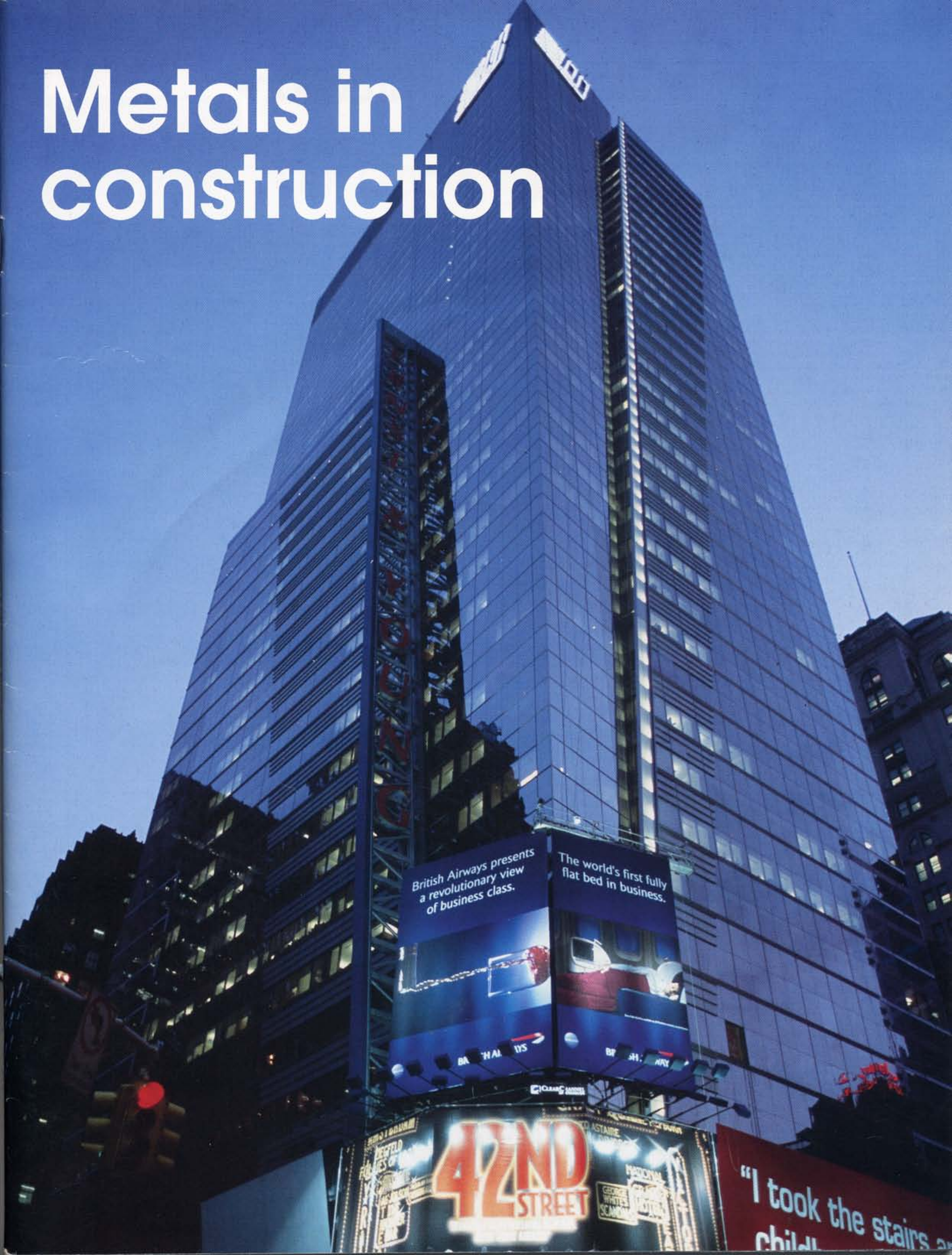
Metals in construction



5 Times Square Lets Creativity Rein

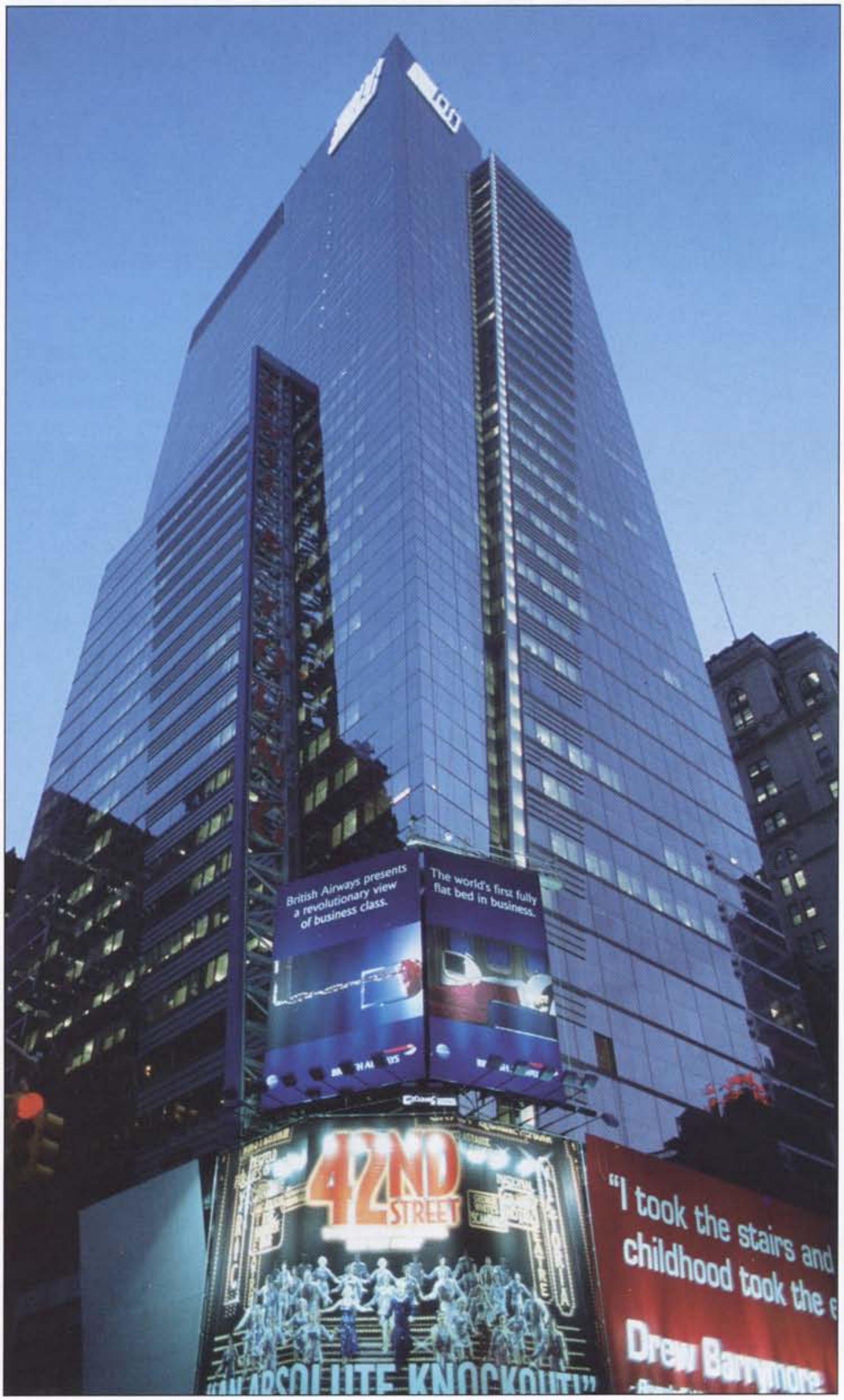


Photo: Fran Solomon

There is no doubt that the redevelopment of the Times Square district has proved fertile ground for architects and engineers. The guidelines established by the 42nd Street Development Corporation have set certain parameters, such as the buildable area for the four towers on the site, and have mandated that the mass of the buildings be broken up to avoid a "big box" effect. But otherwise, the area is "removed from the normal constraints of urban planning," said Douglas Hocking, senior associate principal for Kohn Pedersen Fox, the architect for 5 Times Square. The architects have thus been able to give free rein to their creativity to determine the look of the buildings.

"Modern-style structures tend to be a collection of pieces put together in an additive process," according to Hocking. "Instead, for 5 Times Square, forms were combined in a subtractive way, like a fractured crystal."

The building volumes step in and out vertically and horizontally to form a series of broken planes. Although the façade of the 575-ft.-tall tower has no right angles, the juxtaposition of the angles creates a unified volume. Angles meet at a common juncture, then flare out from one another, and the setbacks share a common edge.

"The design concept produced a structure ideally suited to the site," said Hocking, "elegant while also razzmatazz".

Increasing the Volume

Aside from the unique aesthetic of its exterior, the architects had to provide for the utmost rentable space in a neighborhood where real estate is at a premium. The fragmented geometry increased the volume of the building to more than one million square feet, but the structural design was critical to maximize the interior space. The structural engineer, Thornton-Tomasetti, was actively involved in the design process, as was the major tenant, Ernst and Young, which required some modifications to the floor plates to suit its fit-out needs.

"The structural design was driven by the architecture and required considerable ingenuity, due to the shifting planes of the façade," explained Aine Brazil, principal in charge for Thornton-Tomasetti. "The design was engineered to meet structural requirements while maintaining the maximum floor layout with a minimal core," she said. "The complex design and layout of the building could only have accomplished by using a steel frame."

The short east-west dimensions of the building would have provided a very narrow core with insufficient depth to resist high wind loads, and a centrally braced system would have greatly reduced rental space. Therefore, an exterior moment frame around the building's perimeter was used for the lateral system. The resistance of the frame is increased by closely-spaced columns that create a tube-like effect around the perimeter.

A tube system is only efficient if the columns can run continuously for the entire height of the structure, which is unusual in New York buildings, where setbacks are common. In 5 Times Square, the system was viable because the setbacks are limited in scale and location.

Unlike a true tube, however, the system "was modified to open up the column spacing along the east-west faces of the building," Brazil said. The steel columns are 10 ft. on center along the north-south faces and at the ends of the east-west faces, and 30 ft. on center in the middle of the east-west faces, where the loads are smaller. The columns are linked with W36 girders around the entire perimeter.

The spacing created two channels in which the columns, particularly those at the corners, are larger than those in the middle, in order to stiffen the structure more efficiently. Because of the loads they must sustain, as well as an unbraced length of 22 ft. at the ground floor, some of the columns at the base of the building weigh as much as 1,000 lbs. per foot.

The spandrel beams are 3 ft. deep and are hidden behind opaque curtain wall panels, while the remaining floor height contains windows offering views of various parts of the city.

Photos this page: Courtesy of SCE/Shmerykowsky Consulting Engineers

Column-Free Space

Practical design considerations, such as loading dock access on the building's south side, created the need to decrease the number of perimeter columns at the ground floor. The usual structural design accommodated this need by using a perimeter truss system between the second and third floors to transfer the column loads. "At this level," noted Marco Shmerykowsky, the project's former project engineer who has joined SCE/Schmerykowsky Consulting Engineers of New York, "diagonal members consisting of four 6x6 steel angles were added to the perimeter frame to create a 'belt and suspenders' system consisting of moment connections and a typical truss system." "The bottom and top chords of this hybrid system," Mr. Shmerykowsky continued "consist of the W36 moment frame girders which form the majority of the tower's perimeter frame." The walls at this level are covered by signage, so the belt system caused no loss of window space.

To maintain a column-free interior and the same floor to floor heights throughout the building, a one-story-high, 90-ft.-long transfer truss was employed along the west side of the building from the eighth to ninth floors to pick up the columns and transfer the loads to new locations. This made it possible to eliminate a series of columns below. A windowless wall on that side, where the building abuts the theater next door, furnished a convenient location for the truss.

A 500-ft.-high light fin on the building's north face slants diagonally further and further west as the building steps back and "defines the architecture," according to Brazil. To achieve this architectural feature, the engineers designed a column that slopes upward continuously through the building from the ground floor, thereby supporting the fin.

Some of the columns at the lower floors are large built up columns. The perimeter moment frames heavy built-up columns in the tower's northeast corner work well in combination with the second floor perimeter truss system to transfer the tower's northeast corner column at the second floor. "The hybrid belt truss system allowed the design team to efficiently create a column free space which looks out onto New York's famous Times Square" said Mr. Schmerykowsky.

One of the benefits of the perimeter tube system is that it reduces the steel tonnage and number of pieces to be fabricated and erected. The columns spaced 10 ft. on center were built as "trees," prefabricated with half a beam welded to them at four locations. The only fieldwork necessary was the shear plate connection between them. The larger span members for the frames were shipped as separate columns and beams, but all connections were bolted, thus requiring minimal welding in the field.

Additional Construction Challenges

"The tight nature of the site and the close proximity of the subway lines to the building's foundations created a situation where it was not feasible to install the transformers in the more typical sidewalk vault spaces" noted Mr. Shmerykowsky. Consequently, it was decided by the design team to place the six vaults and network protector rooms on the third floor. "The solution," Mr. Shmerykowsky noted, "was to create a cradle of W16 and W21 beams spaced roughly 5'-0" on center which would support the massive concrete box structure dictated by Con Edison requirements."

A perimeter wind frame is not typical, noted Pat Muldoon, project executive with AMEC Construction Management. Although it eliminates the core bracing, it adds columns, and is therefore more difficult and time-consuming to erect. Because of the building's geometry, no two floor layouts were the same, he added, so very few of the pieces were the same.

Ensuring correct detailing was a major undertaking. Prior to beginning the job, the steel detailer, DOWCO Consultants, spent more than a month developing a 3-D computer model to get the geometry right and reach a higher level of comfort about avoiding misalignment in the field. The model made it possible to get an accurate dimensional representation of each floor, and to detail each individual member.

The close column spacing meant extremely tight tolerances and required plant quality assurance procedures well beyond the norm to minimize fabrication and erection deviations. More than 7,000 drawings were prepared.

In the eagerness to get started on the floor elevations, the work began before the last architectural and mechanical-electrical details were finalized. This resulted in numerous design changes during fabrication of the steel for the lower floors. But the project team focused on making the changes rapidly and there were no big delays.

Another oddity of the construction process was that the site was not ready all at once, so to meet the tight schedule, excavation on the southern portion began while a property on the northern side was still being demolished. Steel erection on the south side had already started when the foundation on the north was just beginning.

"There were concerns that this would throw the work off," Muldoon pointed out, "but it was a big benefit to start the steel early, even if it was out of normal sequence. Erection of the two basements and first six floors of the 38-story building were done before the two sides caught up with each other."

Excavation for the south side of the structure began in December 1999 and for the north side, in April 2000; steel was topped out a year later and the building was completed in March 2001.

5 TIMES SQUARE

Owner: Boston Properties, New York, NY

Architect: Kohn Pedersen Fox, New York, NY

Structural Engineer: Thornton Tomasetti, Newark, NJ

Construction Manager: AMEC Construction Management, New York, NY

Misc. Iron: Skyline Steel, Brooklyn, NY

Structural Steel Erector: Falcon Steel, Wilmington, DC

Metal Deck Erector: A.C. Associates, Lyndhurst, NJ

Photos these pages: Courtesy of SCE/Shmerykowsky Consulting Engineers