Terminal Tower Façade Repairs

Cleveland, Ohio

Submitted by Sika Corporation

The Terminal Tower, the signature building of the Cleveland skyline, is a unique architectural design topped with an elevated and detailed dome. Designed by the firm Graham, Anderson, Probst & White, it was modeled after the Beaux-Arts New York Municipal Building and built for $179 million ($2.5 billion in 2010 dollars) by the Van Sweringen brothers.

Originally planned to be a 14-story office building, the structure was expanded to 52 floors resting on 280 ft (85.3 m) caissons. At 708 ft (215.8 m), it stood as the tallest building in North America excluding New York City from 1928, when it was completed, until the Prudential Center in Boston was completed in 1964. In 1976, the tower was added to the National Register of Historic Places as the Union Terminal Group. Today, it serves as the centerpiece of mixed-use Tower City Center development, with the entire complex comprising 557,000 ft^2 (51,747 m^2) on 34 acres (13.76 hectares).

The 52-story building is supported by a concrete-encased steel frame clad with decorative limestone and glazed terra cotta. At the 34th floor, the tower begins its transition from square to octagonal to round with multiple setbacks. Terra cotta clads these exterior walls, along with an ornamental window system behind the colonnade, culminating with a monumental flagpole atop an ornamental iron spire.

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TOLL OF 75 YEARS

As the building approached its 75th anniversary, a number of repairs were completed, including selective terra cotta replacement and patching, sealant removal and replacement, installation of protective netting at the 44th and 46th floors, and complete removal of the terra cotta of the west portico and supporting columns at the 44th floor.

Continued water infiltration as a result of decades of exposure to the harsh Midwest coastal environment caused interior water damage and accelerated deterioration. Active paths for water infiltration included failed mortar joints, flashing, and terra cotta units. There were cases where sealant had pulled away and exacerbated the problem by slowing the evaporation of water. Steel flanges rusted and expanded, causing pieces of terra cotta to loosen and fall and resulting in cornices that needed to be strapped into place.

To save time and money, the owners made the decision to follow a design-build mode for the repair. Examinations and bidding for repairs were developed concurrently as the project moved from floor to floor, which avoided delays and separated the work into more than 40 manageable packages.

INNOVATIVE REPAIR SOLUTIONS

Historic preservation tax credits were essential for funding this $20 million-plus project. The condition of the building's steel framing required the owners to come up with an innovative solution. Replacing terra cotta with terra cotta was not an option, as the steel holding it could no longer support the weight. The terra cotta was replaced with fiberglass cornices and other shapes manufactured

Falling pieces of terra cotta needed to be secured with straps

Scaffolding around the entire 37th to 52nd floors allowed engineers to inspect every square foot (meter) of the façade

with embedded aluminum extensions that could be bolted to new steel. In addition to being lighter and easier to manufacture and install, fiberglass pieces remain watertight. For salvageable terra cotta, an elastomeric coating employing a fiberglass mesh component provided waterproofing protection.

The project started with scaffolding being erected around the entire 37th to 52nd floors. It allowed engineers to inspect every square foot (meter) of the façade. To expose the cause of deterioration at specific sites, selective demolition was used. Repairs were then designed and competitively bid out for that section, with the process repeated for each section as the project moved from floor to floor.

To eliminate the biggest problem—water infiltration—mortar joints were cut out and replaced. Every mortar joint from the 44th floor to the top of the building was removed and repointed. Where the terra cotta was determined to be beyond repair, all material was removed down to the underlying substrate. Concrete was replaced, steel was cleaned and coated, and new material was installed. Based on the extent of deterioration, either original material, such as limestone or terra cotta, or fiberglass replicas (duplicated from salvaged material) were used.

One of the first renovation tasks involved repairs on the cast-iron cupola at the base of the flagpole. Originally, the cast iron served as a form for poured concrete. Over the years, the cast iron had cracked and reinforcing bar in the concrete had rusted. Workers removed all loose and split cast-iron cornices and replaced them with new steel, duplicating the shape of the original. Handrails and windows were replaced, and the area including the existing metal deck was cleaned and coated with a fiberglass-reinforced polyurethane liquid-applied membrane system manufactured to match the original.

As the project moved to the 51st floor and below, a method of repair for unsalvageable terra cotta was developed. All loose and broken cornices and rusting and expanding steel lintels that were splitting apart the façade were removed. The framework was replaced with stainless steel and aluminum, and the terra cotta was replaced with fiberglass molded from original pieces. Fiberglass units replaced hundreds of lineal feet of specialized cornice as well as thousands of square feet of terra cotta, including 32 columns, each 40 in. (1016 mm) in diameter and 30 ft (9 m) tall.

The repair for salvageable terra cotta entailed grinding out mortar joints and replacing them with new mortar, as well as repairing all cracks and broken pieces with polymer-modified repair materials. Over 10,000 ft^2 (929 m^2) of surface was coated with a UV-cured, elastomeric, fiberglass-reinforced coating system, which conforms to intricate detail and is color-matched to the existing terra cotta.

The walkthroughs and terra cotta balconies were found to be structurally failing on the 44th floor. The walkthroughs required demolition of the roof slab and removal of all masonry parapet walls. The roof slab, single-ply roof, and copper flashings were replaced. New concrete beams above the doorways and parapet stones were cast and coated with the fiberglass-reinforced coating. The balconies required demolition of top and bottom slabs and removal of all masonry. Steel framing was cleaned and reinforced. The new top slab was roofed with copper, and new bottom slabs were formed to replicate the original terra cotta. The walls were framed with stainless steel and aluminum and rebuilt with fiberglass pieces.

At the 37th floor, the rusting lintel had expanded so much that it was lifting the balcony. This required demolition of one course of masonry to expose and completely remove the lintel. Stainless steel fastened back to the building framing replaced the lintel, and new stone and weep tubes were installed.

The 34th-floor cornice required demolition of the entire bottom half and removal of all masonry and rusted lintels. Stainless-steel framing was installed to support the top half of the cornice, which was then repaired and coated with the fiberglass-reinforced coating. Fiberglass pieces were installed to replace the bottom half.

Below the 34th floor, the main shaft of the building needed the mortar joints replaced, all relief angle joints caulked, and weep tubes installed. The 30th-floor columns were repaired and deteriorated stone pieces were replaced. The 10 ft (3 m) 15th-floor cornice required removal of masonry and rusted steel angles. Steel beams were cleaned and coated and new steel framing and fiberglass units were installed. Finally, the entire building surface was cleaned.

SUSTAINABILITY ADVANTAGES OF FIBERGLASS

The ability of fiberglass to reproduce complex shapes and configurations allows designers to recreate historic designs and finishes without sacrificing the authentic look. Lightweight fiberglass replicas can be brought up freight elevators to the appropriate floor for installation, eliminating the need for cranes or other large structures required for terra cotta replacements. Material cost and production lead times are a fraction of those of traditional materials. It is estimated that the 32 columns for the Terminal Tower project were produced for about the same cost as four new terra cotta columns.

The energy consumed to produce and install fiberglass is less than with traditional products like concrete and terra cotta. Lightweight fiberglass contributes to overall savings through lower transportation costs, faster project turnaround, lighter structural requirements, less lifting equipment, and lower insulation requirements. It requires less maintenance, as the resistance of fiberglass to rust, rot, and corrosion reduces the need for replacement, repair, or repainting.

Terminal Tower

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Cleveland, Ohio

PROJECT ENGINEER/DESIGNER
Barber & Hoffman
Cleveland, Ohio

REPAIR CONTRACTOR
Provenzale Construction
Cleveland, Ohio

MATERIAL SUPPLIERS/MANUFACTURERS
Architectural Fiberglass
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AHEAD OF SCHEDULE AND UNDER BUDGET

After 5 years, the owners hope to continue building on their momentum. Their wish list includes the restoration of the observation deck to its original grandeur, as well as the restoration of Van Sweringen's living space. In the meantime, recognition to the Principals and subcontractors who worked together to tackle this massive project is warranted. They beat the 5-year time line—6 months ahead of schedule and $8 million under budget.

Cracked and rusted cast-iron cornices were replaced with new steel, duplicating the shape of the original

Fiberglass-reinforced polyurethane liquid-applied membrane in custom gold to match the original

A total of 32 fiberglass columns replaced the originals