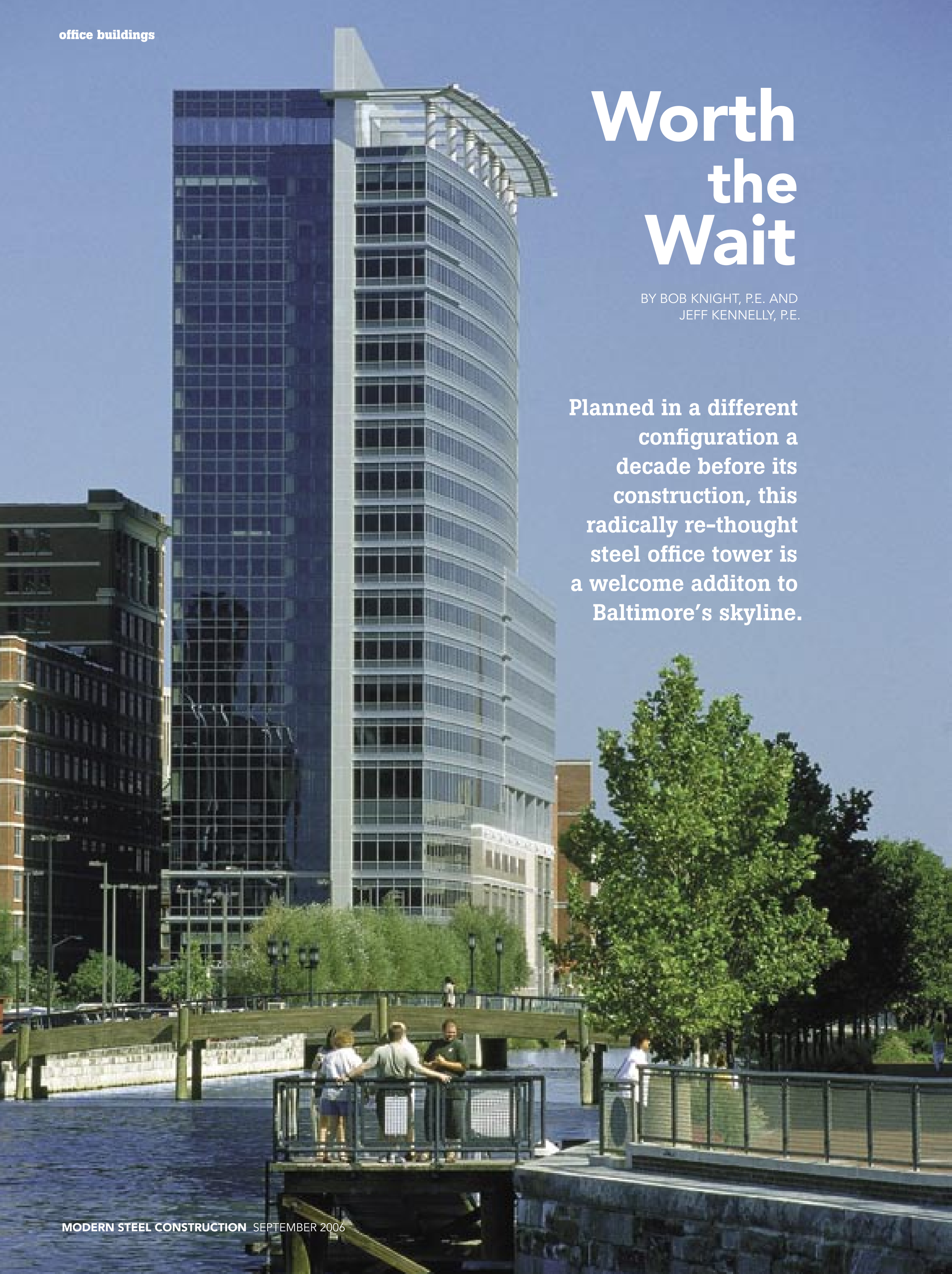

Worth the Wait

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Planned in a different configuration a decade before its construction, this radically re-thought steel office tower is a welcome additon to Baltimore's skyline.

AN OFFICE TOWER WAS ALWAYS PART OF THE PLAN TO TOP THE BALTIMORE GAS AND ELECTRIC (BGE) SUBSTATION FACILITY AT 750 E. PRATT ST. The substation was placed in service in 1990 to serve a projected growing demand for electricity from downtown Baltimore's business and residential customers.

The original project program, conceived in the late 1980s, called for three phases of construction as follows:

- A 3-story podium facility housing the electrical substation at the north end of levels 1, 2 and 3, including the transformer yard, switchgear, reactors, capacitors, and a loading dock.
- A 22-story speculative office tower facing Baltimore's Inner Harbor constructed above the south end of the podium. Public lobbies and office circulation functions were accommodated in the southern end of the 3-story podium structure below.
- A future 3-story vertical expansion of the substation above the north end of the podium to serve predicted future rising demands for energy.

Phase 1 Construction

The 65,000 sq. ft Phase 1 substation is framed with structural steel and concrete floor slabs on metal deck. Schematic-level design studies were completed for future Phases 2 and 3 in order to incorporate critical aspects of future construction into the Phase 1 podium design. Ground floor transformer layouts did not align with anticipated office grids, leading to steel transfer girders at level 3 for support of future office tower column extensions. The original lateral load design for the building's short direction, which was governed by wind, relied primarily on two 28-ft-wide braced frames that would extend vertically through the Phase 2 tower. In addition to the braced frames, rigid moment frames were also required to control uplift and drift values. Since the transformer yard has a 42 ft floor-to-floor height, controlling lateral drift in this area posed a challenge. Concrete-encased columns as large as W14×730, coupled with 21-ft-deep concrete link beams spanning between these columns, provided the required stiffness for this tall, storied space.

While the substation facility was completed and opened on schedule in 1990, plans for the office tower were put on hold due to the commercial real estate recession that occurred in the early 1990s. Later in the decade, with a strong economy and increasing downtown electrical demand, BGE began to look at expanding the 750 E. Pratt St. substation facility. In 1998, as BGE designers were beginning their expansion studies, a local developer approached BGE about acquiring the air rights above the substation to build an 18-story office tower.

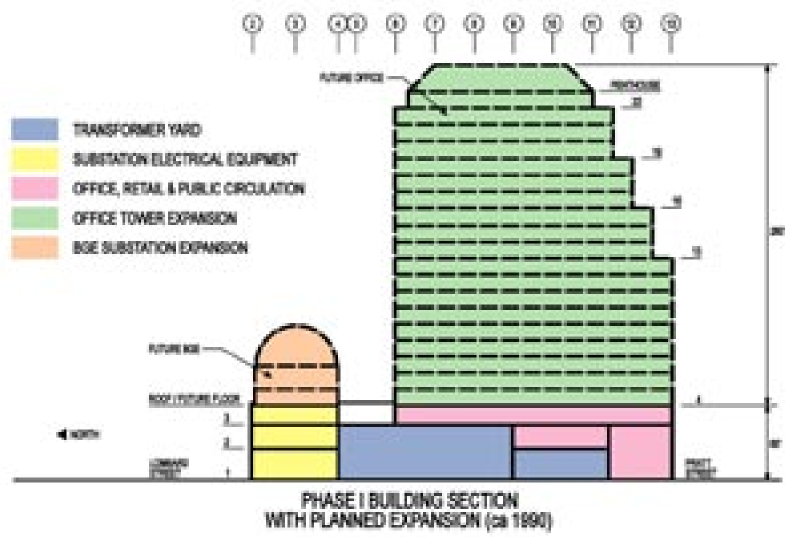
An air rights development agreement was reached and RTKL Associates Inc.—architects, structural and MEP engineers for the original substation and expansion concepts— was retained by the developer to commence design studies for an office tower as well as the BGE substation expansion.

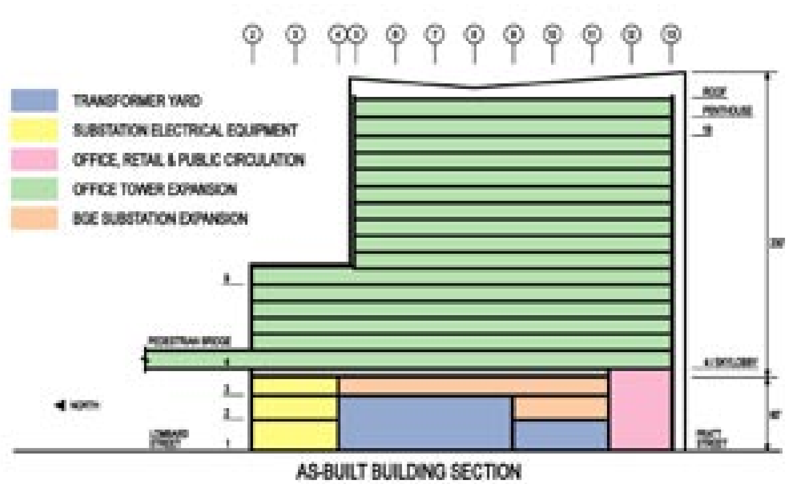
Change in Plans

Although the existing podium structure was designed to accommodate an office tower as well as vertical expansion of the substation, there were substantial changes in the final program and building requirements relative to the schematic design assumptions made in the 1980s. Some of the more significant design challenges created by these changes include:

The original office tower design was based on 19,000 sq. ft floor plates stacked at the south end, with several setbacks with height along the south face. Current office market conditions demanded larger floor plates; ideally on the order of 25,000 sq. ft. Because of this, the tower footprint needed to extend further north than originally planned, with portions of the tower located above podium structure that was not designed for the higher loads.

The northerly expansion of the larger office footprint interfered with the originally planned location of the three-story vertical substation expansion. This led to the requirement that BGE expand its operations within the existing second- and third-levels of the podium structure; spaces that were originally designed to accommodate pub-





As originally planned (top), the office tower footprint did not encroach on the electrical substation. As built (bottom), the office tower has a much larger footprint.

lic commercial spaces and office tower M/E equipment. Resulting modifications included substantial structural reconfiguration and reinforcing, additional fireproofing, provisions for adequate cooling and ventilation, and installation of electromagnetic shielding to protect office tenants above.

The original design schemes called for a 40-ft-wide gap between the future office tower and the BGE vertical expansion. This space was allocated to house BGE's cooling towers at the third floor of the Phase 1 podium structure. With the northerly expansion of the final office footprint, these cooling towers had to be relocated to the roof of the new office tower. Scheduling of this major equipment move was driven by seasonal energy demand constraints.

The original tower footprint conceived in the 1980s was planned as rectangular. In response to architectural concerns regarding the height and mass of the highly-visible east facade, this face was revised to a curved shape (in plan). As a result, five columns along this face no longer aligned with existing podium columns below. Two of the columns were at an existing open courtyard structure, and thus had to be demolished. The other three columns were located above the existing substation structure which had to remain. Column offsets ranged from 1 ft to 3 ft 6 in. The solution involved encasing the existing steel column below with concrete that projected beyond the column above. The existing columns were effectively converted to composite concrete columns which were designed to resist the eccentric loading from offset columns above. The overall resulting moment was resolved as a couple, resisted by horizontal forces distributed to the third and fourth floors.

Both the original and final design schemes planned for a separate elevator bank to carry office patrons from the ground floor to a fourth-floor sky lobby, where there they would transfer to the tower high-rise elevators. The new tower design, however, resulted in a shift in the high-rise tower elevator and stair core. Existing third-floor framing beneath the revised tower elevator pit locations was found to be inadequate to support pit design loads. So, a new pit structure was constructed above the existing level 3 slab.

Tower Construction

The 350,000 sq. ft office tower floor construction consists of composite steel beams supporting 2 in. steel deck with 3-¼ in. of lightweight concrete topping to achieve a 2-hour fire rating. Filler beams are typically W14×22 spaced at 8 ft 4 in. spanning 30 ft. Girders span the short direction of the building and are typically W24 members, although heavy W16 girders are used at the center bay to accommodate HVAC distribution below these beams. Rigid moment frames occur at select locations, with member sizes as great as W36×150.

Office floors were designed for a 100 psf live load for beams and girders. Columns, transfer girders, and foundation elements were designed for a 50 psf live load plus 20 psf for partitions. The basis of these criteria was two-fold: first, to allow tenant flexibility for localized areas of higher-than-usual office loading; e.g. at law libraries; and second, to maximize the available capacity of existing column and foundation members in the podium structure for support of new tower gravity and lateral loads. The Phase 1 podium and planned expansion concepts were designed based on the 1984 BOCA Code, while the eventual Phase 2 office tower was designed based on the 1996 BOCA Code. Per the 1996 BOCA Code, the building was excluded from seismic requirements for the building's lateral force resisting system.

The office tower program included an enclosed pedestrian bridge at the north end of level 4. The bridge structure spans 90 ft over a major downtown street and connects to an existing parking garage. The east face of the bridge has a concave-curve shape (in plan), contrasting with the convex-shape of the tower's east facade. This shape induced torsion into the bridge structure. The structural and aesthetically driven solution was a vierendeel box truss; that is, vierendeel trusses at the horizontal and vertical faces. The bridge was largely assembled on-site, and then lifted in one piece with a single large crane.

Capacity Dictates Design

The architectural massing and height of the tower was largely governed by structural capacity-related constraints. While the tower was originally planned for 22 stories, several factors lead to the final design for an 18-story structure,

First, there was a substantial increase in lateral wind pressures between the 1984 and 1996 BOCA Codes.

Second, larger office floor plates along with a reconfigured interior layout (i.e. cores) led to a revised lateral load resisting system and system load paths.

Increased wind load effects on existing caisson foundations (due to the factors previously mentioned) played a significant role in determining construction limits for the new tower, including bearing and uplift capacities as well as lateral translation limits in the relatively loose soils. In addition to taking several new borings, the geotechnical engineer reviewed existing boring logs and inspection reports from the Phase 1 construction, and was able to justify an increase in the allowable caisson bearing capacity from 100 ksf to 150 ksf. The outcome of this investigation generated additional foundation capacity, which was particularly beneficial for caissons beneath the 40-ft-wide zone where no vertical expansion was planned.

Lastly, the north end of the podium was designed to accommodate a 3-story expansion of BGE's substation, including provisions for heavy equipment loading. With the lower design live loading generated by office usage along with the increased caisson bearing capacity, six new office levels were constructed.

Architectural Design Challenges

The Phase 1 substation building is clad in granite, with metal and glass accent panels, all backed by precast concrete panels. Precast concrete was utilized for fire resistance and, perhaps more importantly, to combat the potentially dangerous effects of electrical equipment failure. The original 1980s architectural design concept for the tower leaned towards postmodernism, drawing from local architectural history and surrounding buildings. The concept renderings depicted a precast and granite skin, with punched windows and setbacks along the south face similar to those of neighboring buildings.

When the project resurfaced in the late 1990s, a new RTKL architectural team decided to bring a fresh perspective to the tower design. The building is located at a highly visible, specially zoned high-rise district, at a strategic entrance to the Baltimore Harbor Redevelopment Zone. The east wall of the tower is not obscured by intervening buildings, allowing unobstructed clear views of up to 600 ft of this facade. The team decided to bring a more modern look to the building, employing a curtainwall and metal skin. The designers wanted to emphasize the tower as a gateway to the downtown business district, introducing the curved wall at the east face, thus softening the facade and making it seem less like an obtrusive wall.

Rooftop Eyebrow and Screening

Perhaps the most defining feature of the design is the rooftop cornice or "eyebrow" structure that caps and overhangs the curved east face of the building. Architecturally exposed structural steel (AESS) requirements were utilized for this exposed trellis-type framing. Primary members are HSS28×24, and typically cantilever about 15 ft to the east off of exterior building columns. The southeast corner cantilever condition is nearly 28 ft long. RTKL worked closely with the contractor and fabricator in developing erection-friendly connection details for this precarious construction.

In contrast to the eyebrow which consists of highly visible structural components, the architectural design conceals a large network of structural framing that support other feature elements at the tower roof. A decorative metal-clad spine wall extends nearly 30 ft above the main roof level, and appears to split the building down the center. Internal support framing for this 5-ft-wide wall structure consists of a 3-D truss assembly. The west side of the roof footprint includes a partial penthouse, BGE's exterior cooling towers, and provisions for future cooling towers. This area is screened on three sides with 20-ft-tall freestanding walls, supported by HSS horizontal purlins and diagonal bracing. The wall backup structure also accommodates a continuous walkway for staging and "launching" of tower window-washer support chairs.

Fast-Track Process

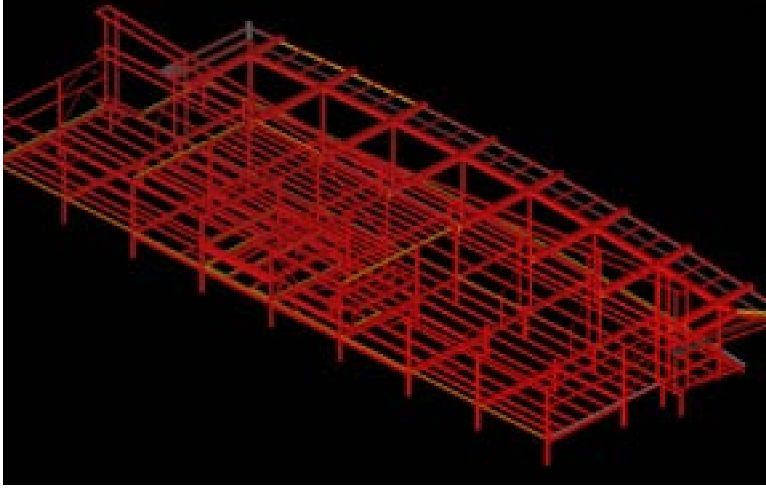
Nowadays, a fast-track design process is more the norm than not, and the 750 E. Pratt St. expansion project was no exception. Several other business district office projects were in the planning stages in late 2000, and it was critical that the office tower be completed as quickly as possible to effectively compete for prime tenants. This demanded a highly aggressive design and steel procurement schedule.

RTKL was released to commence structural design in November 2000, and an early steel bid package was issued in late February 2001; bid drawings for other major disciplines (i.e. AMEP) were issued 14 weeks later, in June 2001. Based on the early steel bid drawings, Whiting Turner—the General Contractor—selected Allstate Steel as the fabricator for the project. Moving forward, the contractor, fabricator and design team worked together closely through a series of meetings to track the progress of the design for balance. The design team identified areas where the structural design was incomplete and, to the extent possible, RTKL prioritized their design process to respond to Allstate's proposed fabrication and delivery schedule. With some give-and-take by all parties, the process was successful, focusing on the needs and time constraints of each project participant.

Design and Detailing Software

RAM Structural System was used to design the building frame, including all gravity and lateral analyses. While the original Phase 1 podium was not designed using RAM, the design team easily constructed the overall computational model to incorporate the entire building frame. RAM was used to identify overstresses in the existing construction due to the unplanned expansion of BGE's equipment. A separate RAM model was used to design the complex framing above the penthouse level; i.e. for the eyebrow, screenwall and spine walls. This saved a significant amount of computational time for the basic building frame model.

Steel detailing was performed with SDS2. One of the challenges for a fast-track project using the latest 3-D steel detailing software is that the detailer needs to have all the dimensions before the shop drawings can be generated. In the past, shop drawings could be developed with some incomplete dimensions, then forwarded for approval. The engineer would then provide missing dimensions based on final interdisciplinary coordination and detailing. This created a challenge for the design team to stay ahead of the detailer's need for dimensions, as the structural drawings were more than three months ahead of the AMEP shell drawings. The response to this challenge was for the detailer to create their 3-D SDS2 model in separate segments. This allowed provision of final dimensional information from the design team to be phased along with the detailing. Shop drawings could then be submitted for review in sequences before the entire SDS2 model was generated.



The roofop "eybrow" features HSS28×24 primary members that typically cantilever about 15 ft to the east off of exterior building columns.

The 750 E. Pratt St. substation and office tower project was successfully completed despite a decade-long delay and substantial changes to the original expansion design concepts. Structural steel was clearly the appropriate framing selection for this project, for all phases of work. Renovations and structural reinforcing within the Phase 1 podium were readily accommodated due to the inherent flexibility of a steel-framed structure. The aggressive schedule was met as a result of an accelerated fast-track process, along with the cooperation of all project team members.

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