More than 40,000 pieces of ornamental precast concrete are being used to restore the façade of historic Shepard Hall at the City College of New York (CCNY).

Shepard Hall, originally completed in 1907, contains load-bearing stone and terra cotta in its exterior walls in conjunction with steel framing. The terra cotta began cracking soon after the building was completed, due to inadequate allowances for building movement. Water entering through the cracks contributed to freezing and thawing damage in the remaining terra cotta and to severe corrosion in some of the structure’s steel framing. By the late 1980s, according to the restoration project’s architect, Carl Stein, FAIA, Principal of Stein White Nelligan Architects, LLC, a third of the building’s terra cotta had failed and half of what remained showed serious distress.

**DESIGNED FOR DURABILITY**

Stein’s firm was charged by the project’s owner, the Dormitory Authority of New York State, to devise a system that would extend the life of the nearly 100-year-old building well into the next century. Stein’s team responded with a “thin shell” reconstruction strategy that eliminated the factors that had contributed to the failure of the original cladding. Stein explains that this approach “allowed us to remove the failed terra cotta, rebuild the structure using conventional masonry, and put an ornamental cladding over the new structure.”

This technique offered several benefits. First, Stein says, “The inner wythe is treated as an exterior wall, so that if the cladding or joints fail, the weather integrity of the building is not compromised. The cladding could actually function as a rain screen, providing a ‘belt-and-suspenders’ reliability.” Additionally, he continues, “the use of small precast elements with sealant joints instead of mortar joint allows the cladding to accommodate movement in the structure and prevents cumulative loads from being transmitted through the cladding.”

The design team’s next concern was to ensure that the new cladding provided sufficient environmental resistance and architectural stability. They thus developed a 6-month-long accelerated testing program to simulate up to 50 years of exposure to the elements. These efforts included the following testing: carbon-arc weatherometer, salt-fog chamber, resistance to freezing and thawing, mildew resistance, chalking resistance, and structural. In addition to the standardized tests in this regimen, the firm had a customized test developed to evaluate thermal shock. Stein explains that this new procedure simulated what “happens on a zero-degree winter day on a south-facing façade where there’s a hot sun. Suddenly, there’s a violent snowstorm and the surface temperature drops from 40 to 10 °F (4 to -12 °C) in a 15-minute period.” Several of the cladding systems under consideration had failed dramatically under these dynamic conditions.

**NUMEROUS CLADDING MATERIALS TESTED**

Despite the rigors of the required testing program, 11 manufacturers and suppliers responded to a request for proposals and submitted samples for testing. Each specimen was given a blind identification number to conceal its source and assure objectivity. Of the 11 materials tested, two products outperformed the others. Both were precast glass fiber-reinforced concrete (GFRC); one was based on a concrete mixture that did not contain portland cement, and the other was based on the Cem-FIL Star system offered by Cem-FIL International Ltd.

Both types of GFRC were written into the project specifications. The Cem-FIL system has proven to be the less-costly product however and has been selected for use in each of the four bid packages that have been let to date under Phase II of the Shepard Hall restoration. This system contains portland cement and alkali-resistant glass fiber reinforcement specially produced for chemical compatibility with concrete. In addition, the concrete used contains MetaMax®, a high-reactivity metakaolin...
(HRM) manufactured by Engelhard Corp. Tests have shown that the HRM significantly improves the strength and durability of portland concrete mixtures. In GFRC, the HRM also provides another benefit.

As portland cement hydrates, it forms the calcium silicate hydrates (C-S-H) that give concrete its strength. Unfortunately, it also produces lime (Ca(OH)₂) that can have a deleterious effect on concrete. Over time, dissolved lime is drawn by capillary action into the microscopic voids surrounding the glass fibers. There, the lime crystallizes and decreases the ductility of the fibers. When this happens, the concrete becomes more brittle and prone to failure. HRM, however, is a pozzolanic material that reduces the free lime content of concrete and helps protect the glass fibers in a GFRC mixture against crystallization of lime. Stein notes that concrete with high-reactivity metakaolin “produced an extremely dense architectural surface that was much less affected by the kinds of environmental attacks we expect in today’s world.”

**AESTHETIC CONSIDERATIONS**

The HRM’s white color proved also to be a benefit. The new cladding had to replicate the off-white shades of the original terra cotta. This required the use of white portland cement and the careful selection of aggregates and concrete admixtures to preserve the desired tonal values. MetaMax HRM is a white material and can be used with light or colored concrete mixtures without compromising hues.

The long duration of the project has made it challenging to maintain color consistency throughout the work. Phase II of the renovation began in 1991 and, more than a decade later, is still not complete. Because of the staging of the work, it is possible for new precast elements to be installed on the same façade as work that has been in place for up to a decade. To maintain uniform appearance throughout such a project, Stein cautions that concrete additives should be obtained from a supplier who is able to maintain a consistent product. Stein is pleased with the results on Shepard Hall: “The concrete units have been produced over nearly a 10-year period by several precasters in different parts of the country. Still, there is quite a consistency of the pieces throughout the history of the work.”

Selected for reader interest by the editors.

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