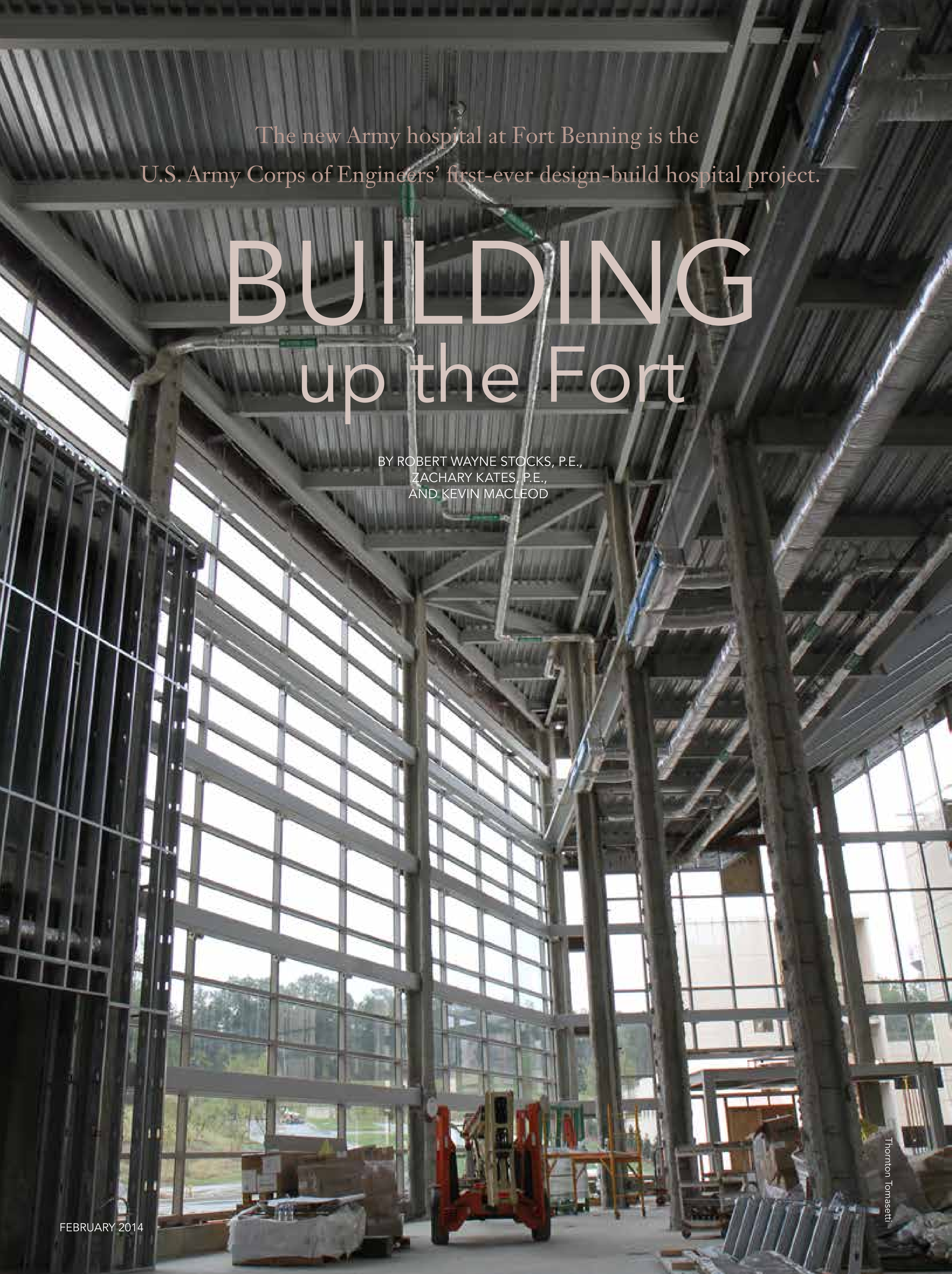
The new Army hospital at Fort Benning is the U.S. Army Corps of Engineers' first-ever design-build hospital project.

BUILDING up the Fort

BY ROBERT WAYNE STOCKS, P.E., ZACHARY KATES, P.E., AND KEVIN MACLEOD



Thornton Tomasetti

BRAC MEANS SOMETHING DIFFERENT for every military installation.

Under the Base Realignment and Closure program, facilities are generally downsized, consolidated or demolished altogether. In some cases, however, the program mandates new or replacement facilities.

The U.S. Army base at Fort Benning, on the outskirts of Columbus, Ga., is one of these cases and is currently undergoing major redevelopment. A critical part of this realignment includes replacement of the aging Martin Army Community Hospital, which originally opened in 1958. Since April 2011, a team led by Turner Construction Company has been constructing the new Martin Army Community Hospital, the U.S. Army Corps of Engineer's first-ever design-build hospital project.

The 745,000-sq.-ft facility, which is seeking LEED Silver certification, was designed by a joint venture between architects Ellerbe Becket (now AECOM) and RLF. It features a 70-bed hospital with two attached clinic buildings, which are separated by a four-story, column-free concourse that serves as the primary entrance to the facility.

Structuring the Campus

The project is located on a challenging 50-acre site that slopes 230 vertical ft from front to back. The site layout was designed to "communicate" with the surrounding wooded areas with the intent of improving the patient experience. The hospital building is eight stories high and is set into the sloping site, with two floors located below grade and exposed to daylight on the downhill side. The lower levels of the hospital support diagnostic space and are separated from the upper floor patient rooms by an interstitial mechanical level housing the hospital's air-handling equipment.

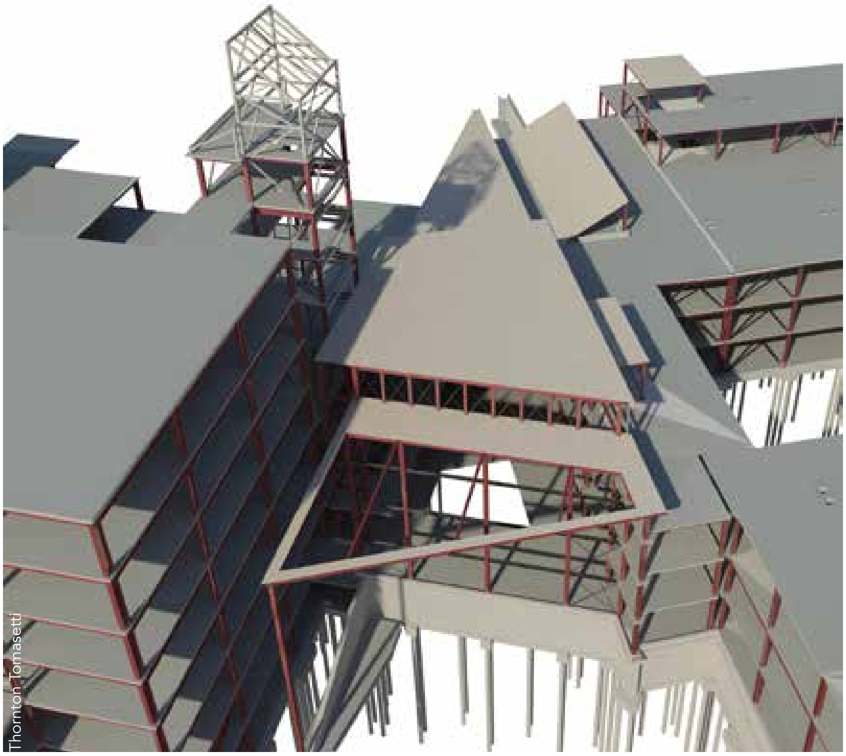
The structural floor framing system of the hospital consists of composite steel deck supported by wide-flange steel W16 beams, W24 girders and W14 columns with a typical 32-ft by 32-ft bay size and a typical floor-to-floor height of 16 ft. Lateral forces for the hospital are resisted by steel moment frames that are located at the building's perimeter and with one interior line in each direction. The moment frames transition to steel braced frames at the lower two levels to match the stiffness of the concrete basement walls and to participate in resisting the unbalanced earth pressure, as well as wind and seismic loads. The clinic buildings are of similar steel construction to the hospital, and the lateral system for the clinics consists of perimeter steel braced frames.

The grand concourse is structurally independent and is sandwiched between the hospital and clinic buildings. It functions as the main entrance to the entire facility, welcoming occupants into a four-story, high-bay space surrounded by a glass curtain wall and views of nearby Upatoi Creek. The triangular-shaped roof area includes steel roof deck supported by steel beams and girders, and the column-free space is made possible by two long-span tension rod trusses—the longest being 75 ft—located in the clerestory between the high and low roofs. The truss diagonals consist of double 1¼-in. tension rods in one direction and single 1¾-in. tension rods in the opposite direction. Steel wide-flange columns surrounding the high bay space support a grid of HSS girts that provide lateral support to the glass curtain wall. The lateral system was carefully integrated with the architecture of the space and includes braced frames hidden in elevator shafts, exposed tension rod bracing in the panoramic glass wall and wide-flange columns that cantilever above a low roof diaphragm.

◀ A four-story, column-free concourse that serves as the primary entrance to the facility.

➤ Topping out the building.

Robert Wayne Stocks (wstocks@thorntontomasetti.com) is a managing principal, **Zachary Kates** (zkates@thorntontomasetti.com) is a vice president and **Kevin Macleod** (kmacleod@thorntontomasetti.com) is a senior engineer, all with Thornton Tomasetti's Washington, D.C. office.



A rendering of the concourse framing.

The councourse separates the 70-bed hospital and two attached clinic buildings.

The Design-Build Pursuit

The team participated in several full-day design charettes attended by all disciplines, where design concepts were studied for cost and constructability. Having all of the major stakeholders present at the charettes improved collaboration and focus and allowed decisions to be made quickly, with everyone understanding the driving forces behind the decisions. For example, the team prioritized flexibility of space in the hospital building and quickly determined that perimeter steel moment frames, in lieu of steel braced frames, would meet that goal. Schuff Steel, the fabricator, was on board from the beginning of the pursuit and offered great direction into the availability and selection of steel materials and steel-related detailing. Repetitive design details such as exterior wall attachments, steel connection types and slab edge support conditions were chosen to align with Schuff's fabrication and erection preferences.

"The collaboration and active participation of the designers and the builders in these early charettes made the difference," said Martin Miller, project executive for Turner. "The collaboration allowed the team to study, discuss and decide on design concepts in days what would normally take months."

To accurately capture steel costs, Thornton Tomasetti (TT) created preliminary design models using RAM Structural System and transmitted them directly to Schuff Steel for tonnage determinations. TT provided estimates of additional tonnage required for project-specific requirements, such as steel framing premiums at vibration-sensitive areas supporting medical equipment or additional framing needed to support major piping runs. Preliminary tonnage estimates for the steel frame were found to be within a few percent of the actual steel frame tonnage.

In addition, the design met the strict requirements of the request for proposal authored by the Corps of Engineers, including the referenced International Building Code, *Savannah District Design Manual* and Department of Defense "Unified Facilities Criteria." Overall, the pursuit phase was a two-month effort.

A truss for the concourse.

Model Sharing

From day one, Turner was committed to a building information modeling (BIM) approach for the project, which minimized conflicts during construction and reduced requests for information and costly field work. The design team produced work using Revit and traded coordination models on a weekly basis, and the structural Revit models were transferred to Schuff as the basis for the Tekla fabrication models. The fabrication models were then combined with the architectural and mechanical models by Turner's in-house modeling group to create one comprehensive BIM model. This model was used to coordinate the location of work in the field, perform clash detection and help resolve system interferences.

"The steel frame became the base layer for the development of the architectural model, providing excellent coordination of the entire exterior shell," said Miller. "The interior details were then added as design progressed. In retrospect, the biggest coordination problems in the field were with construction elements that did not get put into the BIM model during the accelerated proposal development period, such as precast panel bracing."

Consistent with Turner's commitment to BIM, TT and Schuff employed an innovative use of the 3D Tekla fabrication model by performing in-model review of the steel shop drawings. Specifically, a model-based shop drawing review was performed wherein steel elements were approved directly in the model. Because hard-copy shop drawings were a required submittal by the Corps of Engineers, shop drawings in PDF format were linked to each steel piece and accessible directly through the model. Shop drawing markups were made using a PDF writer, and the submittal, model and shop drawings were returned electronically. This allowed a more efficient and higher-quality review process for TT, as repetitive elements were grouped and reviewed together. More complex, highly detailed connections were viewed in 3D, clearly showing the relationship to adjacent connecting members. The process resulted in a faster approval process and a reduction in re-detailing efforts, which subsequently led to a reduction in fabrication time and field work.


Turner

▲ Truss installation.

▼ The triangular-shaped roof area includes steel roof deck supported by steel beams and girders, and the column-free space is made possible by two long-span tension rod trusses.


Thornton Tomasetti


Turner

➤ A bird's-eye view of the new facility.

The truss diagonals consisted of double 1¼-in. tension rods in one direction and single 1¾-in. tension rods in the opposite direction. Steel wide-flange columns surrounding the high bay space support a grid of HSS girts that provide lateral support to the glass curtain wall.

TT's Construction Support Services group in Kansas City was employed directly by Schuff to perform all steel connection design on the project. This allowed the connection designers to communicate directly with the structural engineers to resolve questions quickly, avoiding the cumbersome RFI process; confirming RFIs replaced the traditional approach of inefficient sequential communication. The construction support team was able to help identify and resolve areas where complicated and expensive connections could be avoided or simplified, and working as an integrated team saved time and ultimately produced an efficient and coordinated end product.

Designing For the Unthinkable

The hospital, clinics and concourse comply with Department of Defense requirements of the Anti-Terrorism Force Protection (ATFP) Directorate and resistance against progressive collapse, with the goal of minimizing occupant fatalities during a terrorist attack. Blast consultant Weidlinger Associates determined the blast loading on the structure and provided reactions at critical steel connections. Resistance against blast loads is mainly provided by the exterior precast concrete panels and glazing on the clinic and hospital buildings, while the blast loads on the concourse are supported entirely by the steel frame. The blast-rated curtain wall is supported by a grid of 12-in. by 8-in. HSS girts tied to the perimeter wide-flange columns. These columns span from the ground level to the roof diaphragm, a vertical distance of up to 60 ft, and horizontal truss members were introduced into the roof diaphragm to ensure that the concourse roof will distribute blast loads to the lateral frames.

The goal of the progressive collapse requirements is to prevent an uncontrolled collapse of a large portion of the structure in the event of removal or damage of a local structural element. Horizontal and vertical tension ties extending the full height and width of the buildings were detailed into each steel frame to allow the structure to bridge over damaged areas without disproportionate collapse. Tension forces were considered in all connection and element designs along each tie, and the steel moment frames for the hospital also provide a high degree of redundancy to help mitigate any progressive collapse conditions.

Medical Equipment

The vibration-sensitive medical equipment was carefully coordinated early to help mitigate its impact on the steel frame; these units are not only heavy but also have strict deflection and vibration requirements. In a typical bay for the hospital, the floor system consists of 4.5 in. of normal-weight concrete on a 3-in. composite metal deck and is supported by W16×31 beams and W24×55 girders. For the typical MRI bay, the floor system was increased to 6 in. of normal-weight concrete on 3-in. composite metal deck to minimize sound transmission. In addition, the beams and girders were increased to W30×124 and W30×191, respectively, to stiffen the floor system and control vibration.

The design-build team members on the Fort Benning Martin Army Community Hospital were true partners during the design and construction of this project. The 3D BIM approach allowed full integration of the systems and is driving the on-time delivery of this fast-track project to the base.

"Without the entire team's active participation and the use of BIM, we could not have achieved the successful design and construction in the 1,200 calendar days allowed in the RFP," said Miller. "The results have been extraordinary. I can't imagine building another project in the future without the full use of BIM and the active collaboration of the design and construction professionals." ■

Owner
Fort Benning/Army Corps of Engineers, Savannah District

Design-Build Contractor
Turner Construction Company

Architect
Ellerbe Becket (now AECOM), Arlington, Va., and
RLF, Orlando, Fla.

Structural Engineer and Steel Detailer
Thornton Tomasetti, Inc., Washington, D.C., and
Kansas City, Mo.

Steel Fabricator and Erector
Schuff Steel – Atlantic, Inc., Orlando
(AISC Member/AISC Certified Fabricator)