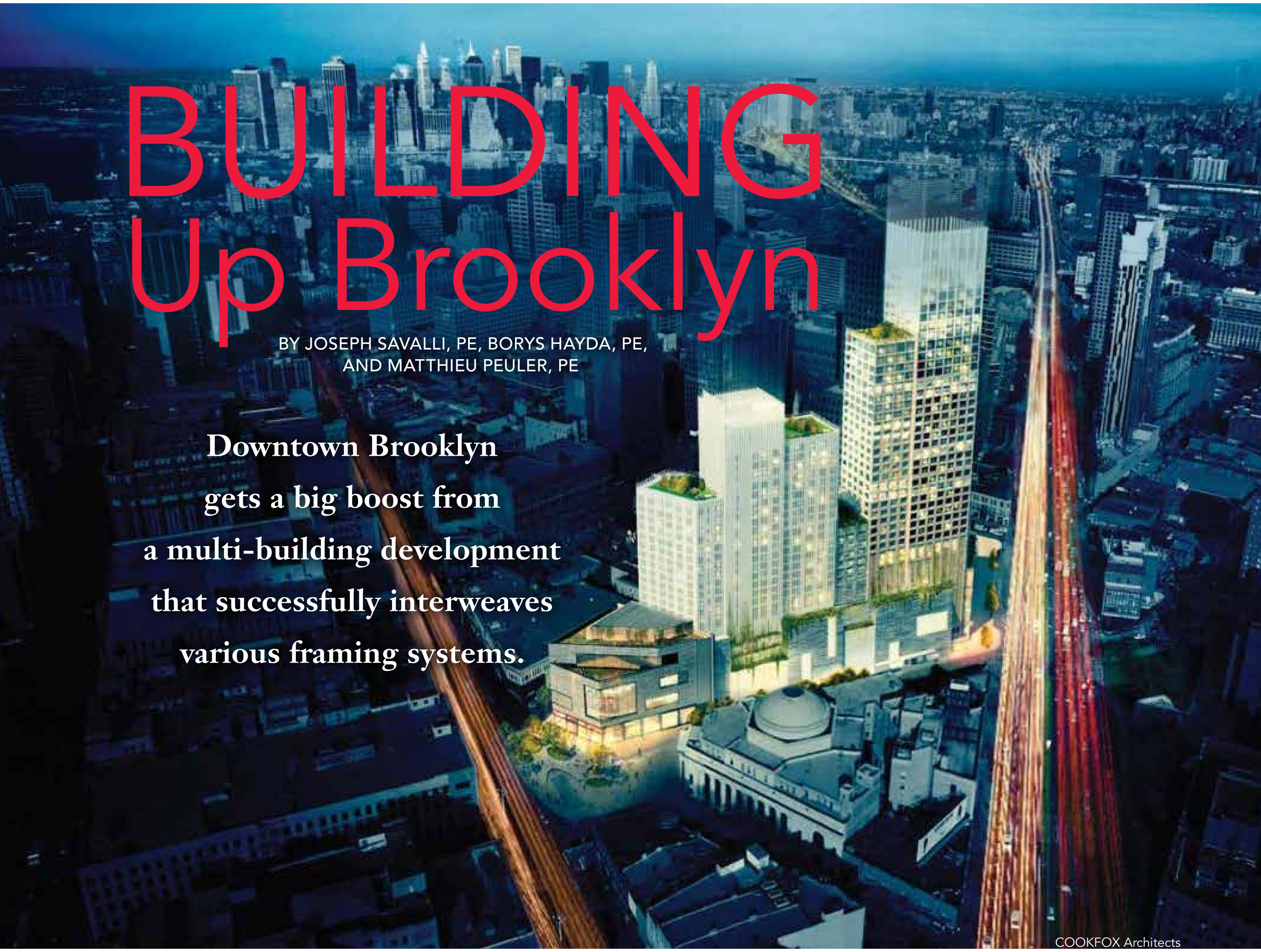

BUILDING Up Brooklyn

BY JOSEPH SAVALLI, PE, BORYS HAYDA, PE, AND MATTHIEU PEULER, PE

Downtown Brooklyn gets a big boost from a multi-building development that successfully interweaves various framing systems.

WHILE SKYSCRAPERS HAVE ALWAYS told the story of Manhattan, they are also becoming a more regular sight across the water in Brooklyn.

One of the largest and most prominent new developments in Downtown Brooklyn is City Point Phase II, a 1.2 million-sq.-ft development comprised of a retail podium (using 11,000 tons of structural steel) and two residential towers. (Phase I is a three-story, 50,000-sq.-ft building to the south of Phase II and opened in 2011.)

Each of the three structures has a different framing system and is developed by a different entity, which contributed to the complexity of the design. The podium, which includes numerous big-box, retail anchor tenants, is constructed of structural steel framing with metal deck floors, braced frames and concrete shear walls. The most typical podium bay has W21 or W24 beams spanning 39 ft, 7 in. to W27 or W30 girders spanning 30 ft. The second through sixth floors are occupied by full-floor tenants; the concourse, ground and mezzanine floors house multiple tenants; and the sub-concourse provides required support space with a loading dock and mechanical and storage spaces.

Tower 1 is a Girder-Slab structure with reinforced cast-in-place concrete shear walls. (The Girder-Slab system is an assembly of asymmetrical steel beams referred to as "D-Beams" and is fabricated from a standard rolled wide-flange section and a flat bar. It supports a hollow-core precast plank on its bottom flange. For another DeSimone-designed project employing this system, see "Mix and Match" in the November 2016 issue, available at **www.modernsteel.com**.) Tower 2 is a flat-plate cast-in-place concrete structure with a concrete shear wall core and slab frames.

DeSimone worked closely with the fabricator, Banker, throughout the detailing and construction phases of the project. This helped anticipate and resolve coordination issues such as constructability of complex steel connections and embedding major structural steel elements inside congested concrete shear walls.

Architectural Discontinuity

Throughout the design and construction phases of the project, the complexity of the architectural design created many structural obstacles. Discontinuity in architectural programming between the three buildings required transferring most tower loads at the podium roof. As a result, Tower 2's concrete columns transfer onto steel plate girders, which are supported by steel columns and con-

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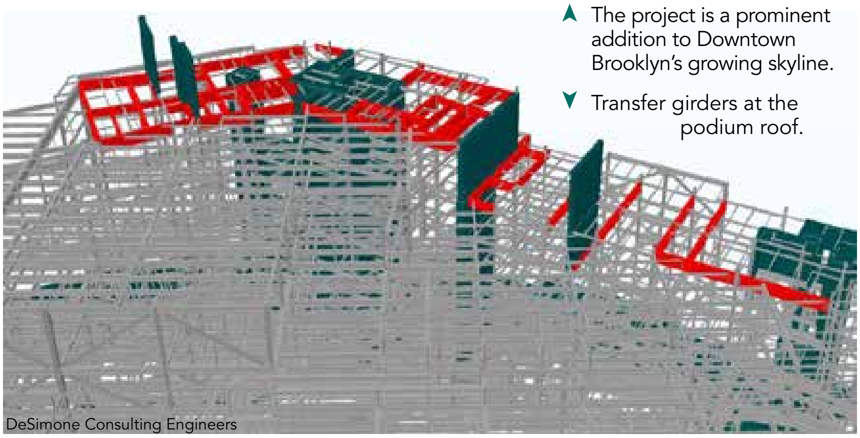
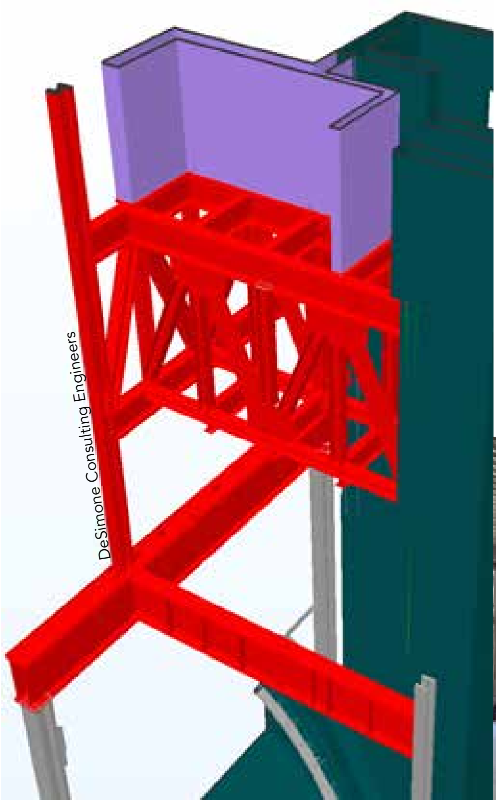


The project is a prominent addition to Downtown Brooklyn's growing skyline.

Transfer girders at the podium roof.



Steel trusses transfer to concrete shear walls in Tower 1.

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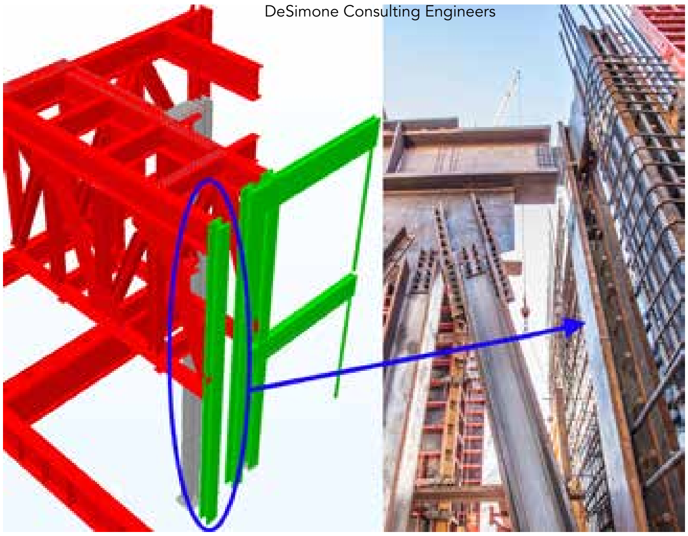
An 84-in.-deep, double-web plate girder required a special truck for transport.



Steel-to-concrete connections at a truss.

A defining feature of the podium is its two 65-ft-tall by 60-ft-wide glass walls.

crete shear walls, and Tower 1's steel columns transfer onto a grid of steel plate girders.

To provide a column-free truck ramp into the podium's sub-cellar loading dock, additional long-span built-up steel plate girders were needed. The truck ramp required that a large section of Tower 1's shear walls transfer onto steel trusses, which are in turn supported by steel columns on one side and concrete walls on the other. Because of retail layouts, one of the columns supporting the trusses was transferred again onto an 84-in.-deep, double-web plate girder. This large girder is 36 in. wide, spans 56 ft and weighs 3,000 lb per linear ft (83 tons total), and a special truck was required to transport it. Minor column shifts were accomplished by using sloped columns, with the resulting horizontal forces resisted by the floor framing and the building's lateral system.

The truck ramp wasn't the only building element requiring transfers. The ground-floor retail promenade that angles through the building required six, 78-in.-deep transfer girders. In addition, the sub-concourse loading dock includes a 90-ft by 180-ft column-free area necessary for semi-trailer maneuvers. This area was accomplished with three 90-ft-long, 46-ft-deep trusses.

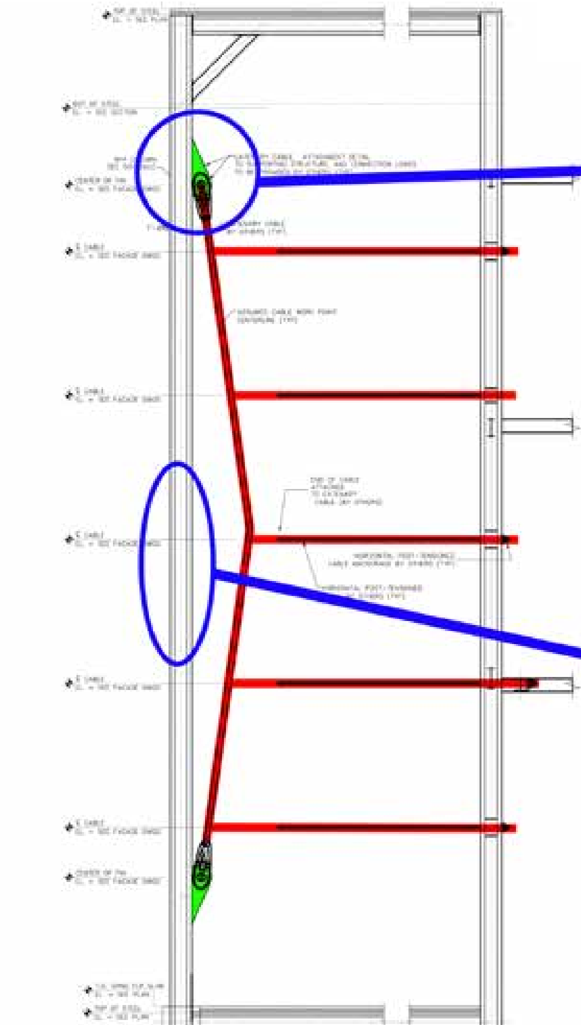
Connecting large steel transfer beams and truss elements to concrete shear walls proved challenging and required special attention to detailing at the steel-to-concrete interface. Studded steel beams, plates and columns embedded into the concrete walls and pockets in the concrete allowed for these connections. Typically, at the transfer girders, vertical load was transferred from concrete columns and walls to steel plate girders by connecting rebar to welded mechanical couplers.

The podium's lateral system consists of concrete shear walls supplemented by steel-braced frames and moment frames, which provide lateral restraint for wind and seismic lateral loads in addition to loads imposed by sloping columns and the tension glass wall. A portion of the new podium's lateral force resisting system was connected structurally to an existing adjacent steel building (part of Phase I), and this interface between the two phases consisted of a four-story, laterally braced frame.

Bleeding Down

A highly intricate podium façade with little repetition necessitated particular attention to spandrel details. Portions of the tower façades "bleed down" into the podium floors, requiring careful structural coordination between all three project design teams, owners and façade consultants. A defining feature of the podium comprises two, 65-ft-tall by 60-ft-wide glass walls, which are suspended on horizontal post-tensioned cables that span across each glass wall's structural frame.

The usual construction of a tension glass wall has anchor points at both ends of the horizontal cables. But in this case, since the architectural layout placed the glass walls at the North edge of the building, an alternate anchoring scheme was required. The South ends of the cables are anchored to structural steel members, as is traditionally done, but the north ends of the horizontal cables are attached to a post-tensioned cable spanning vertically and deflecting into a catenary shape,



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▲ Support structure for the post-tensioned glass wall.

▼ Each glass wall is suspended on horizontal cables spanning across the structural frame.

resembling the string on a bow. The catenary cable is anchored to a column with 4-ft-long, 7-in.-thick steel gussets. Large post-tension forces and stringent deflection criteria required close collaboration between the podium structural engineers and the glass wall engineers, and the unbalanced forces required floor trusses and upgrades of the adjacent lateral system to resist the sustained load imposed by the cables. The robust columns required to support the catenary cable assembly weighed as much as 1,150 lb per linear foot, with 7½-in.-thick flanges.

Today, the City Point mega-project serves as a transformative development to the Downtown Brooklyn community and makes up the largest retail, dining and entertainment destination in the area, thoughtfully contributing to and bolstering an already thriving hub of commerce. ■

Owners

Acadia Realty Trust, Inc., New York
Washington Square Partners, New York

General Contractor

ZDG, LLC, New York

Architects

SLCE Architects, New York
COOKFOX Architects, New York

Structural Engineer

DeSimone Consulting Engineers, New York

Steel Fabricator

Banker Steel, Lynchburg, Va. AISC Certified Fabricator

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