



## Dolphin Towers Condominium Remediation

By Frank Morabito, P.E., SECB

*Morabito Consultants, Inc. was an Outstanding Award Winner for Dolphin Towers Condominium – Remediation project in the 2015 NCSEA Annual Excellence in Structural Engineering Awards program (Category – Forensics/Renovation/Retrofit/Rehabilitation Structures under \$20M).*

On June 24, 2010, the residents of the Dolphin Towers, a 12-story residential condominium constructed over a 3-story parking garage in Sarasota, FL, heard a large BANG. The residents of the plaza level condominium units discovered large cracks in walls and floors, along with doors that would not open that caused much concern. Five days later, the building was condemned by the City of Sarasota and the residents began a 5-year ordeal to get their homes back. After independent structural assessments and evaluations, over a 30-month period, that identified many structural deficiencies, Morabito Consultants, Inc. (MC) and Concrete Protection & Restoration, Inc. (CP&R) were hired to repair the 40-year-old building. The work included strengthening of the failed 24-inch thick concrete transfer slab, enlargement of the supporting concrete columns, installation of additional foundation piles, punching shear strengthening of numerous apartment tower columns, and installation of new concrete shearwalls to resist Category 4 hurricane wind loading.

Though the apartment building remained vacant, the street level retail shops and Florida Power and Light's (FP&L) electric room had to remain in service during construction. To expedite the construction process and to assure the safety of all working personnel, the design/build team first repaired the failed transferred slab, followed by the balance of the work. MC designed and detailed the construction documents and all temporary shoring and column jacking. Also, MC prepared all mild steel reinforcing and post-tensioned tendon shop drawings.

To proceed with the transfer slab repairs, it was necessary to install shoring under all tower columns. At 5 locations where the stress in the existing transfer slab far exceeded the allowable punching shear stress, MC designed a jacking scheme that lifted 5 tower columns sufficiently to allow a drop panel + column encasement solution to eliminate the slab punching shear overstress. The repair of all spalled and cracked concrete in the transfer

slab was completed per ICRI standards. The major failure cracks were filled with 80 gallons of low-viscosity pourable epoxy placed over 2 days.

The strengthening of the failed 24-inch thick concrete transfer slab required the installation of continuous drop panels around the entire tower building footprint and under the new tower shearwalls, along with the enlargement of the garage tower columns and the installation of a bonded overlay over the entire fourth level transfer slab. Depth and size of drop panels were determined to eliminate punching shear and transfer slab overstress, and prevent excessive residual stress in the existing concrete slabs. Post-tensioning reinforcing was added to the drop panels to reduce mild steel reinforcing, reduce shear and residual stresses, and control deflection in the existing transfer slab. The design of the transfer slab considered the existing transfer slab, 15-inch drop panels, and 6-inch concrete overlay to be one composite section throughout the entire floor footprint. To assure that the drop panels, existing transfer slab, and overlay worked as a composite section, it was necessary to install shear lugs throughout the drop panel footprint anchoring these 3 elements together. The shear lugs consisted of (610) 6 x 3/4-inch steel channels installed in 8-inch diameter holes that were drill thru the existing 24-inch slab. Where new tower shearwalls stopped on top and at the bottom of the 4<sup>th</sup> level transfer slab, the horizontal shear stress and uplift were transferred to the new composite slab by installing rebar dowels in (86) 5-inch diameter cores drilled thru the 24-inch slab. The 8-inch diameter shear-lug holes and 5-inch diameter shearwall cores provided a place to pour the drop panel self-consolidating concrete which created a natural head pressure to assure full volume placement of the drop panel concrete. The bonded overlay included sufficient flexural reinforcing to resist all negative moments in the composite transfer slab.

To increase the existing foundation capacity, (168) 30-ton helical piles were installed and tied to the existing pile caps. MC designed



numerous eccentric pile caps to keep all new piles at the tower perimeter inside the garage footprint, allowing occupancy of the retail shops to remain undisturbed. Since access to the FP&L electric room was forbidden, MC designed a 2-story tall 60-foot long post-tensioned beam to transfer the overstress portion of the column and foundation in the electric room to the adjacent building columns which were strengthened for the additional load.

A testing program initiated by the City of Sarasota found that the existing concrete strength in the framed tower slabs was typically less than the specified 3,000 psi and as low as 1820 psi. The MC punching shear repair solution included grouting the exterior block walls and jacking up the 6-inch tower slabs in 4 locations adjacent to the new interior shear walls that transferred the framed slab live and dead loads to the new shearwalls and eliminated column punching shear overstress.

The design by MC and construction by CP&R saved the unit owners over \$5,000,000. The Remediation of the Dolphin Towers won the 2015 ICRI Award of Excellence in the Repair of High-Rise Structures and was a finalist for 2015 ICRI project of the year. ■

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