EXPANSION Goes Up and Over

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Steel framing facilitates multi-phase project designed to add space and functionality.

WHEN ATLANTIC HEALTH BEGAN TO IMPLEMENT its 330,000-sq.-ft master plan for Morristown Memorial Hospital in Morristown, N.J., in 2003, two things were immediately clear: the new buildings would be much-needed additions to their campus, and designing and coordinating the project would be extremely tricky, given that it would be built above existing structures and no part of the hospital could cease operations at any point during construction.

The campus-wide master plan for Morristown, designed by architecture firm Francis Cauffman, was created to expand the hospital's key cardiology, obstetrical, and surgery services; upgrade its infrastructure; improve internal and external circulation; and accommodate the hospital's projected growth. This was a long-overdue improvement for Morristown, which particularly needed an upgrade to its cardiovascular services. As one of the region's leading heart hospitals, it required a facility that could accommodate growing numbers of patients and provide the latest technology in cardiac care.

Building Up and Above

The master plan was organized in two principal phases. The first involved a major expansion of the hospital's north tower, which was to become a structure called the Meade Pavilion. This 120,000-sq.-ft addition was both a vertical and horizontal expansion of two existing structures, a one-story steel frame building and a two-story concrete building. Both were more than 20 years old. Before construction on the tower began, Francis Cauffman and structural engineer DiStasio & Van Buren, Inc., designated an existing 15,000-sq.-ft steel frame building as swing space for the hospital's cardiac care intake unit, a key programmatic element that had to be relocated in order to maintain continuous operations during construction.

The particular character of today's healthcare design posed a major challenge to the compatibility of the addition and the existing structures. Current demand for open floor plans, evolving technologies, and private rooms requires column spacings that can accommodate the present program yet be adaptable in the future. Accordingly, the addition to the north tower is a three-story steel moment frame that utilizes a 32-ft column grid. However, it is supported by the existing concrete structure, which has a 20-ft

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Highlighted buildings indicate the additions to the Morristown Memorial Hospital campus. Both phases included building over existing construction to minimize campus size increase.

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The 120,000-sq.-ft expansion of the north tower enveloped two older buildings—one a single-story steel frame building and the other a two-story concrete frame.

Francis Cauffman.

The framing for the north tower addition, which is above an existing concrete frame building, is supported by large steel transfer beams threaded into place just below the existing concrete slab.

bay arrangement. The mismatch in size required the introduction of large transfer beams to make the transition between old and new structures.

In order to carry this out, the designers carefully located holes in the concrete flat plate roof slab to allow the new columns to pass down to transfer beams added just below the roof level. This required very close coordination with the operating mechanical systems already in the space through which the transfer beams would have to pass. Only a structural steel solution could meet the depth restrictions while still accommodating the heavy column load from the upper floors.

Evaluating Seismic Forces

The existing concrete building was originally designed for vertical expansion. However, since its construction the state adopted the BOCA 1996 national building code, which stipulates higher earthquake loads.

Based on the new code, the designers determined that both original buildings would need to be seismically reinforced to accept the vertical expansion. Each

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Francis Cauffman.

Using modular metal panel assemblies with a thin brick facing sped construction. It also helps the new construction blend in with the older buildings on campus.

structure was analyzed and retrofitted to be integral with the addition. To meet the seismic code requirements, the designers introduced new structural steel braced frames in both structures, reinforced several columns, and modified footings. Bracing systems were tied into the existing concrete frame building with adhesive anchors and through-bolted connections.

Using structural steel for the vertical expansion resulted in a lighter structure that allowed the footings to accommodate the additional stories, as well as the high localized reactions at the braced frames due to the seismic loading. It also minimized the number of columns that required strengthening. Structural steel jackets were also used to reinforce existing concrete columns to meet the higher load demand at the new brace frames.

Staying Open for Business

Because the additions were both adjacent to and built over existing hospital operations, the construction manager, William Blanchard Co., staged the construction schedule to minimize its impact on patients, staff, and visitors while maintaining continuous operations. Breaking the overall project into smaller sub-projects allowed the construction manager to aggressively bid portions of the overall project independently to multiple fabricators and erectors.

Starting with the vertical expansion allowed moving quickly from bidding to construction. The contract documents were broken into a core and shell package, permitting steel design to run concurrently with the interior design documentation.

Because much of the new construction involved threading transfer beams—some as large as W40×503—and cross bracing through existing facilities, work often had to occur during the off-hours of the hospital's administrative departments to minimize disruption. More than 1,200 tons of steel were erected during the nine-month construction of the north tower. Meticulous project phasing allowed the construction team to reconcile large wall openings, headroom clearances, and the location of existing equipment without compromising hospital operations.

Toward a New Heart Hospital

Meanwhile, the design focus shifted to the second project phase: consolidating the hospital's cardiac care program in the west tower, which would become the Gagnon Cardiovascular Institute. The first challenge was to devise a practical plan for building a new 10,000-sq.-ft loading dock in a two-story "knuckle" of the larger heart hospital assembly. The new loading dock had to be fully operational before construction could begin on the west tower because the existing loading dock, situated within the footprint of the new tower, would be demolished.

This scenario had the advantage of allowing interior fit-out plans to be finalized while excavation and foundation work began. The designers devised a structural steel framing system to create a cold joint between the two-story loading dock building and the five-story tower. As a further bonus, the two story addition was able to house a portion of the hospital's air-handling and electrical systems. This two-story structure was designed to be structurally independent of the tower, since it would stand alone for months before the tower construction could begin. However, it would become fully integral with the tower once construction was complete, thereby optimizing the lateral resisting system. Starting this portion of the work in advance of the larger tower also allowed framing design and installation of critical systems to begin early.

The Gagnon Cardiovascular Institute

The west tower addition added approximately 213,000 sq. ft of floor space to the existing campus and now houses the Gagnon Cardiovascular Institute. A five-story structure designed to accommodate a future two-story vertical expansion is part of the footprint, which includes mechanical rooms, loading docks, cardiovascular and endovascular operating rooms, and patient rooms. Using a modular steel façade for this tower helped speed construction, which also resulted in cost savings for the project because the team could work through the winter using cranes, as opposed to scaffolding, for installation.

The west addition that houses the majority of the cardiac functions consists of two pediment levels of metal on

The west wing expansion was not originally conceived of with a panelized exterior. However, additional miscellaneous steel framing was easily incorporated to provide panel support as needed, such as where the open dimension exceeded the limits of a panel's ability to be self-supporting.

Francis Cauffman.

light gauge steel framing, capped by three levels of brick cladding. What is not readily apparent is that the metal panel and brick façade is actually a pre-fabricated panel system consisting of either composite aluminum panels or thin brick facing on light gauge framing supported by the main structural system. This structural system supports both the gravity and lateral loads created by the panels.

A Change in Codes

New Jersey adopted the 2000 International Building Code (IBC) just prior to final design of the west tower. This code is even more stringent than BOCA 1996 and required Francis Cauffman and DiStasio to swiftly assess the best approach for the lateral resisting system under the new code requirements and reevaluate elements of their design. Because of the mix of soils on the site and the criticality of hospital operations, the site was rated Seismic Class D, which carries more rigorous design requirements than those typical for the region. The designers selected intermediate moment frames, which are specifically detailed for seismic design, because they allow for maximum flexibility of present and future space planning while still affording an economic solution.

Several moment connection types were possible given the design, but the fabricator ultimately selected the reduced beam section (RBS) type for its ease of fabrication and reduced material requirements. This type of connection design was actually quite new to fabricators on the east coast at the time, so the structural engineer worked closely with the detailer and fabricator to clarify the detailing requirements. The RBS connection also was favored by the design team for its demonstrated performance in improving ductility under high seismic loading.

The balance of the building's exterior is composed of a field-built aluminum curtain wall. In some instances the curtain wall spans up to 60 ft and is supported by the frame's spandrel beams and dead-loaded on a hung steel lintel below. By hanging the lintel, Francis Cauffman was able to level the glass curtain wall with an adjacent roof. In the original design, a portion of this curtain wall framed a glass elevator lobby expansion, but that design had been submitted under the earlier code. By construction time, IBC 2000 precluded its use. The structural redesign for this area again relied on using steel cross-bracing to brace the original 1970s concrete frame structure and support the slender elevator hoist way and lobby addition. In some instances the support of the floor slab was achieved using a steel cantilever spanning in two directions.

More Steel Solutions

To create a pedestrian- and vehicle-friendly drop-off area for the Gagnon Cardiovascular Institute while maintaining the square footages dictated by the program, the lead designer proposed cantilevering the tower's bed floors over the access drive, thereby creating a main entry reminiscent of a hotel check-in area.

Creating this cantilevered condition was no easy task, as the cantilevers needed to carry columns from the three current stories and two future floors. The designers used W40 steel rolled shapes for the 16-ft cantilevers to limit deflections at the lowest level. This entrance also features a dramatic 40-ft-high atrium space enclosed by the exterior window wall system. Interstory movements had to be carefully considered when sizing the framing in this area due to the stringent tolerances and deflection limitations of the specified mullion assembly. Flying beams were also introduced to laterally support the window walls and create a bold architectural statement in the space.

More than 2,000 tons of steel went into the west tower addition, bringing the project's total to more than 3,200 tons. Through its flexibility and strength, using steel on this project enabled the design team to build upon and enhance the functionality of aging facilities to maximize their use in the present and for many years to come. MSC

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Cantilevered steel beams over the Gagnon Cardiovascular Institute's new reception and drop-off area carry column loads from the three current stories. They also have the capacity to support the addition of two more floors in the future.