EMERGING TECHNOLOGY

Advances and innovations affecting design and construction

# Thick-stone restoration mends Rockefeller Center

*Stone patching material, lime-rich mortar and new anchors help restore Rockefeller Center's thick-stone facades*

By Michael Bordenaro, Associate Editor

While there is an increasing focus on the repair of thin-stone curtain walls built since the 1950s, little attention has been given to the restoration of thick-stone facades common prior to that time.

Examining innovative restoration techniques that are a part of an ongoingprogram for New York City's 60-year-old Rockefeller Center provides insights into the successful restoration of these older facades.

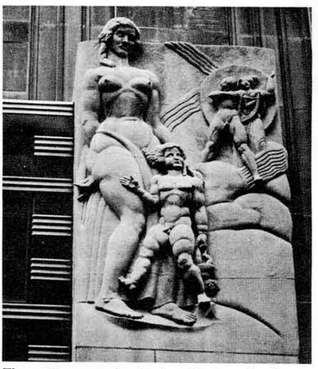
Some of the Center's 20 buildings were constructed with 4- to 8-in.-thick limestone cladding tied to a masonry backup. The back, in turn, was supported by a structural steel frame. The dissimilarity of these materials contributed to the need for a variety of restoration techniques, according to Theodore Babbitt, project architect for Hoffmann Architects, North Haven, Conn. Hoffmann has been a restoration design consultant to Rockefeller Center since 1983.

The diverse repair procedures included replacing epoxy mortar with lime-rich mortar; removing some of the 4- to 8-in.-thick stone panels in order to replace rusted supports; rebuilding portions of the masonry backup; and using a stone patching compound to restore the panels. The scope of the work also included the restoration of limestone sculptures that are integral to one of the facades.

"An epoxy mortar was used to repoint the facades during a previous renovation program," said Alan Hantman, vice president of architecture, planning and construction for Rockefeller Center. However, the epoxy is harder than the limestone. When the stones move due to thermal expansion, the epoxy can spall the edges of the limestone panels, according to Hantman.

The epoxy was replaced with a site-mixed portland cement and lime mortar, which is softer and more likely to concentrate cracks in the joints than in the stone panels. "If there is any cracking, we want it to occur in the joint, not the stone," said Hantman.

Unlike the nonpermeable epoxy, the lime also helps make the mortar highly vapor permeable, thereby allowing moisture trapped behind the facade to evaporate through the joints. The mortar also bears a closer resemblance to the original mortar. This was an important consideration since Rockefeller Center recently achieved landmark status and requires all improvements to be approved by the New York City Landmarks Commission.



***The maintenance and restoration of limestone facades*** *on the 60-year-old Rockefeller Center include the repair of both sculptures (foreground) and thick ashlar panels (background).* Photo: Cathedral Stoneworks

### Patching mortar helps repair sculpture

The repair of deep-relief limestone sculptures that adorn entrances to one of the buildings was another critical aspect of the recent restoration activities. Carved out of the same limestone that clads the building, the four 9-ft. by 14-ft. sculptures each consist of four panels and are an integral part of the facade.

The anchors that fasten the sculptures to the building's structure had rusted, causing the limestone to crack and break away from some of the anchors. Most of the panels were restored and resecured in place, according to Ivan Myjer, project manager for the sculpture's restorer, New York City-based Cathedral Stoneworks. However, two of the panels had to be removed for restoration. One panel was so severely cracked, it came apart in 16

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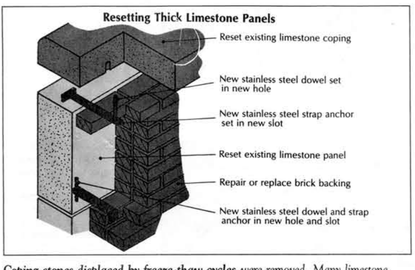
*Patching material was carved and textured to replicate original stone*




***Coping stones displaced by freeze-thaw cycles*** *were removed. Many limestone panels underneath them were also removed in order to replace rusted anchors. New holes for stainless steel dowels and straps were drilled in the stones, which were then reanchored to the wall.* Diagram: Hoffmann Architects

pieces when it was removed.

The panels were taken to Cathedral Stoneworks' shop where they were reconstructed with a combination of stainless steel pins, new limestone backup and patches made from Jahn Restoration Mortar.

The limestone-compatible, premixed Jahn mortar is a proprietary product available from Cathedral Stone Products, Washington, D.C., a company unrelated to Cathedral Stoneworks. It is cement-based, contains no leachable components and is water permeable. These qualities help prevent the patches from being spalled off by trapped moisture.

The mortar, which has been available in the U.S. for less than 10 years, can be mixed to match the color of existing stone and is available in mixtures that are compatible with numerous types of stone.

The Jahn mortar bonds so well to the original stone that it can be carved to replicate deteriorated stonework. "We rebuilt and resculpted areas where items like fingers were missing by recreating the surface of broken and spalled

## Computer-age stone carving

The age-old art of stone carving has moved into the computer age. While the fine details will always be completed by hand, modern technology, including laser-imaging digital cameras and CAD/CAM controlled routers and saws now help to expedite fabrication of carved stone.

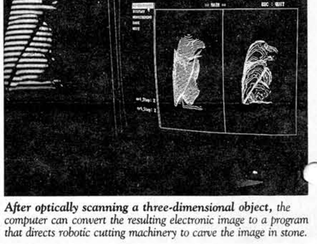
Cathedral Stoneworks, New York City, which utilizes such European-manufactured equipment as a three-axis profile saw and a six-axis router, is leading the U.S. in this technological evolution.

"I felt we had to reinvent the business if we were going to be relevant in the '90s and beyond," said David Teitelbaum, general manager of Stoneworks. Affiliated with the Episcopal Cathedral of St. John the Divine that is under construction in New York City's Morningside Heights, Stoneworks uses a portion of its profits to help fund building programs and stone-carving apprenticeships for the cathedral. When completed some time in the next century, it will be the world's largest Gothic cathedral.

To take full advantage of Stoneworks' computer capabilities, architects who contract with the company for private projects usually submit drawings on computer disk. The designs are coded into toolpath tapes that direct the robotic carving tools. An architect can also submit dimensioned drawings that can be entered into the computer.

Three dimensional models can also be submitted. These items can be optically scanned by machinery that was originally designed for the medical industry. The process involves projecting a low-powered light over the object to be duplicated. The light is reflected back into the scanner where it is reconfigured as an electronic drawing. This electronic information is then reconfigured by a program that directs the robotic carving tools.

Before running the program, Stoneworks' in-house designers calculate additional information to determine the most efficient fabrication and anchoring methods. The three-axis profile saw can be programmed to make straight-cut blocks or to rough-cut stones that are to be detailed by hand carvers. The six-axis router, which pivots like a human hand, can be programed to carve details with a 1-mm. tolerance. The only operation it cannot execute is an undercut.



***After optically scanning a three-dimensional object,*** *the computer can convert the resulting electronic image to a program that directs robotic cutting machinery to carve the image in stone.*

According to Wei Ching-Song, Stoneworks' director of computer services, "What once took 14 days to carve by hand can now be produced in 30 minutes."

An addition to New York City's Jewish Museum is one project that took full advantage of Stonework's computer services. Designed by Hamden, Conn.-based architect Kevin Roche John Dinkeloo and Associates, the addition's exterior replicates the stone facade of the 80-year-old French Renaissance-style museum building.

"For the Jewish Museum addition we received a directive to make the new facade appear as if it were built at the same time as the original," Teitelbaum said. "If we had not used our imaging and computer-carving capacity, the stonework would have cost twice as much," he said of the $1 million project.

The computer system also helps to make carved-stone cost competitive with cast stone. At the new Student/Faculty Center at the University of Maryland, Stoneworks created limestone elements that were originally specified as precast stone.

The project required window surrounds with 5- to 12-ft. radii, radial-cut soffit pieces, recessed medallions and radius trim pieces around the windows. "What we were able to do with CAD/CAM and computer milling came in at a cost that was between 5 and 10 percent less than cast stone," Teitelbaum said.

The CAD/CAM also allows perfect alignment of stone, according to the Cathedral's Clerk of the Works, Alan Bird. "At the Student/Faculty Center, the arcs and the sweeps of window frames run true, whereas if you had someone cutting them by hand, there might be a little space for the 'wind and the wallpaper,' " Bird said referring to a traditional stone carvers' saying.

Computerized stone carving is not going to make stone cost effective for every building project. However, this new-age technology may make the age-old beauty of natural stone affordable for an increasing number of them. □

***Unmanned, computer-guided stone-carving*** *equipment can produce overnight what formerly would have taken as much as five days to carve by hand.* Photos: Cathedral Stoneworks



areas. Then we shaped and textured the rebuilt areas to look like the original stone," Myjer said.

The Jahn mortar was also used by the facade restoration contractor, Brisk Waterproofing of New York City, to patch spalls and cracks on the flat ashlar sections of facades. The cracks were saw-cut to ensure that the mortar would bond to sound stone; spalls were cleaned and given squared edges.

### Stone wall reconstruction

Special attention was given to a free-standing limestone facade and masonry backup that screen a cooling tower located on top of one of the buildings. Moisture from the tower had penetrated the wall and rusted the metal connections between the limestone cladding and the masonry backing.

"The rusting metal pushed the limestone and bricks so far out of alignment that we had to remove many of the limestone panels," said Babbitt.

More than 100 panels measuring approximately 4 feet square were removed and repaired. The panels ranged from 4 to 8 inches thick and weighed as much as 800 lb. each. Cracks and spalls in the panels were repaired at a rooftop storage area.

After the panels were removed, failed masonry was repointed and replaced where necessary. Badly deteriorated structural steel was replaced, while other members were repaired by welding steel plates to weakened areas.

The stones were then reset with a new anchoring system. New holes were drilled into the top and bottom of the limestone panels to accommodate stainless steel dowel rods. The rods pass through new stainless steel straps that are anchored in the masonry wall (see diagram).

While these issues do not exhaust the restoration approaches to thick-stone facades, Rockefeller Center provides many examples of how to address the problems presented by this type of cladding. □

***A Jahn mortar that can be mixed*** *to match the color and texture of the original stone was used to patch spalls and cracks in both the limestone sculpture and flat ashlar.* Photos: Cathedral Stoneworks