

CONCRETE MATERIALS DISTRESS REINFORCING STEEL CORROSION

EXCESS SALT NOT GOOD FOR OUR BODIES OR BUILDINGS

Coastal environments are some of the most severe for building materials such as reinforced concrete. Winds can carry ocean-borne chloride-based salts considerable heights and distances for deposition on structures in their path. Together with moisture, chlorides soak into concrete and stimulate steel corrosion that tears it apart from within, skyrockets maintenance and repair costs, and diminishes overall building health and life. While building codes now severely limit the amount of chlorides that can be mixed in new concrete as was once more practiced, older codes had no such provisions, even further setting the stage in some structures. SKA combines knowledge from different facets of our engineers' experience to provide restoration methods commensurate with level of contamination, corrosion and deterioration so that wise money can be spent. This includes damage repair, strengthening, limiting future salt and moisture penetration and arresting ongoing corrosion to save long-term dollars.

CASE STUDY: DOCKSIDE CONDOMINIUMS



Constructed in 1978, Dockside Condominiums is a 19-story residential reinforced concrete structure on the bank of the Charleston Harbor in South Carolina. As one of the last high-rise buildings constructed in Charleston prior to city-imposed height restrictions, preservation of the structure is of utmost importance to its residents.

Corrosion-related distress and deterioration were

identified at reinforced concrete balconies and walls, and in the post-tensioned concrete parking deck located under the building during earlier surveys. As the concrete distress progressed, loose concrete pieces fell from balcony nosings and parking garage ceilings. The condominium homeowners realized the need to remedy the falling hazards and extend the useful life of the building. Due to strict city ordinances, maintenance of the aesthetic qualities of the building were important during work that included repair of the parking deck, building balconies and walls, and installation of new handrails.

A comprehensive survey was conducted on the parking garage and each of the 191 balconies. The project included two separate Engineering firms, SKA was responsible for design and oversight of structural repairs and overall project engineering construction, and the other responsible for design and oversight of a slotted mesh anode impressed current cathodic protection (ICCP) system on balconies and thermal spray galvanic cathodic protection (GCP) in the parking garage. Due to the high year-round occupancy rate and the expected construction duration, it was imperative that the building remain open and functional to residents. This proved to be a significant challenge.

Specialized performance-based repair specifications were developed that required laboratory testing for properties including strength, elastic modulus, cracking (ASTM C 1581) and bond (ASTM C 1583). Quality assurance testing included bond testing on a percentage of field-installed concrete repairs to verify performance.

Two contractors simultaneously performed the work that was divided between the concrete repairs and coatings and cathodic protection. The



Slab edge distress and overhead spalling hazards prior to repair



Reinforcing steel corrosion and concrete distress at balconies prior to repair



Mast climbers used to access balconies for repairs

SKA CASE STUDY

contractors used mast-climbers to access balconies in a phased approach to minimize impact to the owners. Concrete repairs were conducted first, followed by installation of the ICCP system, a polymer-modified cement-based protective deck coating, new handrails, and finish coating systems to the balcony walls and soffits. Extensive coordination was required between the two design firms and two concurrently working contractors. Special considerations were required for replaced handrails and re-used shutters, coatings and concrete repair materials to ensure compatibility with the ICCP system, and for addressing identified hazardous materials. Repairs were conducted on post-tensioned concrete in the parking garage prior to installation of thermal spray GCP.

During restoration construction, some hidden or unanticipated conditions were discovered that presented special challenges and required specialized repairs. Longitudinal concrete cracking was discovered near some balcony thresholds due to improper placement of reinforcing steel during original construction that resulted in a significant reduction of flexural capacity. Initially, this condition was corrected by slotting new supplemental reinforcing into the top of the concrete slab. However, due to high costs and the impact on residents during the repairs, this approach was abandoned in favor of installing beam sections on the underside of the balcony decks that could be completed without accessing resident units.

A variety of aspects of this project were atypical to normal projects. A great deal of coordination was required between two separate contractors so that work could be finished from the outside of the building on a limited number of mast climbers while the building remained occupied. Coordination was also required between designers to specify concrete repair materials with properties compatible with the impressed current Cathodic protection (ICCP) system. Securement of handrails and hurricane shutters to the repaired concrete deck was a critical task from several standpoints, including the need to provide adequate structural stability while avoiding damage to the new CP anodes embedded within the concrete and preventing stray currents from the CP system from potentially deteriorating the anchors.

Because of the extensive amount of repairs and the desire to confirm that selected repair materials met necessary performance criteria that are not necessarily on manufacture data sheets, a performance-based approach was utilized. This approach used state-of-the-practice test methods and required laboratory testing of the repair materials. Also, a level of quality control/quality assurance not typically used on projects was implemented to confirm bond of a percentage of repair areas.

Intricate repairs were required at some balconies where inadequate original construction was identified. The project was further complicated by the presence of existing hazardous coating materials which were either completely removed (abated) or were protected in-place to avoid being disturbed by the work.

This project received the *2015 International Concrete Repair Institute Carolinas Chapter Project of the Year Award*.



Post-tensioned beam repairs in progress



Thermal spray cathodic protection by the System Provider at garage components under the building



Concrete repairs in progress at balconies



Impressed cathodic protection system installation in progress at balconies



Finished balcony showing new guard rails, completed repairs and new deck coatings



Supplemental beams to address structural deficiencies