Breaking the Surface

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The cosmetic renovation of a New England building grows to include a significant structural repair.

FEW THINGS ARE AS FRUSTRATING AS BUYING A BUILDING ONLY TO DISCOVER THAT YOU'RE ALSO BUYING INTO STRUCTURAL DAMAGE. But that's just what happened when a major bank purchased a one-story reinforced concrete building, constructed in the early 1900s, with the plan of renovating it to house a new branch.

A stepped crack had developed on the concrete block wall on the building's western side, adjacent to a corner concrete column. Although the wall appeared to be a non-bearing filler wall, the owner was concerned with the situation and wished to investigate the reason for the cracking and repair it before the renovation was complete and the new tenants moved in.

The owner brought in an architectural consultant, Ardalan Associates, as well as structural design firm Gregorian Engineers to evaluate the situation at the corner column and concrete block wall area, determine the extent of the crack, prepare a condition survey report, and suggest repair methods.

Unfortunately, no existing structural drawings were available for review, and almost all structural elements were concealed by gypsum board and suspended ceilings, preventing observation of the structural framing system in the first floor and ceiling area. So, the engineers had to make measurements of the existing structural elements and document the existing conditions in accordance with ACI guidelines.

The condition survey report compiled by the evaluation team included drawings indicating size and location of existing members, as well as photographs and descriptions of the structural condition of the corner based on visual observation and tap testing (striking the surface with a hammer and a steel bar).

Preliminary Investigation

During our initial visit, we noticed a 3-in.-wide crack that extended through the entire cross section of the column. The crack was diagonal, at a 45° angle, at the top of the column approximately 6 in. below the floor and column joint. Settlement, measuring approximately 5 in., was also observed at the corner of the building.

The existing structural system consisted of rectangular and square columns (in the basement) supporting the floor structure on a 25-ft by 20-ft system in the long and short direction. The floor system consisted of a one-way cast-in-place joist system with reinforced concrete girders spanning the 25-ft-long dimension. The joist system spanned 20 ft, resting on the girders.

Repair Options

The following factors were critical in the selection of repair options:

- ✓ Repairs had to be performed as quickly as possible.
- ✓ The building had to be secured to avoid vandalism.
- ✓ Repair materials had to be readily available.
- ✓ The repairs had to be relatively simple.
- ✓ The aesthetics of the finished product were not of concern because the area would not be exposed to view.
- ✓ Structural repairs had to cause minimal disruption to the other renovation work being performed.

Three repair options were considered:

1. Repair the column and the attached corner roof beams using FRP (fiberglass-reinforced polymer) sheets. This option was

Above: The damaged corner column (on the right) is actually at the junction of the main building and an adjacent building.

Enlarged view of the corner cracked column. The surrounding structure is covered and could not be observed.

Hollow steel columns, 6 in. by 6 in., now reinforce the damaged concrete corner.

eliminated since it would not alleviate the decreased load-carrying capacity of the inclined column due to deformation. Also, with the column being at the corner of the building and the crack being close to the roof, a beam-column joint would make the installation difficult and unpractical.

2. Demolish and reconstruct the column and part of the roof. This option was ruled out due to problems performing demolition in a congested area and because it would take too long.

3. Relieve the load on the damaged corner column by installing steel support columns to support the concrete roof beams framing into the column.

Option 3 was eventually selected. Since the structure had settled and cracked and was out-of-plumb, the best solution was to support the existing concrete frame using new structural steel members to transfer the load to the foundation. This solution required minimal demolition, and the steel columns could be fabricated in the shop and transported to the site for installation. In addition, installation was performed in one day, and the whole operation was performed in less than a week, without disrupting the non-structural renovation work.

Installing the Columns

Six-inch-square HSS columns with 12-in. by 12-in. base and cap plates were installed and anchored with 5/8-in.-diameter epoxy anchors. The columns were installed about 24 in. away from the cracked corner column to support the roof corner beams where the concrete was intact, and away from the deteriorated concrete areas.

The base plates were installed on the existing basement wall on the exterior side (at the rear wall) and on the concrete basement ceiling beam on the inside (at the side wall). The side wall column was continued to the basement slab by adding steel columns supporting the concrete basement beam from below. Non-shrink grout was used at the base and cap plate support locations.

Looking Forward and Upward

With the installation of the new steel columns, the concrete corner column no longer acted as a load-bearing element. To prevent possible further deterioration, the deteriorated part of the column and part of the attached roof beams were cleaned, steel dowels were installed at the 3-in. gap, and the gap and repairs were filled with concrete.

Finally, in anticipation of expanding the building upward, a new steel column independent from the existing structural system was installed at the newly reinforced corner. As such, steel has prepared the building for the present, with an eye on the future. MSC

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Photos courtesy of Gregorian Engineers.

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