Cardio Construction

BIM is at the heart of the design process for an upcoming hospital in Detroit.

BY ANDREW HERMIZ AND LAWRENCE F. KRUTH, P.E.

Photos courtesy of Douglas Steel Fabricating

WHAT BETTER PLACE for a new heart hospital than the heart of the city?

Upon its completion next year, the $78 million, steel-framed Detroit Medical Center Heart Hospital will house cardiology centers, surgical rooms and clinical offices on a vast hospital complex in the Midtown area of Detroit near the campus of Wayne State University.

Rising six stories and designed for two stories of future vertical expansion, the new facility—which uses 2,014 tons of structural steel—is connected to an existing, adjacent Harper University Hospital building at the lower and upper levels. Access to a concurrently constructed parking deck is provided via a 150-ft-long steel-framed pedestrian bridge, and an 80-ft-long steel-framed canopy defines the main entry, which leads into a large clear-story space.

Soil Conditions

Soil conditions on the site were not conducive to the use of shallow foundations. Belled and straight-shaft drilled piers were required to transfer the building loads to competent hardpan, which was nearly 140 ft below grade.

The use of a steel-framed structure significantly reduced the applied loads on the foundations. Taking advantage of the composite action between the steel beams and the concrete slab further reduced the building self-weight and corresponding foundation loads. Not only was the direct dead load reduced, but also a reduction in the applied seismic loads was possible since seismic loads are a function of the building mass.

These factors reduced the drilled pier diameters, leading to a reduction in the total required excavation, volume of concrete and pier reinforcing, and also minimizing the number of belled piers required. On a site with substantial groundwater, this resulted in significant savings in expense and schedule.

Expansion and Flexibility

The new hospital is designed with two floors of vertical expansion capability, and the current roof level has been designed to act as a future seventh floor. The columns and

➤ Framing for the Detroit Medical Center Heart Hospital, which will be completed next year.

➤ A rendering of the final project.

braces have been designed to accommodate the additional loads imposed by the two future floors. To further ease the future expansion process, the columns at the top level have been extended to the top of slab and prepped with cap plates, and this will allow for minimal intrusion when the time comes for vertical expansion.

The building is laterally supported via moment frames in the long direction and five braces in the short direction. The braces are a mix of single-strut and inverted chevron configurations. To accommodate architectural and mechanical requirements, work points are shifted away from column-beam centerlines as needed.

The use of steel braced frames in lieu of concrete shear walls yielded significant architectural and mechanical advantages. Braced frames allow contiguous space in an otherwise narrow footprint. Not only are corridors and spaces capable of "passing through" the brace lines, but also the steel braces allowed the engineers and architects to vary the strut locations and configurations from bay to bay along the height of the structure. At one point, a space usage requirement forced a column relocation on the sixth floor after construction had commenced. Luckily, the design team was quickly able to find a solution without negatively affecting the construction schedule. (This type of change would have been extremely difficult, if not impossible, in concrete construction.)

Designer-Fabricator Collaboration

Harley Ellis Devereaux (HED), the project's structural engineer, was able to seamlessly collaborate and communicate with Douglas Steel, the fabricator, through 3D modeling, resulting in painless problem solving and significantly speeding up the shop drawing review process. HED's Revit model was translated into a CIS/2 model and imported, including all end reactions, into SDS/2. This provided two distinct benefits. The first was time savings. The hospital contains nearly 200,000 sq. ft of steel framing, and beginning with a complete model from the outset saved the detailer a significant amount of input time. This approach also helped avoid a bottleneck by allowing multiple people to start work on the detailing process instead of forcing one person to build an entire model before the detailing process can being.

The second benefit was accuracy. Since all beams, columns, braces and end reactions are transferred into the detailing model, minimal verification of the geometry, beam sizes or locations was required. The design model and the detailing model matched exactly. If the detailer inputs the model from 2D drawings, then there is greater potential for errors to occur, and by using only 2D drawings for a large project such as the Heart Hospital, this would create the possibility for these errors to be missed until erection begins.

A distinct advantage of the SDS/2 3D environment, in conjunction with steel construction, is automated connection design. Using the detailing software, Douglas Steel was able to automatically design connections for each beam, brace, column and framing condition. This design ability is not only helpful for the fabricator, but is also extremely helpful for the reviewing engineer, and allowed HED engineers to quickly validate the connection capacities against the required values per the construction documents. As mentioned above, certain brace struts shift bays at the higher floors. Using the

Rendering: Harley Ellis Devereaux

▲▼ The six-story structure uses more than 2,000 tons of structural steel.

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▲ The new facility connects to an adjacent Harper University Hospital building.

▲ Installing a staircase.

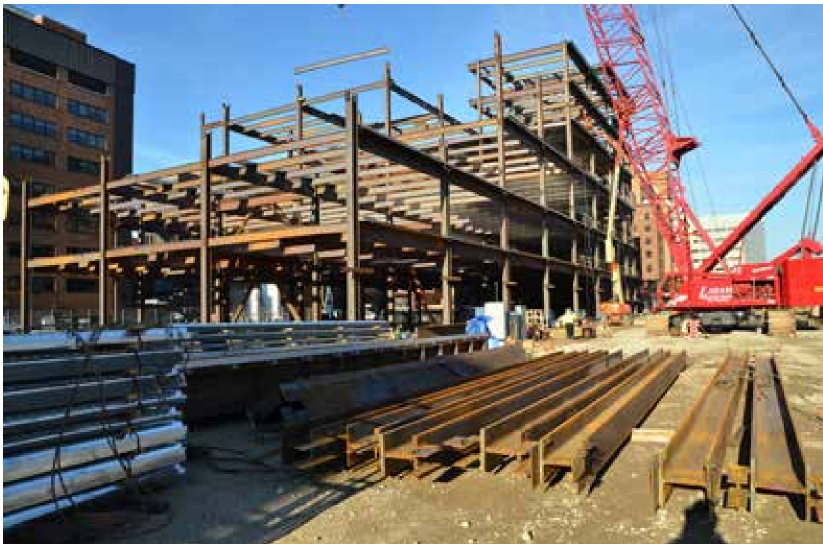
design capabilities of SDS/2, HED was able to verify that the detailer correctly interpreted the load path and the connections were properly designed.

The use of the SDS/2 steel detailing software was pivotal in the shop drawing review process as well. Douglas transferred a complete 3D model along with each of the 30+ steel submittals, allowing HED to quickly review shop drawings without using added time and resources for printing and combing through thousands of erection and detail sheets. Another major advantage of this process is reduced review time. Since all members were imported from the design model, there is minimal need for the reviewing engineer to verify the geometry, member sizes and end reactions. And the use of a 3D model for review makes it easier to locate members in the structure and visualize the final framing condition. With these added benefits, review and approval times were reduced from the industry-standard two-week allowance to less than one week per submittal.

The BIM approach also aided in validating the cost-effectiveness of the project. HED transferred the 3D model to Douglas Steel in the design development phase, and Douglas was able to use the model to provide a preliminary cost estimate for the steel structure. The accuracy of the 3D model and involvement of the fabricator early in the project resulted in a mere 2% difference between the preliminary estimate and final cost of the entire steel structure.

▼ Fitting up a column.

▼ The hospital, designed via a BIM approach, contains nearly 200,000 sq. ft of steel-framed space.



The new hospital is designed with two floors of vertical expansion capability, and the current roof level has been designed to act as a future seventh floor.

The facility is a stone's throw from Detroit's iconic Renaissance Center.

A view of the elevator divider beams, which will bear on the elevator shaft masonry walls once they're installed.

The building is laterally supported via moment frames in the long direction and five braces in the short direction.

Bridge

Possibly the most striking element of the Heart Hospital is the 150-ft steel-framed pedestrian bridge that spans to the concurrently constructed concrete parking deck. The bridge is made up of two HSS trusses boxed together and uses 55 tons of steel in all. The bottom chord consists of an HSS20×8×$\frac{5}{8}$ and the top chord is a W18×55 with HSS6×6×$\frac{3}{8}$ web members. The bridge is clad in glass, exposing the steel trusses on each face, and the BIM approach was taken with this portion of the project as well. The bridge serves as a visual focal point to what the design team hopes will become a landmark in the heart of Detroit. MSC

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Architect and Structural Engineer
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