



# BUILDING ENVELOPE FAILURE

## CONCRETE & CORROSION DISTRESS / WINDOWS, DOORS & GUARDRAILS / WATERPROOFING

### NOT JUST ANOTHER DAY AT THE BEACH

Coastal structures have increased susceptibility to corrosion, concrete distress, leaks and safety hazards due to moisture and airborne salts from the ocean. Restoration projects at beach front condominiums can be complex, often necessitating intricate repairs and advanced preservation techniques for meaningfully extending the life of the building. These projects typically require specialty engineers and contractors for addressing materials distress; concrete contamination with ongoing corrosion activity; deficient or deteriorated fenestration and cladding; waterproofing and specialty structural issues (including guardrails, wall systems, deficient original construction and corrosion). They also generally require completion within compressed off-rental season time frames or while the building remains open and accessible to tenants.



Corrosion distress at beam and hollow-core panel

### CASE STUDY: SHIPYARD CONDOMINIUMS

Shipyards Village Buildings A and B are five story, forty unit beach front condominiums located in Pawleys Island, SC. Repairs totaling approximately \$8.5 million were undertaken at both buildings, including concrete repair and replacement, cathodic protection (CP), coatings and fenestration replacement. The structural system includes prestressed hollow-core panels (PHCP) supported by load bearing concrete masonry walls and reinforced concrete beams. Corrosion-related distress was observed at portions of the exterior PHCP and beams supporting the panels, and reinforced concrete slab edges supporting windows. A study was conducted to determine the contamination levels and distress of representative components with respect to the different areas of the building



to select the economical repair methods. Corrosion of embedded reinforcing and prestressing steel was the result of elevated chloride levels in the concrete. Ocean-front slab edges were replaced with pre-packaged repair materials prior to new window installation. Land-side PHCP and ocean-side reinforced

concrete haunches supporting ocean-side masonry walls with minimal outward distress were protected with thermal spray CP and a breathable aesthetic topcoat. CP monitoring stations were installed at representative locations. Ocean-front PHCP and land-side PHCP with increased oceanic wind exposure, contamination and distress, and associated cantilever beams were removed and replaced with a high-performance lightweight concrete mixture. The mixture was designed with weight similar to the replaced PHCP, and resistance to chloride ingress, cracking and other deterioration mechanisms. New slabs were keyed into the existing masonry walls or supported on cantilever beams on the ocean-side balconies, depending on existing configuration. The land-side walkway sections were cast integrally with replaced cantilever beams without control joints. Because some existing beams did not meet current live load requirements, supplemental reinforcing or pilasters were installed to increase capacity. Cathodic prevention point anodes were installed at interfaces to deter incipient corrosion. Most concrete and repair work was conducted in winter, requiring close attention to placement and curing. Slabs were sloped to promote drainage and components were coated.



Corrosion distress at hollow-core panels



Thermal spray cathodic protection being applied to walkway hollow-core panels with contamination but limited distress

### CONCRETE REPAIR VS. REPLACEMENT?

In review of the data, distress patterns, general costs and complexity for intricate repairs on the thin-section PHCP with additional long-term preservation strategy (CP), it was decided to remove and replace panels in areas with heightened observed distress (ocean-side balcony panels and courtyard-side panels in the central portion of the condominiums) and implement limited repairs and a preventative protection strategy at remaining panels with a thermal spray CP system. Costs associated with removal and replacement of cantilever beams with variable amounts of distress at walkway and balcony locations and slab edges supporting curtain walls on the ocean-side were also favorable compared to widespread implementation of individual concrete repairs and CP strategy at these areas. Ocean-side haunches were patched and galvanically protected. Although coatings alone are generally not effective as long term solutions to on-going corrosion in coastal environments, protective coatings were used to compliment the cathodic protection system performance and provide architectural finishes.

# SKA CASE STUDY

## FENESTRATION AND GUARDRAILS

Sliding glass doors and windows were beyond useful service life. Demising walls were installed so that slab edges could be replaced and new impact resistant sliding doors and curtain wall fenestration could be installed. Curbs were installed at thresholds and new sliding glass doors were installed at all units. Extensive water testing was conducted on new windows and doors to confirm watertightness, especially important in hurricane zones subject to storms and high winds. Handrails, similarly at the end of useful service life, were installed and also included high-performance fluoropolymer coatings.

## WORK SCHEDULE

The buildings were unoccupied during the renovation work. Work was primarily conducted between September and May of successive years, with much of the concrete replacement and repair being conducted in the months of December through March. This schedule necessitated a highly responsive team and specialized specifications and construction procedures to address accelerated work and cold weather.

## SUMMARY

A pragmatic approach was used to cost-effectively replace and preserve portions of the structure to extend the service-life of a coastal condominium. This included concrete replacement at locations with extensive and complex repairs and protection of other members where warranted. A high-performance concrete mixture was used to provide a viable solution to replacement of PHCP. Galvanic protection was used to protect areas of the structure with limited distress. Curbs at thresholds were installed to prevent water from entering units and windows, doors and handrails beyond their service-life were replaced. Protective coatings were installed to further extend the life of the structure and provide a clean, aesthetically pleasing look.



Slab edge replacement prior to window installation



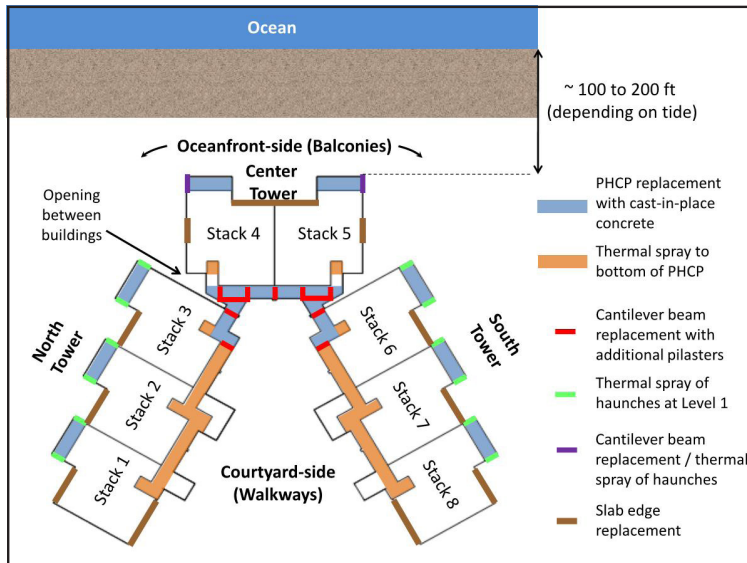
Curtainwall window installation



Oceanfront elevation showing balconies with demising walls and scaffolding - scope area included flanking balconies



Finished oceanfront elevation showing new balconies, guardrails, windows and doors



General concrete restoration and preservation methodology (coatings installed at all locations)



Courtyard window and concrete replacement in progress at area of heightened distress



Finished courtyard elevation showing new beams, walkways, guardrails and windows

This project received a 2012 *International Concrete Repair Institute ICRI Award of Merit* for the work associated with the concrete restoration and preservation.