Now Arriving

BY KEITH ITZLER, P.E.

By Bernstein Associates.

Re-using century-old structural steel construction helped get this transit-centered development moving.

THE CORNER OF FLATBUSH AND ATLANTIC AVENUES IN THE HEART OF BROOKLYN, NY IS HOME TO A NEW MIXED-USE COMPLEX. Developed by the Forest City Ratner Companies, Atlantic Terminal is a 14-story tower with five levels of retail, including a Target store and numerous shops and restaurants. The building's Class A office space, located above the retail portion, is home to the Brooklyn operations center for The Bank of New York.

While the successful redevelopment project now welcomes thousands of people each day to work, shop, and dine, there is yet another vital hub of activity located on the site. Atlantic Terminal is situated atop Brooklyn's Flatbush Avenue Terminal, the third largest transportation hub in New York City and one of the busiest in the United States.

The Flatbush Avenue Terminal links nine New York City Metropolitan Transportation Authority (MTA) subway lines, MTA's Long Island Rail Road, and four MTA bus lines. Building the new 370,000-sq. ft retail complex and the 470,000-sq. ft office tower over the station without disrupting daily rail operations was the central challenge of this massive two-year construction project.

Keith Itzler is a senior associate and assistant manager of the New York City office of Dewberry.

New Life for Old Steel

The decision to build upon century-old steel became a key launching point for the design and construction of Atlantic Terminal. The original, above-ground Flatbush Avenue station was demolished in the 1980s. However, the building's foundation, which dated back to 1902, remained in place. A portion of the original columns and floor framing that had been constructed at grade level over the depressed tracks were also still intact.

The building foundation consisted of concrete spread footings founded on the existing soils. Adjacent to MTA's Brighton Line Tunnel, which runs under the site, the original spread footings had been underpinned with cast-in-place concrete piers, effectively lowering the bearing elevation so as not to surcharge the subway tunnel walls.

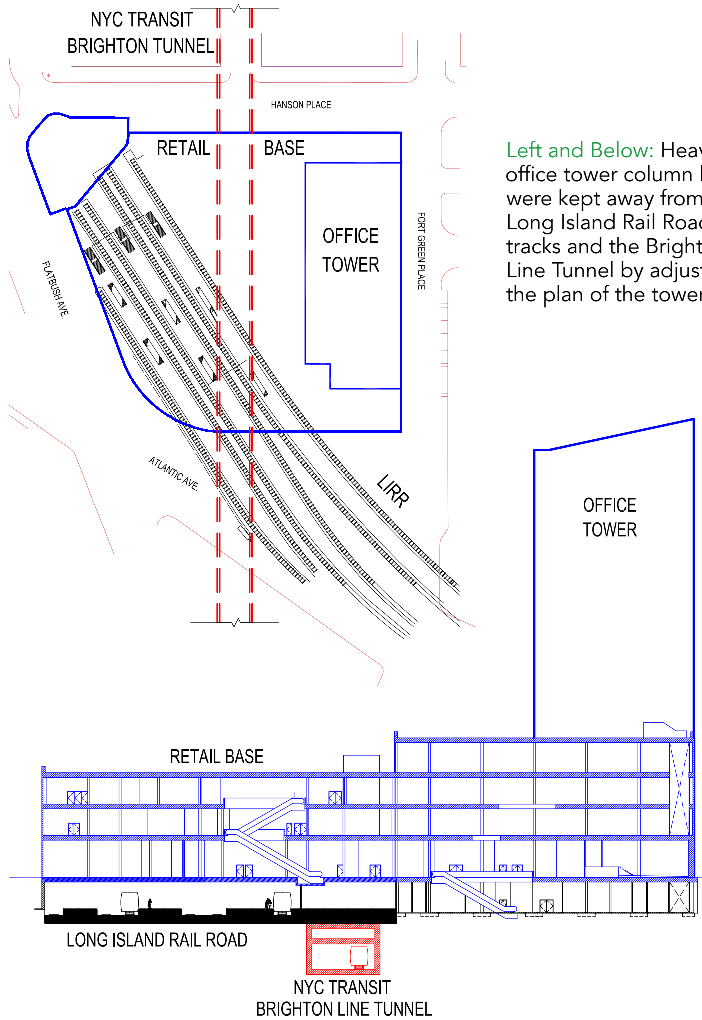
The original columns were built-up members that consisted of plates, angles, and channel sections that had been typically riveted together to form built-up, modified I-shaped compression members. Similarly, the floor framing consisted of riveted built-up beams and girders consisting of plates and angles. In-fill beams consisted of rolled shapes that supported concrete "jack-arch" floor construction that served as the roof of the old station.

Dewberry, as the civil, structural, and geotechnical engineering consultant for the retail portion of the project, performed a detailed assessment of the existing foundation and structural steel, including the old, built-up, riveted steel columns and girders. The firm's engineers determined that many of the elements, including the footings, columns, beams, and foundation walls, could be used to support the new complex.

Although this approach would require careful integration of the new building frame into the old foundation, while also incorporating the required retrofit measures to meet current seismic and wind load regulations, the plan to "recycle" the steel would provide a starting point that would ultimately save time and money. Most importantly, the reclamation would enable rail traffic to continue to operate without disruption.

Map and renderings courtesy Dewberry.

Brooklyn's Flatbush Avenue Terminal is New York City's third largest transportation hub, linking the Long Island Rail Road, nine Metropolitan Transportation Authority (MTA) subway lines, and four MTA bus lines.



Left and Below: Heavy office tower column loads were kept away from the Long Island Rail Road tracks and the Brighton Line Tunnel by adjusting the plan of the tower.

Working with Existing Steel

Throughout the structural design process, the engineering team was careful to respect the existing structure. Working closely with the retail space planners, the team determined that the somewhat irregular track-level column grid could be accommodated in the leasing program for the building directly above the station tracks. A matching column grid was adopted in the retail space, which avoided an expensive transfer girder framing scheme that would have been required to achieve a more standard rectangular column arrangement.

As the architectural design of the building progressed, engineers focused carefully on the loads on the existing columns and footings. Because of the need to maintain train traffic, the preliminary design phase included numerous studies that examined architectural building layouts that avoided reinforcing the existing columns and footings. The design team worked closely with retail planners and construction managers from Forest City Ratner, the developer and general contractor. Many hours were spent reviewing options to eliminate expensive work that would have been needed at the track level. The footprint of the office tower also was developed with this consideration in mind. Heavy office tower column loads were kept away from the Long Island Rail Road tracks and the Brighton Line Tunnel by adjusting the plan of the tower.

As the original steel structure had been designed for gravity load only, it proved impractical to attempt to resist current seismic and wind loads in the old steel. Wind and seismic loading requirements were addressed through the use of new steel moment and braced frames linked together by a cast-in-place concrete slab on metal deck, which served as a structural diaphragm at the street level. The steel was effectively "recycled" through the team's collaborative efforts to design a building that enabled reuse by eliminating overloads.

In developing the design drawings for the project, the engineering team was able to locate fairly accurate and complete records of the existing structure that remained after the demolition. Record drawings were found in the archives at the Long Island Rail Road and MTA. The information obtained from these drawings was substantiated through field investigations to verify the as-built arrangement, which matched with the exception of a few areas where minor undocumented field changes had been made.

The field investigations also reviewed the condition of the existing structure, which was generally good except in locations where water intrusion had made the existing steel susceptible to corrosion. When the original station building was demolished, a light metal roof had been constructed over the tracks. Over the years, the waterproof membrane had been compromised in certain areas, which allowed water to enter the structure and resulted in localized areas of corrosion that required repair.

For some of the older steel, testing determined whether the material was weldable in order to facilitate the connection of the old steel to the new. Coupons were cut from existing steel members and sent to a laboratory for testing. The chemical composition of the steel indicated that it was capable of being welded, and welding conducted in the field substantiated this determination. The team also obtained extensive site measurements in order to locate the position of the existing steel accurately, both in plan and elevation.

Tunnel Reinforcement

The engineering team also analyzed the Brighton Line Tunnel beneath the site to gauge its capacity to support new building loads associated with the retail building columns. While the loads were not necessarily heavier than the original building loads, in most instances they were applied to the structure in different locations. With updated documentation in hand and inspections complete, the project team coordinated closely with the MTA regarding the placement of the anticipated structural loads. All proposed loading and design alternatives were also reviewed in detail with MTA's New York City Transit Office of Outside Projects, which is responsible for reviewing proposed non-system construction projects for impact on the existing subway system.

Considerable planning and design effort was expended so as not to overload the 4'-thick reinforced concrete tunnel roof slab and the steel framework inside the tunnel. Constructed in the 1920s, the tunnel is a two-level structure at the location of the project site. Subway trains run on the lower level, where a passenger station is also located. The upper level of the tunnel allows for passenger circulation and houses transit offices, crew quarters, and maintenance and storage space.

The tunnel roof is a 4'-thick reinforced concrete slab that was originally cast on the ground. The tunnel structure underneath was then constructed below the roof slab. The exterior tunnel walls are cast-in-place concrete. The roof and upper-level floor are supported on two lines of steel framing, also made up of riveted built-up steel shapes. The majority of the steel framing was encased in concrete. The existing concrete roof slab had some capacity to support new column loads; however, in some cases an auxiliary system of cast-in-place concrete transfer beams constructed above the tunnel was required to bypass the old roof structure. These foundation beams transferred the new retail building column loads directly to the exterior tunnel walls and interior steel columns, which were found to have adequate structural capacity. This approach avoided extensive reinforcing of the steel inside the tunnel, which would have interfered with transit operations.

By Bernstein Associates.

To build upon the existing steel and to accommodate the railroad, the retail component of the development is positioned about 30 degrees off axis from the office building.

Speed and Constructability

Use of the existing foundation provided a strong start for the overbuild's structural system, which proved critical in terms of meeting the project's aggressive schedule and the need to maintain the rail operations.

Flexibility was another key factor. The retail areas, which included nearly 200,000 sq. ft for Target alone, required expansive, column-free floor space. Steel moment frame construction, along with lightweight concrete floor decks, enabled the retail portion to be designed without internal bracing, yet provided the strength needed to support the office tower for lateral loads resulting from wind and seismic forces.

The designers characterized the project's geometry as complicated: the retail component was positioned about 30 degrees off-axis from the office building in order to build upon the existing steel and accommodate the railroad.

Avoiding Disruption

The terminal's ongoing rail and commuter activities proved to be challenging during construction, as no section of the site could be closed at any point. People and trains were regularly moving through an active construction zone, so safety precautions were paramount. Shielding was constructed around the work area to protect the public and railroad equipment. Where possible, construction details were developed to eliminate or minimize work that needed to be conducted in public areas. Additional egress stairs from the platform level to the street were constructed to allow for emergency exits when some of the existing stairs had to be temporarily closed.

The steel erection process was also affected by the 3.6-acre site's location along Flatbush and Atlantic Avenues, both congested urban streets. Adjacent subway and street improvement measures underway at the time presented additional complications. The street improvements involved reconstructing a portion of Atlantic Avenue in front of the retail building site.

Atlantic Avenue, in this area, is supported on a steel structure that forms the roof over the Long Island Rail Road tracks. Water intrusion over the years had resulted in severe corrosion problems that required replacement of the concrete roof slab and steel floor beams in the area. As the station improvements, street improvements, and Atlantic Terminal construction were all occurring simultaneously, there was extensive coordination between all of the design teams involved to work out the details at the project interfaces. The contractors coordinated schedules and logistics to ensure that everything ran smoothly.

Teamwork

Forest City Ratner served as its own general contractor for this modified design-build project, working closely with the various trade subcontractors. This direct relationship allowed for greater flexibility in addressing unforeseen issues that often arose as a result of the operating rail environment. Steel contractors worked with Forest City Ratner to determine crane locations, capacities, and types of equipment—including a tower crane and a crawler crane—to allow for erection of the steel frame. Due to heavy traffic on the adjacent Flatbush and Atlantic Avenues, the site was only crane-accessible on two sides. The erection effort also included working with the rail road's safety engineers to coordinate lifting and placing steel over the active tracks.


Courtesy Art Huneke.

The original Flatbush Avenue station, constructed in the 1920s, was demolished in the 1980s, but original structure remained in place below street level.

The many complex solutions generated to create the Atlantic Terminal development, from archival research of the existing structure through the final stages of construction, were coordinated with a large team of local agencies and authorities.

Now open and proving popular with shoppers and office workers alike, Atlantic Terminal reflects the successful marriage of old and new steel construction. And though vastly complicated and technically challenging, the project has enlivened a central city block that had remained vacant for nearly 20 years.

Developer & General Contractor
Forest City Ratner Companies, New York

Architects
Retail—Ives Group, Fairlawn, NJ
Hardy Holzman Pfeiffer, New York
Office Tower—Swanke Hayden Connell Architects, New York

Engineers
Retail—Dewberry, New York
Office—Cantor Seinuk Group, Inc., New York

Engineering Software
RAM Structural System