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University of Houston East Garage Fire Emergency Response

HOUSTON, TEXAS

SUBMITTED BY WALTER P MOORE & ASSOCIATES, INC.

Fig. 1: University of Houston East Garage (top) and fire-damaged area after repair (bottom)

BACKGROUND

To accommodate the growing population of students, the University of Houston's 2006 Campus Framework Plan included the addition of parking spaces. The East Garage (Fig. 1) was designed to meet the needs of students, faculty, visitors, and residents of the nearby campus lofts. Utilizing a "double zero" ramp configuration, the garage was designed to have "nested" visitor parking with the capability to use the upper levels for overflow parking.

The garage utilizes pay-on-foot machines for visitors with pay stations located on the ground floor, and is designed to accommodate future residential development on two sides. Traffic engineering services on this project included a traffic impact study, site circulation review, Texas Department of Transportation (TxDOT) driveway approval, and traffic control plans. Recommendations from the study included the installation of a traffic signal, the addition of turn bays, and improvements to existing pavement markings to improve safety for vehicles and pedestrians.

In April 2018, The University of Houston (UH) suffered a multiple-vehicle fire on the third level of the four-level East Garage (Fig. 2). Significant structural damage occurred to two columns, the framing of the level above, and the exterior signage (Fig. 3). Before any testing could be performed, shoring was installed to prevent the risk of collapse (Fig. 4).

INSPECTION AND EVALUATION

Together with the Houston Fire Department, the Engineer performed a cursory visual review. The extent of the fire damage was confined within the two bays adjacent to the garage expansion joint on the east side. Shoring and cleaning requirements for the damaged members were provided on-site on April 26, 2018, the same day that the fire occurred.

Additionally, available background information and plans were reviewed, and a follow-up visual assessment of the damage was conducted on May 2, 2018. Prior to the second visual evaluation, the structural members within the fire-damaged area were cleaned using dry ice blasting that allowed a closer look at the extent of the damage. In addition to visual observations, a limited floor delamination survey was performed utilizing a chain dragging device to detect unsound concrete. An acoustical monitoring wheel and hammer sounding was used to detect delaminated concrete on the vertical and overhead elements.

Concrete testing was performed (compressive strength and petrographic examination) and non-destructive evaluation (NDE) was conducted to determine the severity of damage and repair approach. NDE methods included ground penetrating radar (GPR) survey, ultrasonic pulse velocity (UPV) testing, and pulse-echo scanning (Fig. 5).

The visual reviews and delamination survey indicated that fire-related distress had occurred in the form of concrete cracking and spalling, including delaminations identified in several crucial structural beams and columns. The concrete distress was more severe at members near the expansion joint. Core compressive strength testing did not show degradation of compressive strength as a result of the fire event. However, the petrographic examination of the concrete cores indicated the extent of surficial concrete damage as a result of exposure to fire-elevated temperatures was up to a depth of 0.4 in (10 mm).

Significant carbonation and cracking were also observed in several core samples and correlated with the NDE (UPV and pulse echo) results at multiple locations at each structural member. GPR scanning of cracked double tee beams with significant longitudinal cracking showed that these cracks were located along the prestressing strands, thus indicating possible debonding between the strand and concrete with subsequent reduction in structural capacity. The petrographic examinations also indicated that the concrete members were exposed to elevated temperatures possibly reaching around 1,400°F (800°C).

SITE PREPARATION, DEMOLITION AND REPAIRS

Repairs included replacement of members that experienced severe distress, along with localized repairs of members with moderate or minor distress. Repair drawings were issued on June 1, 2018.

Fig. 2: Fire damage on Level 3 of parking garage

Fig. 3: Fire damage at exterior of garage

Fig. 4: Shoring installed in affected area

Once mobilization took place, the perimeter of the precast double tees were saw cut, creating separation of each member to be replaced prior to removal. In preparation of hoisting the existing damaged precast double tees, cores were drilled at each of the four pick points, allowing a sling to be wrapped around the stem for each double tee. A 350-ton (317,500 kg) crane was used to bring down each damaged precast double tee, with a total of six removed and four new double tees reinstalled. Two of the damaged double tees were found to be salvageable, temporarily placed on the ground, and repaired after they were placed back in their final position. Two existing spandrel beams were hoisted down, hauled off, and replaced with new members (Fig.6). New replacement double tees were hoisted into place for final repairs (Fig. 7).

Fig. 5: Nondestructive testing performed at damaged column

Fig. 6: Spandrel beam replacement

Fig. 7: New double tee beams

Fig. 8: Column repair (a and b)

Other repairs included the concrete columns supporting Level 4 (Fig. 8), spandrel beams on Levels 3 and 4, double tee members on Level 4, topping slab replacement on Level 3, and waterproofing on Levels 3 and 4. The damaged expansion joint system on Level 3 was replaced and a new expansion joint system was installed on Level 4. Joints were tooled in the topping slab and sealed above the double tee flange-to-flange joints, and construction joints were routed and sealed. Cove sealant was installed at the perimeter bumper wall and columns.

SPECIAL FEATURES

Safety

Emergency shoring addressed initial safety concerns for assessing the damage and reducing the threat of a possible collapse. With student finals around the corner at UH, it was understood that the East Garage would need to remain in use on all undamaged levels. This presented another challenge to the construction team: safely making localized repairs to damaged elements with limited intrusion to occupants while considering the safety and comfort of students and staff during the construction.

Logistics

The highly public garage proved to be a limited jobsite space, leaving very little room for building materials and workspace. While the complexities were abundant, the project team worked efficiently to have the garage fully operational by the start of the fall semester. Ultimately, the team was able to come in under budget and ahead of schedule on repairs.

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