

# Roof Sundeck Rehabilitation at a Chicago Condominium Complex

Chicago, IL

Submitted by CTLGroup

The sundecks, constructed circa 1966, are located at the north and south ends of a 39-story condominium building roof. Typical plan dimensions of each sundeck are approximately 71 x 40 ft (21 x 12 m). Structural framing consists of flat-plate floor slabs supported by concrete columns. Existing decking and waterproofing systems consisted of modular wood decking over a modified bitumen roofing system that was installed circa 1988. Original steel railings and steel outrigger rope descent systems were located along the outer perimeters of the sundecks.

## SIGNS OF TROUBLE

By 2005, the 17-year-old roofing system on the sundecks was showing signs of widespread water leakage into the storage space below the sundecks. Accelerated decay of the modular wood decking was evident due to long-term exposure to the elements. The original steel perimeter railings and rope descent systems also exhibited severe corrosion-related deterioration.

Due to the advanced state of deterioration, the owner closed the sundecks.

## INSPECTION AND EVALUATION

Consulting engineers were engaged to perform an inspection and evaluation program. A review of the original design drawings was performed to determine the design intent and understand the construction details.

A condition survey was conducted to assess the existing condition of the sundecks, which revealed extensive roofing failures that resulted in saturation of the slab topsides. The individual modular wood decking sections were not connected to each other and not fastened to the structural slab. Long-term exposure to the elements had resulted in corrosion of nailed connections and decay of the wood decking.

Slab delaminations were localized and were attributed to corrosion of slab reinforcing bars from water infiltration through the floor slab. Concrete cracking on the slab soffit was attributed to flexural performance of the two-way slab system, and restrained drying shrinkage.



*Chicago condominium complex where roof sundeck rehabilitation was performed*

The perimeter steel railings exhibited severe corrosion, resulting in pitting and significant loss of steel cross-sectional areas. Railing post anchorages consisted of bolted base plate connections to the roof slab. Significant corrosion of embedded post base plates was evident, including missing bolts at some locations.

The observed problems with water leakage in the storage areas below the sundecks was attributable to the deteriorated roofing system, poor drainage pitch of slab topsides, and insufficient or malfunctioning floor drains.

Deficiencies in punching shear resistance were identified at a total of six slab-column interfaces.

The slab flexural steel requirements were found to provide sufficient resistance for anticipated design loads.

## REPAIR SYSTEM SELECTION

The consulting engineers recommended the following:

- Perform structural strengthening of several supporting concrete columns below the sundecks to

accommodate design dead and live loads. At interior columns, strengthening was accomplished by increasing the shear perimeter using shear collars with hoop reinforcement. At edge columns, strengthening was achieved with shear corbels to the side faces of the columns. These corbels increase the effective width of the slab for unbalanced moment resistance (transferred through flexure and shear) while increasing the punching shear perimeter.

- Replace existing roofing with a liquid, hot-applied bituminous waterproofing membrane system.
- Replace wood decking with precast concrete pavers to improve durability performance and meet the Class A fire-resistive code requirements. To address the significant wind uplift forces at the building roof, tie downs were incorporated at each corner of paver grid with inverted steel angles along the perimeter edges of the paver grid.
- Concrete patch repairs on localized concrete delaminations and spalls of the floor slabs were performed using form-and-place methods.
- New galvanized flush tiebacks were mounted below the elevated precast pavers for use during routine façade maintenance operations.
- Replace the steel railings with surface-mounted aluminum railings with tempered clear glass panels to enhance durability performance and aesthetics.



*View of south sundeck prior to repair project; north sundeck is identical*



*Typical interior column strengthening with hoop reinforcement for shear collar*

## REPAIR CONSTRUCTION SEQUENCE

The project was performed in two phases: Phase 1 in 2012 and Phase 2 in 2013.

### PHASE 1: COLUMN STRENGTHENING BELOW SUNDECKS AND CONCRETE PLACEMENT

Before wood decking was replaced with precast concrete pavers, select columns in the storage areas below the sundecks had to be strengthened. Demolition required particular care to prevent damage to columns.

At interior columns, hoop reinforcement was installed for the shear collars. At edge columns, new reinforcing steel was installed through holes drilled in existing columns. The engineers used nondestructive testing methods to locate existing column reinforcing bars and thus avoid cutting existing column steel when drilling holes.

**Concrete Placement**—The form-and-place method was performed. Access holes were cored in roof slabs to facilitate placement of structural concrete from top of slabs.



*Typical interior column with shear collar*

### PHASE 2: MASONRY FAÇADE REPAIRS; REPLACEMENT OF ROOFING, DECKING, RAILINGS, AND TIEBACKS

**Masonry Façade Repairs**—First, the contractor rigged swing stages to replace existing roofing edge

metal flashings and underlying deteriorated face bricks. Construction crews removed existing outrigger steel beams, railings, and the roofing system down to top of sundeck structural slab.

**Concrete Repairs**—The engineers located delaminated and spalled concrete on the slab topsides and soffits. Typical patch repair was 3 in. (76 mm) deep with supplementary stainless steel reinforcement.

**Roofing Replacement**—New cast-in-place concrete curbs were constructed adjacent to the outer edges of the sundecks to provide the following:

1. Proper detailing of terminations for new sundeck roofing system and roof edge flashing; and
2. Edge restraint detailing for the precast pavers.

Reinforced curbs were constructed using air-entrained concrete. After curing, a waterproofing membrane was applied on the curbs.

A new liquid-applied, monolithic, fabric-reinforced waterproofing membrane system was installed.

**Tieback Installations**—Manufacturer installed and performed post-installation testing of new tiebacks for personal fall arrest systems.

**New Pedestal Pavers**—A new precast concrete open-joint pedestal paver system was installed.

**New Railings**—New aluminum surface-mounted railings with tempered glass panels were installed along the new concrete curbs.

## UNFORESEEN CONDITIONS FOUND

The team encountered undocumented buried plumbing lines in the slabs and disintegrated brick



*Typical perimeter concrete curb prior to concrete placement*



*View of completed south sundeck; north sundeck identical*

walls below the roofing line that required replacement. The contractor's careful planning and efficient execution of the repairs prevented these conditions from significantly affecting the overall project schedule.

## CHALLENGING PROJECT

### COORDINATION

This work required extreme care in design, sequencing, and execution to access sundecks on the building roof via swing stages, maintain structural support during column-strengthening repairs, and minimize disruption to the regular use of the building.

### IMPROVED DURABILITY, AESTHETICS, AND FUNCTIONALITY

By incorporating durable precast concrete pavers and railings with clear glass panels offering unobstructed views of a nearby lake, the durability, aesthetics, and functionality of the sundeck were improved significantly. As a result, the residents' use of sundeck space increased remarkably.

The new tiebacks also provided code-compliant tieback systems for routine façade maintenance operations. To mark the tieback locations mounted below the elevated precast pavers, custom markers were engraved on the paver units for aesthetics.

### TIMELY AND ECONOMICAL COMPLETION

The base bid work on this project was completed nearly 1 month ahead of schedule and about 10% under budget. These time and cost savings allowed the owner to perform additional work, including painting, replacing doors, and upgrading exterior lighting systems for the sundecks.

## Chicago Condominium Roof Sundeck

### OWNER

**Carlyle Apartments Homeowners Association**  
Chicago, IL

### PROJECT ENGINEER/DESIGNER

**CTLGroup**  
Skokie, IL

### REPAIR CONTRACTOR

**National Restoration Systems, Inc.**  
Rolling Meadows, IL

### MATERIAL SUPPLIERS/MANUFACTURERS

**Rediger Associates, Inc.**  
St. Charles, IL

**American Hydrotech, Inc.**  
Chicago, IL

**Quality Restorations, Inc.**  
Wood Dale, IL