photograph 17 – Ponding Water and Crack on Level 3 Cast-In-Place Slab.

E. EXPANSION JOINT

Large differential live load deflection was observed on each side of the expansion joint on the ramp between the second and third floors of the garage. The joint at Nodes 11 and 12 is the dividing line between the third and second floors respectively on the ramp. Based on observing traffic cross this joint, it appear that the first last tee beam on the level 2 side of the joint (Node 11) deflected relative to the level three double tee beams under live load. The double tee beam at node 11 was inspected from above and below. No cracking was observed on the stem and no crushing was observed on the flange. At this time, it is unclear what causes the large differential live load deflection. Photograph 41 shows the joint from below.

Photograph 41 – Expansion Joint At Node 11-12 On the Level 2 Ramp.

F. STRIP SEAL

Many strip seals have failed in the parking garage. While none of the strip seals are structural, they prevent the migration of water between levels of the parking garage and help to increase the service life of the structure. The most noticeable deteriorated seal is on the third floor of the cast-in-place portion of the parking garage at the interface with the brick façade of the main portion of the parking garage at column B1-4.1. Photograph 18 shows the large gap due to the failure of the strip seal.

Photograph 18 – Deteriorated Strip Seal At Third Floor Column B1-4.1.

G. DRAIN ON FIFTH FLOOR

This drain is located at the end of the prestressed double tee beam near the concrete closure pour that creates continuity between rows of tee beams on the fifth floor of the garage. The drain was not placed at the low point in this location, which creates ponding water. As seen below in Photograph 55, the closure pour (on the left of the photograph) is delaminated and cracked, while the end of the prestressed tee beam (on the right of the photograph) is completely deteriorated creating a void (center of the photograph) in which the fourth floor can be seen through. While this deterioration in the garage floor surface does not necessarily decrease the capacity of the double tee beam, the void allows water to travel down the double tee stem and create issues as seen above in photographs 36, 37 and 40.

Photograph 55 – Deteriorated Concrete on Fifth Floor.

H. MASONRY CRACKS

Masonry cracking was observed in the stairwell at the Southeast corner of the garage between floors two and three. Typically, in settlement induced cracking of masonry elements, the grout between individual blocks will crack. However as seen in Photograph 47, the cracking is vertical and travels through the masonry elements. At this point, it is unclear as the cause of this defect.

Photograph 47 – Masonry Cracking.

APPENDIX A

VISUAL INSPECTION PHOTOGRAPH LOCATIONS