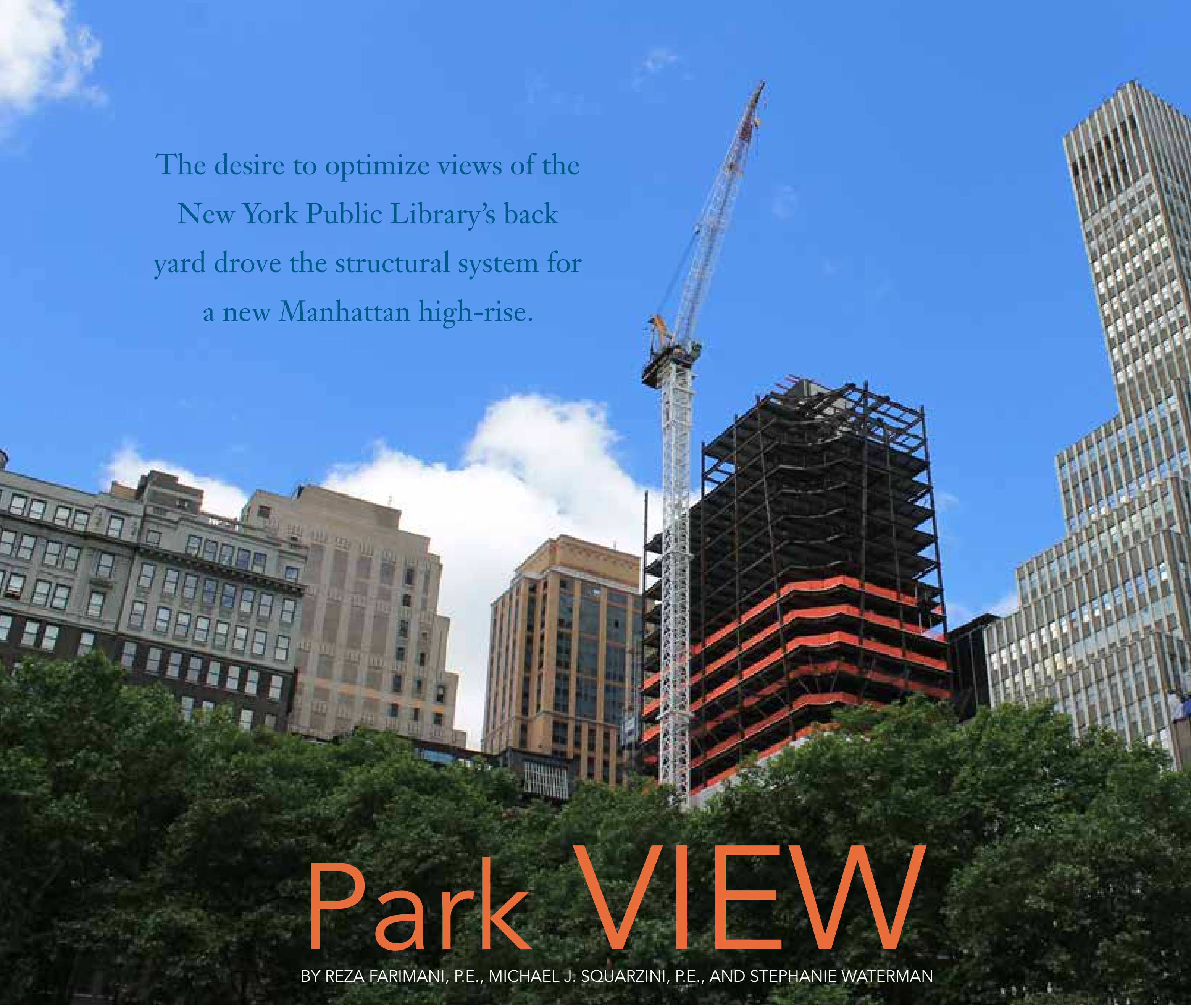

The desire to optimize views of the New York Public Library's back yard drove the structural system for a new Manhattan high-rise.

Park VIEW

BY REZA FARIMANI, P.E., MICHAEL J. SQUARZINI, P.E., AND STEPHANIE WATERMAN

A NEW SKYSCRAPER is rising kitty-corner to Bryant Park, an expanse of green that serves as the back yard of the main branch of the New York Public Library.

Given the location across Avenue of the Americas from the southwest corner of the park, the owners of the 30-story office building, known as 7 Bryant Park, wanted to maximize views of the green space for its occupants.

Off-Center Core

The structural framing for the 475-ft-tall, 471,000-sq.-ft tower is comprised of a hybrid system consisting of perimeter steel framing and a concrete core, and steel floor framing created a column-free office space between core and perimeter columns. For this project, the view dictated the structural system. To maximize park views to the east, the core is offset to the

Reza Farimani (**rfarimani@thorntontomasetti.com**) is a vice president, **Michael J. Squarzini** (**msquarzini@thorntontomasetti.com**) is managing principal and **Stephanie Waterman** (**swaterman@thorntontomasetti.com**) is an engineer, all with Thornton Tomasetti.

▲ The northeast corner of the building.

◀ The building is oriented to optimize its views of Bryant Square Park.

▼ Bolted connection assemblies.

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▼ Below-grade framing. The building is adjacent and connects to a subway station.

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west side of the floor plate, and all floors above grade have a view of the park. The design includes office levels above grade plus a mechanical penthouse, retail spaces and a lobby at the ground floor and two floors below grade for amenities and MEP spaces. The upper levels were typically designed for office occupancy, though a few upper floors are designed for higher live loads should future occupancies require additional loading capacity.

The typical floor framing system consists of wide-flange steel beams and girders with a composite concrete slab on metal deck. At the podium levels, the floor beams span 62 ft from the core to the spandrel girders. Embed plates were provided in the shear walls to support the steel floor beams framing to the walls. At level 10, the east façade sets back and exposes an outdoor terrace. To keep the column-free space above this level, 5-ft-deep built-up

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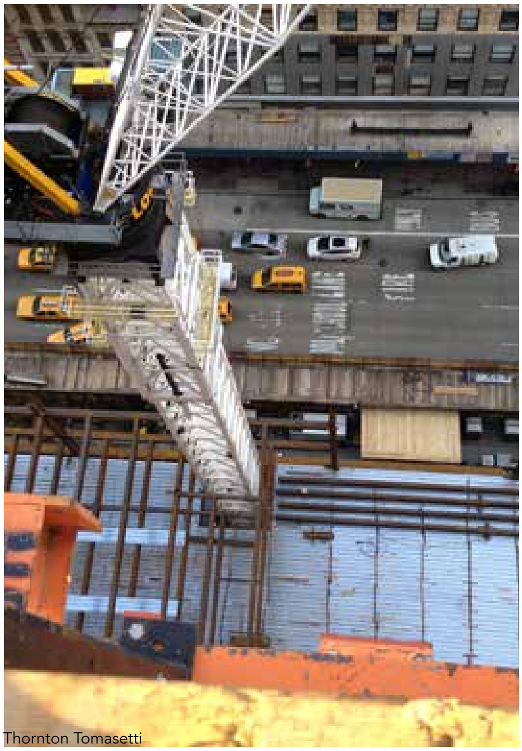
The 471,000-sq.-ft building is 30 stories high.



Looking down at the Avenue of the Americas.

transfer girders were designed to transfer 20 floors above this level.

One of the iconic aspects of this project is the curtain wall at northeast corner facing Bryant Park, which slopes to create an hourglass-shaped façade. To create this form, four sloping columns (ranging from W14×132 at the roof to W14×550 at the base of the building) at the northeast corner of the building—two sloping columns above level 10 and two below level 10—were used, and all of these columns induce lateral kicks at level 10. To transfer these kicks to the core, steel horizontal bracing was introduced at the level 10 diaphragm that had the maximum diaphragm forces.

The core was designed to provide lateral and torsional resistance and stiffness of the building for wind and seismic forces. The core, consisting of shear wall in the orthogonal direction, also transfers the gravity loads of the structure and its own weight, which helps reduce the uplift forces. The 2-ft-thick concrete core wall was constructed using a jumped form system ahead of the steel-framed floors. The concrete was poured eight levels above the steel erection. Staged analysis was performed to predict the core deformation during the construction and lifespan, and the results of this analysis, along with periodic surveying, were used for erection of the steel and curtain wall within specification tolerances.

Flying Saucer

A striking entrance canopy at the northeast corner of the building resembles a flying disc and is located directly below the hourglass façade. The disc is 48 ft in diameter and cantilevers 51 ft off the second-level spandrel beams. A quarter of the disc is exposed steel and detailed as architecturally exposed structural steel (AESS). The disc is made of two long cantilevered steel plate girders off the second level-framing; both girders were tapered to satisfy the architectural cladding shape. The wide-flange "spokes" of the canopy were also tapered for architectural cladding, and the connecting members are HSS. The exposed quarter of the disc uses curved members while the cladded portion employs straight members with curved plates attached.

Two challenges of erecting such a large disc lay in the construction sequences and tolerances. The contractor, Turner, opted to erect the disc after completion of structure, which varied from the original design's construction sequence. Originally, the disc was to be erected at the same time as the second-floor steel. To accommodate this change, a new analysis was performed to include the deflection at the second level caused by the weight of the second-floor slab as well as the column shortening due to the load of 30 stories above. Connections of the disc to the base structure were modified to accommodate the construction sequence. Additionally, by erecting the disc later, the curtain wall at the second level was installed; therefore, staging analysis with deflection prediction of the cantilevers from the second level had to be completed.

Down Under

The site is bordered by 40th Street to the north, the Sixth Avenue subway line to the east, 39th Street to the south and the Springs Mills Building to the west. There is a subway stop at the corner of 39 Street and 6th Avenue, and a new tunnel was constructed to connect this station to the building through lower level 1.

To maximize park views to the east, the core is set to the west side of the floor plan.

The tower is comprised of perimeter steel framing and a concrete core.

The "flying saucer" canopy at the main entrance.

The subgrade condition includes two types of rock capacity: 40 tsf and 20 tsf. Therefore, spread footings were typically adequate to be used as the foundation. One challenge of the substructure was the proximity of the existing subway tunnel to the building property line along the east border of the project. The foundations along the east side of the building required drilled mini-pile supports that extend below and bear on the Sixth Avenue subway influence line. The basement excavation and foundation supports were coordinated such that underpinning of the adjacent building foundation was not required. To avoid underpinning, the adjacent building foundation (a tangent pile system) was used on northwest site of the lot, and the core is supported on a mat foundation with tension tie-downs as required.

Fabricator and erector W&W|AFCO Steel performed the steel detailing and also designed the secondary framing connections for the project, while Thornton Tomasetti designed the main connections and modeled them in Tekla. Since elec-

The conic shape of the curtain wall at northeast corner facing Bryant Park slopes to create an hourglass-shaped façade.

The entrance canopy disc is 48 ft in diameter and cantilevers 51 ft from the second-level spandrel beams.

▼ To keep the column-free space above level 10, 5-ft-deep built-up transfer girders were designed to transfer 20 floors above this level.

Photos this page: Thornton Tomasetti

▼ Divider beams between the elevator shafts.

tronic submission of construction documents in BIM form is not yet industry standard, traditional PDF drawings were also submitted. The Tekla model was translated through in-house software to a Revit Model, which was used for design team coordination. Both the Revit and Tekla models were used in BIM 360 Glue by Turner for contract administration coordination between the subcontractors.

The building's core and shell were completed earlier this year, and the framing system uses approximately 3,500 tons of steel. Bank of China took ownership of the building in April, and fit-out is currently in the design phase. ■

Owner
Bank of China

Developer
Hines

General Contractor
Turner Construction Company

Architect
Pei Cobb Freed and Partner Architects, LLP

Structural Engineer
Thornton Tomasetti

Steel Fabricator, Erector and Detailer
W&W|AFCO Steel