Building the Future

Turner Construction Company

Innovation at the Rockefeller University River Campus Project: Modularization Propels Expansion over Major New York City Highway

Turner

Teamwork. Integrity. Commitment.

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Executing our plan

Over the course of 19 nights, the Turner team managing the Rockefeller University River Campus Expansion project set more than 12.5 million pounds of steel and concrete, spanning more than three city blocks over one of New York's busiest roadways. The story that follows details the project team's extraordinary accomplishment.

100+ Years of Research and Innovation

On the far East Side of Manhattan, Rockefeller University is a quiet enclave where, for more than a hundred years, world-class researchers have conducted 'science for the benefit of humanity'. The Rockefeller Institute was the first institution in the U.S. dedicated entirely to understanding the underlying causes of disease. Since then, it has earned worldwide recognition as a leader in biomedical research and expanded its mission to include education.

By the early 2010's the University recognized the need to further expand and modernize its research capabilities. And so the Stavros Niarchos Foundation–David Rockefeller River Campus project was born.

An Ambitious Program

With the goal of expanding their world-class research facilities, the university engaged architect Rafael Viñoly to provide master planning. Viñoly developed a bold design solution that takes advantage of air rights owned by the institution – adding two acres to the campus by erecting a 900-foot platform over the FDR Drive—a major traffic artery that sees more than 175,000 cars per day and runs along the East River.

The platform comprises the two-story, 136,000-square-foot Marie-Josée and Henry R. Kravis Research Building (which includes a green roof and two pavilion structures), a 9,800-square-foot Academic Building, a 10,000-square-foot Cafeteria, and a 5,200-square-foot Interactive Conference Center. The design also incorporates a public beautification initiative to rehabilitate portions of the existing seawall and upgrade the public riverfront esplanade adjacent to the campus.

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The project site is depicted above (highlighted in red).

A Unique Site with Challenging Logistics

The river campus site is surrounded on three sides by buildings: the Rockefeller Research Building to the south, New York Presbyterian Hospital to the north, and the historic core of the campus to the west. On the fourth side, the entire 900-foot span runs along the East River.

Given these tight conditions, the project team was faced with a host of logistical challenges. And, the idea of closing a major highway for multiple months to facilitate a conventional construction approach appeared impractical from a scheduling and logistics perspective.

An Innovative Solution Emerges

The combination of site constraints and a client receptive to an innovative, out-of-the-box approach emboldened the project team to pursue an alternative to conventional construction: modularization.

The modular approach proposed building the 900-foot-long lab building/platform in 19 segments, constructing them on a waterfront site 32 miles away, and barging them up the East River one segment at a time. Once in position each module would be picked from a crane barge, lifted over the highway, and set in place. And all of that would occur in a short, overnight window to minimize traffic disruption.

To help project stakeholders visualize the project, Turner leveraged Building Information Modeling (BIM) technology to articulate their operational plan. They used BIM software (Navisworks Timeliner, Revit, AutoCAD, Tekla) to demonstrate the erection sequence to the Community, the New York City Department of Building, the New York City Department of Transportation, the New York City Department of Parks and Recreation, and various other Federal, State, and City agencies.

Even as it made the project possible, the modular approach posed its own challenges—challenges that necessitated a high level of collaboration. To be successful, project team members from different firms needed to function as integrated partners, particularly Turner and structural engineer Thornton Tomasetti.

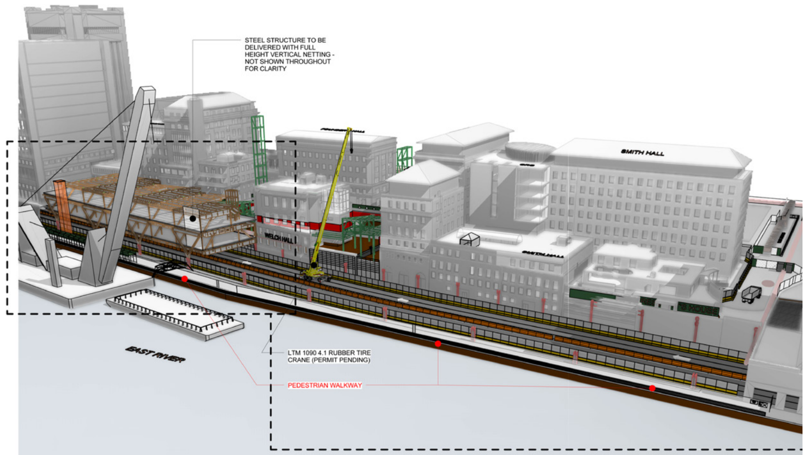
During preconstruction, potential steel subcontractors raised concerns about the approach; from an engineering point of view, the act of picking and setting the pre-constructed modules would subject the steel members to tension and compression.

The act of placing the completed modules on the transport barges before moving them to the site also presented unique structural challenges. Due to the irregularity of the shapes of the modules, each unit's center of buoyancy had to be carefully studied by structural and marine engineers, who fine-tuned the air ballasts on the barges to keep them balanced as they received the full weight of each module.

Despite these challenges, the modular solution offered clear opportunities to enhance the construction's safety, quality, and efficiency. Steel erection would have been especially challenging in the tight space above and along FDR Drive where there is no material lay-down area and workers would have had to work above an active roadway.

Prefabricating the modules on an open site enabled the erection of steel, pouring of concrete, and installation of multiple MEP systems to occur in an environment where the use of bucket lifts and scaffolds provided safe alternatives for workers. "Safety is always our first concern and from that perspective this method made a lot of sense" explained Curt Zegler, the Turner executive leading the job, adding that when it comes to prefabrication, safety and quality go hand in hand. "We got better production of each module because they were erected in a place where the trade workers could safely work from aerial lifts. They had control over their environment. They didn't have to store material along the highway. Compared to working in the congested space over and beside the FDR, it was a lot better for our people and for each piece of the final product."

Crews preassembled the 19 modules in this manner on the waterfront site in New Jersey. Each module comprised a three-level steel frame with composite concrete and metal deck floors. Eighty-eight 92 foot-long, five-foot-deep high-strength plate girders span east to west on each level, with steel beams running north to south. On the eastern façade of the modules, two-story Y-shaped columns spaced 96 feet apart provide support, while the western span is supported by columns spaced at 48 feet. The plate girders are linked by diagonals which provide stability and enable the facilities labs to meet vibration criteria.



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Module Pre-assembly Underway at the Keasbey Site

The floor decks lack expansion joints, instead utilizing slide bearings that allow the building to expand and contract about six inches at either end. Flexible connections were built into MEP installations and other components of the structure to allow for the expansion and contraction of the multi-segment facility.

The team used BIM extensively to enable the prefabrication of the modules, using the technology to coordinate the multiple MEP trades completing installations under each deck.

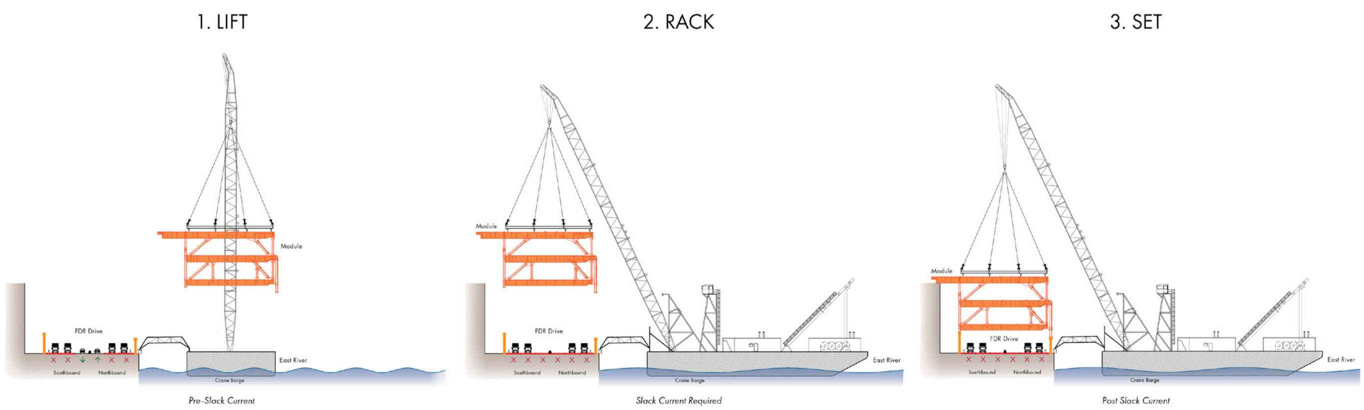


Diagram of each modules three basic movements

In addition to MEP work, the completed modules included stairs, spray-on fire proofing, sprinklers, and were loaded with materials and equipment necessary for installation. The weight of the completed modules ranged from 600 – 790 tons, with the heaviest weighing more than two fully-loaded 747 jet airliners.

BIM was also vital in overcoming the inherent challenges of working across two project sites. Integrating laser scanning with traditional surveying, the team surveyed the New York site location and translated that data to the New Jersey site during construction of the modules. Laser scanning was used to develop a point cloud for the schist wall running along the western side of FDR Drive. The point cloud enabled the team to determine if the wall needed to be modified to properly fit the steel or vice versa. The team also performed quality control using BIM technology, analyzing two locations with different datum and sea level elevations. The process helped ensure that the structure would be erected within tolerances, and also helped account for steel creep, deflection, and alignment. BIM workflows also facilitated the sequencing of the modular installation within the time constraints imposed by river conditions and road closure windows.

Executing the Plan: Careful Choreography

Planned for more than a year, each installation followed a carefully orchestrated sequence that took into account the tide, which rises and falls approximately three feet, and the river current, which flows at approximately six miles per hour, in addition to more traditional coordination considerations. The team's preplanning efforts were extensive and they generated multiple contingency plans to cover a wide variety of potential issues; enabling the team to be proactive instead of reactive. Part of the contingency planning process included conducting a trial run of the sequence to determine the most efficient and safest lift procedure.

By June of 2016, the project team was set to move the first of 19 modules into its final home. The sequence of the lifts centered around three basic movements: lift, rack, and set. The circumstances surrounding these movements were anything but basic. Moving and setting the modules was largely predicated on two constraints: road closures and the river's current. The New York City Department of Transportation (NYC DOT) would only permit full road closure from 1:00 a.m. to 4:30 a.m., which meant the team had to execute the entire sequence within a three-and-a-half hour period, concurrent with a slack current. Slack current is a short period of time when tidal water is not flowing in either direction, in this case providing a respite from the current.

On June 13, 2016 the 1,000-ton, stiff-leg derrick crane barge was anchored in place and the steel mooring arm was attached to a steel waler beam connection on the shoreline along the sites easternmost exterior building columns. A week prior at the New Jersey assembly site, the first five of 19 modules were lifted onto transport barges to be tugged into lifting position.

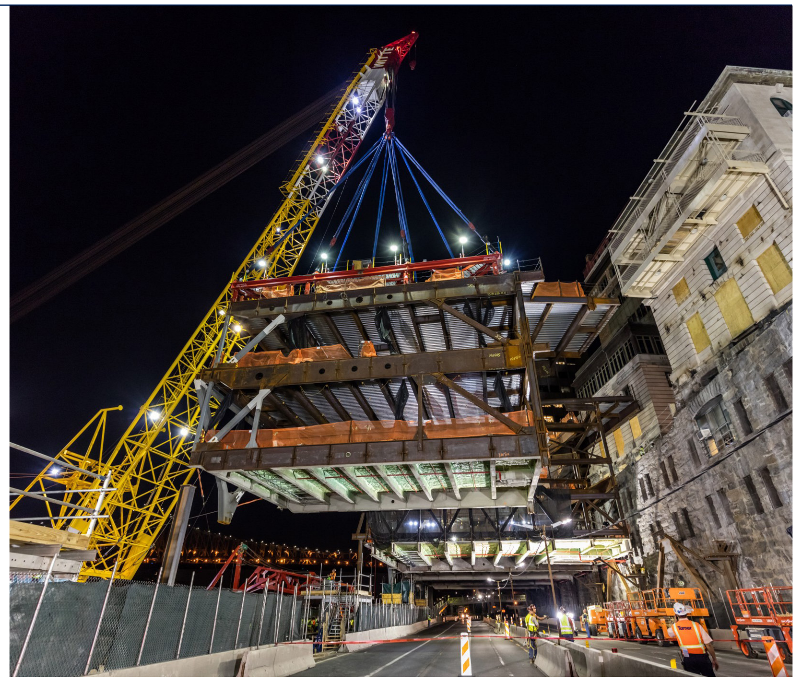
From 8 p.m. – 9 p.m. Turner and steel erector NYC Constructors Inc. held a pre-lift meeting to discuss the night's weather conditions, worker and equipment staging, roadway barrier removals, and updates from the NYC DOT, as well as the crane operator's lift plan.

From 10 p.m. – 11:30 p.m. the crews connected the crane's 100-ton lifting frame to the first module. Using a remotely controlled hydraulic leveling system – each module also housed a generator to run hydraulic pumps – crews utilized pre-programmed cylinder settings tested at the New Jersey site to control the lengths of the rigging slings and level the module.

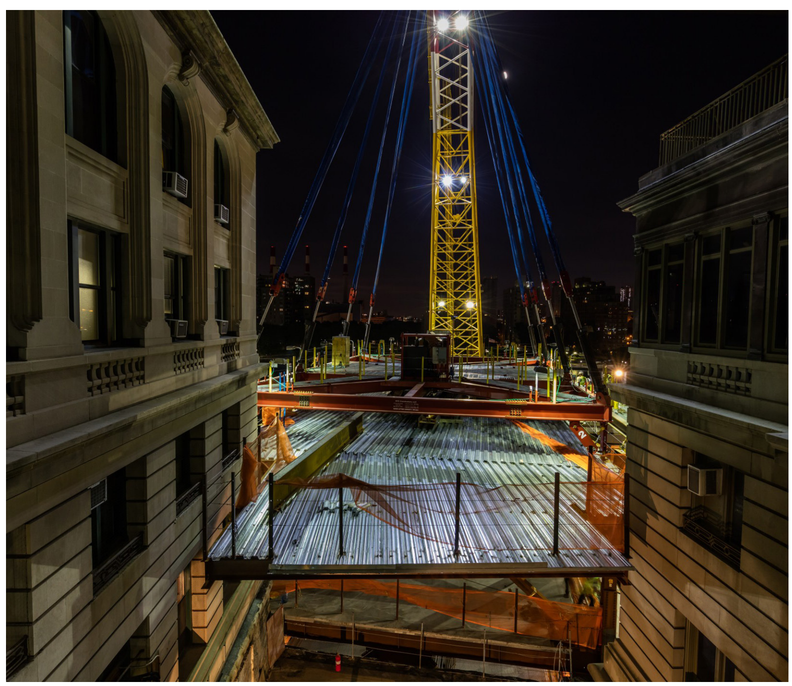
At 11:30 p.m. the right lanes on the northbound and southbound lanes of FDR Drive were closed and the roadway's crash barrier and fencing were removed.

At 12:00 a.m. the center lanes were closed, both northbound and southbound, allowing workers and equipment to enter the roadway and stage for the full road closure.

At 12:30 a.m. full vehicle diversion went into effect as the structure was slowly lifted off the



A module is swung into place over FDR Drive



A module is carefully fit between two existing structures transport barge, employing the hydraulics to confirm levelness of the module. Once the module was lifted into swing position tugboats removed the transport barge.

By 12:50 a.m. the last vehicles had passed through the lift site and workers moved their lifts into place to receive the module. The crane operator started to rack the crane on the mooring arm 90 degrees into place above the highway with the use of cables tied to sea anchors. Since it was a derrick crane barge, the crane had to rack with the assistance of the cables and two tug boats, which also held the crane steady as the river current started to increase. The module was then lowered onto pre-erected columns and leveled again while survey teams checked the module for any deflection incurred during the movements.

For the next 90 minutes, crews moved quickly to fasten the module to support columns, and the beams and girders on the site. Ironworkers on all three levels of the module worked to bolt connections and column support points. Once secured - which required 100% bolted connections on Level 1 and 50% bolted connections on Levels 2 and 3 - crews disconnected the lifting frame and crane from the module and began bolt inspections. The next half-hour was dedicated to completing inspections and protecting all leading edges over the roadway in preparation for opening the lanes.

By 4:30 a.m. crews had completed the inspections needed to open one lane to traffic. An hour later, the team re-opened all lanes of the FDR Drive to the city's morning commuters.

The team's ability to re-open the highway just a few hours after setting the modules was made possible by steps taken during prefabrication. Each of the modules was preinstalled with

The project site after all modules had been set

perimeter edge protection and full-height slab-to-slab netting which satisfied an important request by the New York Department of Buildings. Public safety protection was a key advantage of the modular solution; the concrete decking of each module provided the immediate overhead protection required to re-open the road.

With the next module already en route, the empty transport barge was tugged back to the New Jersey site, and the crane barge was moved 50-feet north in anticipation of the next module. This sequence was repeated 18 additional times as the team placed the remaining modules. With the exception of the last two modules, each was placed sequentially. BIM studies, which early in the process enabled the team to understand the complicated swing radii and pivot points necessary to establish the module sequencing, had determined that the 19th module couldn't be set last due to the proximity of the hospital to the north.

Turner estimates the owner saved $20 million by avoiding an additional year of project oversight and inefficiencies from restricted work hours over FDR drive.

With Great Risk, Great Rewards

Over the course of 19 nights, the team set more than 12.5 million pounds of steel and concrete, spanning more than three city blocks over one of New York's busiest roadways. And the impact of the phased effort was significant. The team estimates that the modular solution improved the project schedule by a full year. Phased nightly road closures significantly reduced the burden on the community and particularly New York City commuters. "Our intent was to minimize our impact on commuters and improve our project schedule," said Zegler who noted, "With a conventional build we would have been looking at partial or multi-lane closures for months, which was just unacceptable."

The modular approach also yielded significant cost savings to the client. Turner estimates the owner saved $20 million by avoiding an additional year of project oversight and inefficiencies from restricted work hours over FDR drive.

An Oasis of Science

In 2019, more than 600 scientific personnel will fill the River Campus and embark on the next generation of biomedical research. In a facility designed to foster interaction and the sharing of ideas, scientists will employ cutting edge technology towards the development of targeted therapies to combat neurodegeneration, Alzheimer's, diabetes, cancer, and a host of other diseases afflicting humanity. Built on a foundation of collaboration, the River Campus will provide Rockefeller University with the ideal environment to cultivate the transformative scientific advances of the next 100 years.

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