Outstanding Repair & Rehabilitation Project Honorable Mention—Underside Roof Slab Repairs at Westview Towers

Shotcrete Segment

This project was for the repair of deteriorated and spalled concrete located on the underside of the roof slab of a 13-story senior residence building in Knoxville, TN. It was part of an overall job to renovate and update a 1973 building for new owners who would then rent apartments to elderly occupants.

Spalling was discovered during removal of acoustic tile from the ceiling of the top-floor apartments. The spalling was caused by carbonation of the concrete on the bottom of the roof slab to a depth of 1-1/2 to 2 in. (38 to 50 mm). This caused corrosion of the lower mat of reinforcing steel and the subsequent spalling of the concrete. When it was discovered that this condition covered essentially the entire 10,000 ft^2 (930 m^2) slab surface of the building footprint, emergency repair operations were called for.

Bids were taken for both form-and-pour/pump and shotcrete applications. Shotcrete was chosen even given the physical problems of working above 11 to 12 floors of occupied space. A high-strength polypropylene fiber-reinforced, silica-fume modified dry-mix shotcrete was chosen for its high-early-strength properties and relative ease of placement and finishing in overhead repair situations. In actuality, nothing is easy about overhead, large-area placement and finishing of any repair medium. Using a 5% microsilica replacement for cement in the mixture, 3-day strengths of 3500 psi (24 MPa) were common with 28-day breaks of 10,000 psi (69 MPa) potential shrinkage cracks were controlled by the polypropylene fibers and the high relative humidity of the interior atmosphere. In fact, no shrinkage cracks were observed in the finished product, which became the apartment ceiling.

The shotcrete material was site-batched at ground level and, powered by a 1300 cfm air compressor, delivered dry to the 13th floor where it was placed by ACI Certified Nozzleman to tolerances close enough that finishers could achieve the required levelness of 9.5 ft in 10 ft (2.9 m in 3.0 m) and surface flatness of 1/8 in. in 5 ft (3 mm in 1.5 m) without destroying the bond between shotcrete and parent concrete. It turned out that the resulting slab was markedly flatter than the original formed-and-poured slab had ever been. Once the surface was trued, a light flash-coat was applied to hide any trowel marks and the final coat of textured paint was placed for the finished ceiling.

Cores were taken in accordance with ASTM C1583-04 to confirm the quality of the repair operation. Bond strengths ranged from 90 to 250 psi (0.6 to 1.7 MPa) with failure typically occurring in the parent concrete. Both hydrodemolition and hand-held chipping hammers were used for deteriorated concrete removal. Hydrodemolition, as expected, provided a better bonding surface for the shotcrete but the associated problems of spent water control and cash control precluded extensive use of that medium.

The methods of choice for this project were form-and-pour/pump or shotcrete. The engineers provided for both options in their bid documents and let the market dictate. Upon review of the bids and interviews with the competing specialty contractors, shotcrete was chosen as most likely to achieve the requirements of speed, cost effectiveness, and documentable repair results. The challenges were to reduce the number of floors affected by the shoring requirements, reduce lost revenue due to relocation of residents during construction, and deliver a quick turn-around to the owner.

Because shotcrete can be placed “as you go,” just behind the demolition without need for formwork, one floor of shoring was eliminated. Demolition was done in 5 ft (1.5 m) strips and leapfrogged from bay to bay. This meant that only 1/4 of a bay was in a demolished condition at any one time, thereby retaining the necessary structural strength to self-support with shoring to each side. Any forming method would have required significantly larger areas of demolition and formwork to be cost effective. This would have required two floors of shoring to ensure the roof did not “pancake” the remaining 11 occupied floors below, an obvious catastrophic occurrence.