Manhattan Repair Project Proves Challenging

by Gerald Valente

Working on a building restoration project in any metropolitan city has its drawbacks and this project was no exception. The specific challenges of this project, however, far exceeded those imposed by its location on the Upper East Side of Manhattan. The tenant, Avis Car Systems, LLC, required the entire project be completed with no disruption to its daily business operations. This included maintaining the rental counter, the office area, car wash and fueling bay, and the storage of several million dollars of vehicle inventory. Although this facility employed only 12 people, on a busy day, the staff would process the rental of several hundred vehicles. This made for considerable pedestrian and vehicle traffic within a very compact space.

Building History and Design

The building was constructed circa 1920 and had been used as a warehouse for various businesses until the mid-eighties, at which time, Avis Car Systems occupied the two-story building. The first floor is used for the rental functions and the second floor is used for long-term vehicle storage. The two floors are connected by a narrow, 11 ft (3.3 m) wide, one-way ramp.

The structure has a footprint of approximately 14,000 ft^2 (1300 m^2) and is constructed with brick walls, concrete floors, and a concrete roof. The second floor and roof are supported by concrete-encased structural steel consisting of beams, girders, and columns. The edge beams and girders are framed into, and supported by, the exterior brick walls.

The second floor concrete slab was originally cast level, with no drainage, and was of a low-strength psi cinder-type concrete, 6 in. (150 mm) thick. The slab concrete tested at 700 to 800 psi (4.8 to 5.5 MPa) compressive strength and, over decades, had been built up with several layers of similar material 12 to 13 in. (30 to 33 cm) thick. The slab design was with a "draped mesh" that depended heavily on the steel reinforcement and concrete encasement, and not the cinder concrete. This design consisted of a heavy wire mesh placed

in the top of the slab at midspan and connected to the top of the steel support frame at the perimeter of the bay with wire clips. This design was common in commercial structures of this era in New York City. The slab, together with the steel frame, provided a diaphragm for lateral support of the brick walls and stability of the structure.

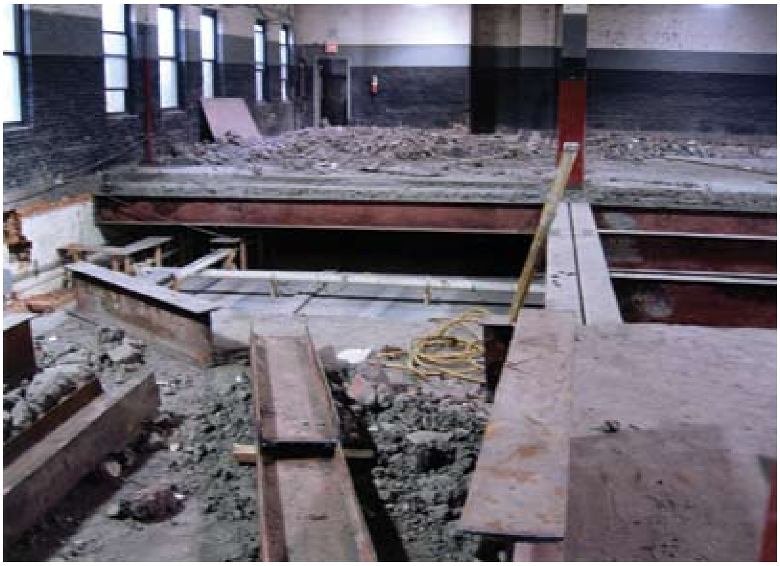
A protective membrane or structural design for vehicle traffic was not considered in the era the structure was built. After many years of vehicle use, the second floor slab began to deteriorate. The deterioration was hidden by the many levels of toppings and concrete encasements; it went unnoticed for years until delaminated concrete began falling from the ceiling to the level below. The owner immediately commissioned an engineering assessment. A survey was performed on the underside of the slab and probes were cut into the top slab and encasement. The assessment discovered heavily corroded slab reinforcement and steel beam flange and web corrosion. The girders and columns were found to be in relatively good condition.

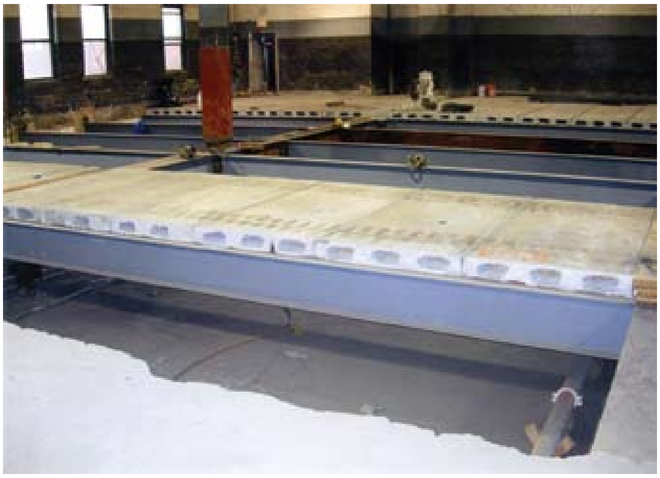
As a result, this required the closing of the second floor to vehicle use and the installation of a temporary protective shield directly below the first floor ceiling. The temporary shield was designed to withstand the impact of falling concrete and facilitate the repairs to the second floor.

Repair Design

The repair design required the complete replacement of the second floor slab, replacement of 70% of the steel beams, and welded plate reinforcement of 25% of the girders. The new slab design comprised 6 in. (150 mm) thick hollow-core plank with embedded weld plates cast in the bottom and at both ends. The new planks were designed to support heavy construction loads and were to sit on the narrow flange of the steel beams. The planks were to be welded to the steel beams, and the joints between planks and end cells grouted. A heavily reinforced sloped concrete topping slab 4 to 8 in. (100 to 200 mm) thick was to be placed over the planks. A steel perimeter angle was designed to complete the engagement of the slab support of the perimeter walls.

The design required that the contractor maintain a "building diaphragm" at all times. This meant the masonry walls had to be laterally supported by removing and replacing no more than 26 linear ft (7.9 linear m) of the slab, consecutively, along the exterior walls, at a time. A second requirement was to maintain two full bays between columns in both directions. Also, no more than six interior and two end bay beams could be removed and replaced at a time. Finally, the width of the beam flange was less than 7 in. (180 mm). This required the precise measurement and fabrication of the planks to ensure adequate end bearing.





Construction Method

The numerous safety and design constraints that were imposed by the owner and engineer forced creative solutions and methods of construction. Maintaining the appearance of normalcy, with no disruption to the customers or the operation of the business, was important.

The site conditions ruled out many conventional methods of construction. Cranes and other equipment were too large and heavy for the existing slab. Removing the entire slab and bay of beams in one phase was not possible due to the diaphragm requirements. Early on, it was discovered that each framed bay was a different size. This required measuring the length and width of each of the 68 bays to provide the dimensions for the manufacturing of the 408 planks. This anomaly and the diaphragm requirements required a detailed ordering and delivery schedule to ensure that only those planks that could be installed immediately were delivered at a particular time.

The demolition and disposal of the existing slab and concrete encasements were completed with a mini excavator, skid steer loader, and small demolition hammers. On slow business days, holes were cut through the temporary shield and debris was removed from below. On busy days, debris was "mucked-out' from above—a tedious task. The removal and replacement of the steel beams and installation of the precast plank was accomplished with the excavator. A temporary support platform was required under the excavator to avoid collapse of the existing slab.

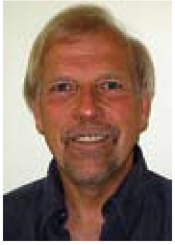
The new planks were designed so that the machine could operate on them to facilitate the placement of other planks and new steel beams. Once the planks were installed in a 26 ft (7.9 m) wide bay, they were welded to the beams. The joints and end cells were grouted and the exterior floor edge angles were installed. New drains and heavy mesh reinforcement were placed on the planks and a sloped topping slab was cast. A new electric service, a heating, ventilation and air conditioning (HVAAC) unit, vacuum system, gas pumps, and other miscellaneous items were installed. The temporary shield was removed, which completed the project.

Final Analysis

The project was completed on schedule in August 2005. If one could attribute a particular factor to the success of the project, it would undoubtedly be the intensive planning before the start date. The strategy was simple: imagine every possible challenge that could arise and devise a practical solution. For work under our direct control, such as demolition and erection, this was quite simple. The opposite was true with systems over which we had little or no control.

Some of the most challenging situations arose in areas where we had the least expectation of trouble. We were aware that the slab strength from which the work was being preformed had been considerably compromised; but to everyone's surprise and dismay, we discovered that it was incapable of supporting even the lightest equipment. This slowed our progress considerably, as all maneuvering of equipment had to be done using improvised bridges that spanned the beams.

Many lessons were learned by the end of the project—the most important being the increasingly apparent fact that it is wise to invest considerable time into planning even in the most mundane tasks. One of the by-products of extensive planning is that it forces one to become familiar with the project and its many facets before you start to work. In the end, we all came away with invaluable knowledge and experience—the most treasured asset in this industry.



__Gerald Valente__ is President and the principle owner of Valente/C.A. Lindman, LLC, a structural repair and restoration specialty contractor that is part of the C.A. Lindman Companies. Valente/C.A. Lindman serves the New York, New Jersey, and Connecticut metropolitan areas. Valente has 30 years of experience in the repair, waterproofing, and strengthening of structures, and has completed over 2000 repair projects. He was previously the Executive Vice President and one of the owners of Structural Preservation Systems, Inc., of Baltimore, MD, where he founded and served as Branch Manager of its New York office for 18 years. Valente currently serves on the Board of Directors of ICRI's New York Chapter. He is a native of Worcester, MA, where he grew up working in a family-owned contracting business. He earned his engineering degree with honors from the University of Massachusetts and is currently a licensed Professional Engineer in three states.