



# A WORK OF ART

An engineering firm relies on BIM to design an art school's new residence hall. BY BRIAN HAINES

The Massachusetts College of Art and Design (MassArt) located in downtown Boston is in the process of building a new 21-story steel frame residence hall. When it opens in 2012, the 493-bed residence hall also will include a café, student lounges, artist work rooms, an art gallery, laundry and kitchen facilities, and a health service office. The building is being built by the Massachusetts State College Building Authority (MSCBA), which plans, designs, finances and constructs housing and student activity facilities for nine campuses.

To manage the structural design of the new dormitory, MassArt and the MSCBA selected Odeh Engineers Inc., a full-service structural engineering consulting firm specializing in the design, analysis and evaluation of commercial, industrial and institutional building structures. The Rhode Island-based company's projects include designing new buildings as well as renovations, additions and historical preservation.

Since its founding in 1982, Odeh Engineers has relied exclusively on digital design representations. In 2006, the firm adopted building information modeling (BIM) supported by Autodesk Revit Structure software. "BIM and the Revit Structure software is at the heart of our design approach," explains David J. Odeh, principal of Odeh Engineers. Odeh Engineers has completed more than 250 projects using the software.

## A Challenging Setting

With Boston's premier art museums just blocks away, the MassArt dormitory's urban setting is well suited for its students, but poses significant challenges for new construction. The site contains a large network of underground culverts that carry waste to a Massachusetts Water Resource Authority (MWRA) wastewater treatment plant.

MWRA has an easement over the state of Massachusetts-owned property, such that the building had to be constructed away from the culvert and running adjacent to their sewage line. The MWRA must have the ability to dig them out for future repair or replacement and required a 30-foot minimum clearance above the culvert for access.

As a result, the architectural design is a tall, slender building that curves around and cantilevers over the MWRA easement. "Our structural design had to ensure that MWRA could construct a 25-foot deep excavation to those pipes without impacting the building or its foundation," Odeh says. "Furthermore, the shape of the building itself posed structural challenges, requiring a deep pile foundation and specialized lateral bracing for wind and seismic loads, as well as the careful coordination of all that additional structural framing with the building systems."

Odeh Engineers modeled the existing culverts and designed rows of protective soldier piles on both sides of sewage lines. The team then used those elements to design the building foundation, strategically

locating the building piles to carry the load of the building without impacting the culverts.

The project's architect, ADD Inc., and the mechanical, electrical and plumbing (MEP) engineer, WSP Flack+Kurtz, also used Revit software products, enabling multidisciplinary design collaboration and coordination. "By sharing our design models, we could more accurately visualize the project and understand the spatial relationships between the structural framing, the architectural elements and the building systems," says Daniel Batt, structural engineer at Odeh Engineers.

"We work on a lot of renovation projects, and typically start those projects by using 3-D modeling software to help create a detailed model of existing conditions," Odeh says. "This enables our engineers and our clients to better understand the issues relating to an existing structure and the feasibility of various design concepts. Although the MassArt residence hall project is new construction, the team still had to work around existing conditions in the form of adjacent buildings, and most importantly, the MWRA easement."

Detailed coordination between the location of the sewer pipes, the soldier piles and the building support piles was essential. So the team modeled the culverts based on existing MWRA drawings, and then designed the soldier piles and building support piles.

"We could not have designed and coordinated this project as efficiently as we did without a model that more accurately reflected existing site conditions," says Jason Bacon, structural engineer at Odeh Engineers. "If the MWRA ever needs to excavate those culverts, the soldier piles will protect their sewage lines as well as the building foundation and the area around it."

The 21-story residence hall sits on a relatively small footprint — only 121 by 52 feet. The height of the narrow structure and its can-

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tilivered form necessitated unusually deep building piles and additional bracing. “Our structural design includes intricate links between the building frame and the foundation piles, along with a great deal of steel bracing for building support,” Batt says. “All the building systems — the duct work, the sprinkler systems, the plumbing and waste lines — had to be woven through the structure.”

Odeh Engineers used Revit Structure to visualize, analyze and refine the building’s foundation and steel framing — helping to design a structure that could bear its own weight, weather the winds whipping off the Atlantic Ocean, and withstand any future excavation of the nearby sewer culverts. To promote a more streamlined design process, the team imported the architectural and MEP software models into its Revit Structure model to facilitate cross-discipline design coordination and proactive clash avoidance.

### Teamwork Counts

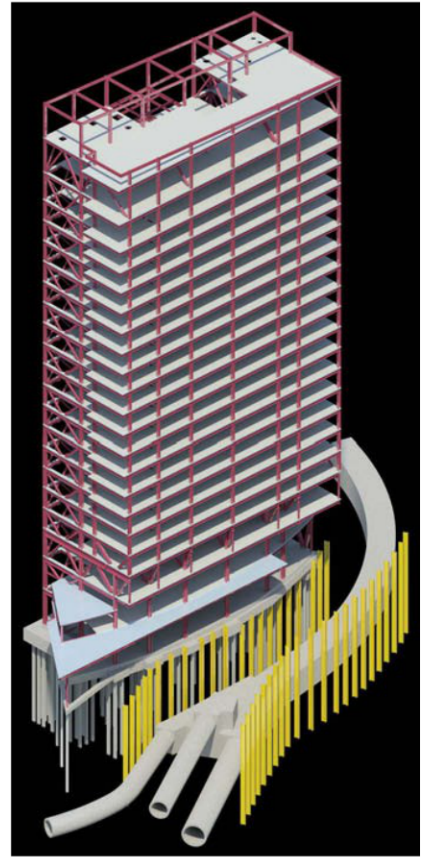
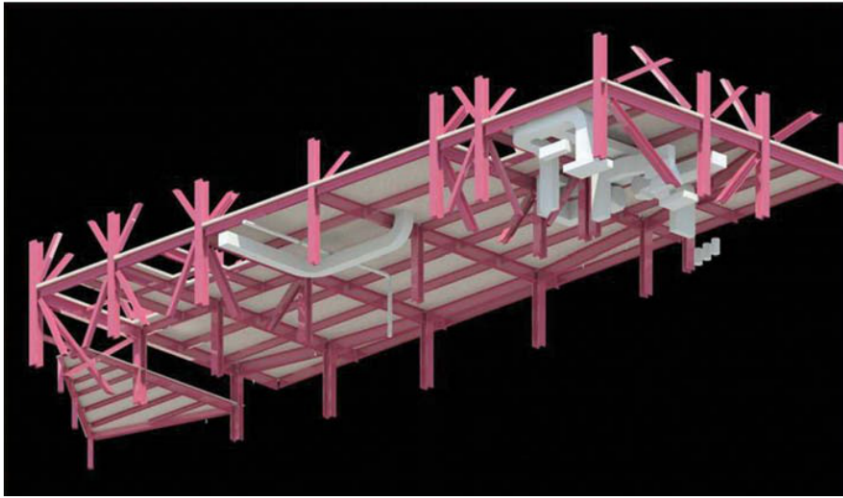
The extended design team and the contractor, Suffolk Construction Co., worked together as a team from the onset of the project. “Transparency and collaboration were critical for the success of this project, and BIM enabled both,” Batt says. “In addition to sharing our



The Massachusetts College of Art and Design’s new \$61 million residence hall will open its doors in fall of 2012.

respective design models for design coordination, we were able to bring all the models together for formal clash detection.” The extended project team attended regular online coordination review meetings and used this combined model to help identify and examine cross-discipline clashes and facilitate quick resolutions.

Suffolk also used the combined models for early quantity takeoffs, as



well as preconstruction estimating, planning and scheduling. "For example, the building support piles are particularly expensive so the team needed an early count for budgeting," Bacon explains. "Using our preliminary structural model, we worked with Suffolk to study different options for the pile systems and generate a more accurate cost estimate for the building support piles."

#### Clear Communication

Suffolk is now using Autodesk Navisworks Manage software to help with construction coordination. "The building was extremely well coordinated during the design process, which is making the contractor's coordination effort much easier," Batt says. "And because Suffolk is using the original design files of all of the major building disciplines, they didn't have to waste time recreating models."

Advanced 3-D modeling technologies not only helped Odeh Engineers visualize and evaluate the project, they were essential for more clearly communicating its design to the extended team and project stakeholders. Like many new construction projects in an urban area, there was a lengthy approval process for this dormitory.

In addition, the MWRA needed to sign off on the project due to the easement. "The use of BIM helped the entire team to visualize the complexity of the design and provided a workflow for interdisciplinary coordination" says Ed Adelman, the executive director of the MSCBA.

The team used the Revit Structure design model and both Revit Structure and Autodesk 3ds Max software to help create a range of design visualizations — sections, cutaways, renderings and even animations — that helped everyone gain a better understanding of the structure and expedite the approval process.

"These visualizations were particularly useful during the MWRA review cycle," Odeh says. "We were able to demonstrate to them that the building could be built safely while protecting their easement."

To improve model fidelity between structural design and fabrication and to minimize the number of requests for information (RFIs), Odeh Engineers shared its design model with the steel fabricator.

The firm exported the design to CIS/2 format and sent the files to the

steel fabricator for use in the steel detailing process. "We're not subject to the fabricator's interpretation of our drawings," Bacon explains. "We know that they're using the most accurate information for their steel detailing and they better understand our design intent. As a result, even though there are thousands of shop drawings on this job, there's been a minimal number of RFIs, and the project has gone extremely smoothly."

"The team's rigorous coordination during the design phase really paid off during the steel fabrication process," Odeh adds. "All the shop drawings were approved on the first pass. The steel fabricator said this was the best steel shop drawing process they ever experienced."

MassArt's new \$61 million residence hall is under construction and will be ready for students in the fall of 2012. "Our firm relies on BIM solutions to help us deliver the highest level of service to our clients," Odeh says. "BIM leads to better coordination, improved visualization and higher-quality documentation." ♦