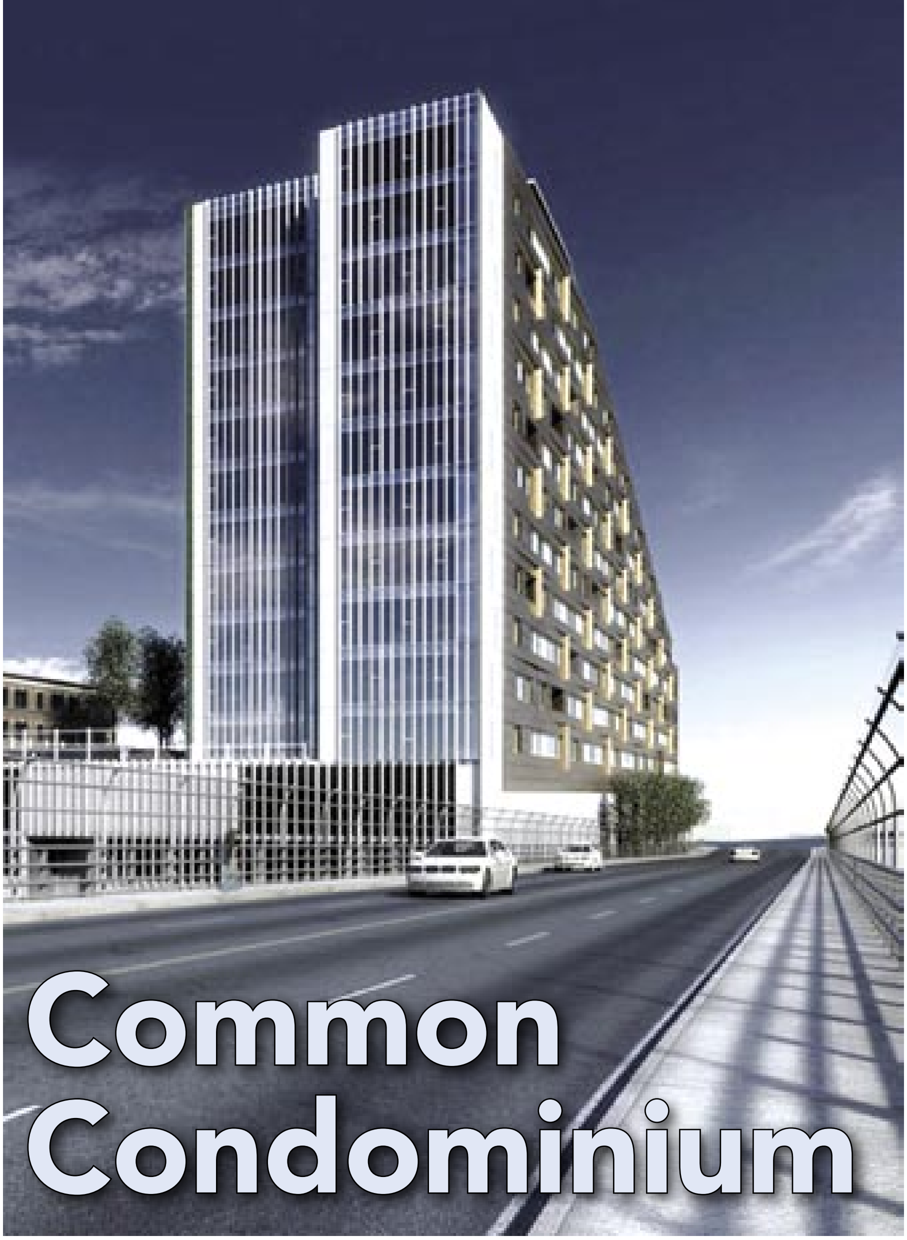
Extensive coordination within the design and construction team produced this progressive condominium project in Boston.

Curing the Common Condominium



BHCH, LLC

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THE MACALLEN BUILDING CONDOMINIUMS IS THE SECOND PHASE OF A DEVELOPMENT AT THE END OF THE FORT POINT CHANNEL. Conceived by Boston-based Pappas Enterprises, the building contains 150 luxury condominium units, parking for 280 cars, a public and private pool, an elevated ½ acre accessible landscaped terrace and a ½ acre sloping garden roof, among many other distinct features.

The building footprint is approximately 45,000 sq. ft. In addition to a subgrade parking level for one half of the eastern footprint, there are three full-footprint levels of parking. The parking garage consists of cast-in-place concrete flat plate slabs supported vertically by reinforced shear/bearing walls and reinforced concrete columns. In addition to the parking spaces, the garage contains storm water retention tanks, the main lobby, four multi-level live work units, bike storage, and all the major mechanical equipment for the project.

The residential portion of the building is 11 stories of steel-framed construction on an approximate footprint of 25,000 sq. ft. The remaining 20,000 sq. ft is a structural steel and composite concrete-slab-supported landscape terrace with lap pool above the northern section of the garage and is accessible to all unit owners.

The building is approximately 375 ft long at the south façade. The building is typically 65 ft wide, but expands to 125 ft along the east façade. In section, the building is six stories at the east façade, four of which are steel framed, and 14 stories at the west façade, 11 of which are steel framed. The roof slopes at a constant rate of approximately 18 degrees from east to west and is covered with a garden roof.

The north and south façades of the building are a metal panel rain screen sys-

The Macallen Building project features a total of 35 trusses spaced at 36 ft o.c. and spanning 64 ft, 4 in.

tem detailed to replicate the weave of a basket. The east façade is a brick veneer cavity wall. The west façade is a curtain wall. There are also sections of corrugated metal panel in various locations throughout the façade.

Simpson Gumpertz and Heger Inc. (SGH) is the design engineer, structural engineer of record, and a consultant to the architects for the detailing and specification of the many building envelope components, including the garden roof.

System Selection

The project ideas developed by design architect Office dA and Pappas Enterprises were presented to the structural engineer and construction manager at an early project meeting. Ideas regarding potential structural systems were reviewed based on cost of construction, ceiling heights, speed of construction, historical material paradigms in New England, building reactions on the required deep foundations, and overall ideas about the architectural and owner goals for both the interiors and exterior façade. The team considered seven potential structural systems and material combinations. Structural analyses of a representative three-bay section of the full building height for each of the seven choices were valuable in selecting the final system for the project. Schematic framing diagrams, typical wall sections, and a material quantity memorandum were developed for cost considerations by the construction manager. During this time, the Boston office of Burt Hill was engaged to serve as the architect of record and the MEP/FP engineer of record.

Subsequent meetings were held to evaluate the conclusions from this preliminary work and resulted in the team choosing a hybrid of the original seven choices. The team settled on a staggered steel truss framing system with a composite beam/slab floor system spanning between truss chords. The staggered truss system resulted in multiple advantages, including: a significant reduction in transfer girders above the parking garage; alignment with the previous architectural proposal to stack shafts but stagger unit types; and the expansion of living unit types, which provided greater variety for the owner to market. Architecturally, the trusses are represented in the façade by fins at each truss location incorporated into the exterior metal panel system.

The early efforts by the design team to evaluate a variety of structural systems with consideration given to the foundation as well as the architecture, coupled with the costing process by the construction manager, resulted in an effective framing system that withstood the test of many subsequent value engineering reviews.

Staggered Steel Truss

The staggered steel truss system is a framing configuration with application to long, rectangular plan buildings. Floor deep trusses span between exterior column lines. Adjacent trusses are vertically "staggered" such that the floor framing spans from the top chord of one truss to the bottom chord of the adjacent truss. The next floor bay spans from the bottom chord of the truss to the top chord of the adjacent truss. This system is repeated through the length and height of the building to provide a column-free interior. Additionally, the story-deep trusses act as staggered braced frames to resist lateral loads parallel to the longitudinal axis of the truss. There

Two trusses are exposed within the living units at the east end of the building. They provide a visual barrier between the kitchen and the rest of the open floor plan.

is a higher shear demand in the plane of the diaphragms of such a building, but careful consideration of the floor framing and slab details is sufficient to maintain the cost efficiencies of the structural steel framing.

The Macallen Building project features a total of 35 trusses spaced at 36 ft o.c. and spanning 64 ft, 4 in. This results in interior column-free modules of approximately 64 ft by 72 ft. The trusses are comprised of W14 top and bottom chords with HSS web members of varying size. Each truss has seven panels including a central vierendeel panel at the corridor. Two trusses are exposed within the living units at the east end where the building widens in plan. These are designed to provide an interesting visual barrier between the kitchen and the rest of the open floor plan.

Typical ceiling heights in the units are 10 ft, 4 in. within the 11 ft, 1 in. floor-to-floor height. During the development, SGH prepared 13 gravity floor framing systems for a typical framing bay between truss chords for review and consideration by the architects and owner. The studies included numerous combinations of typical and long span composite metal deck with varying thicknesses of concrete topping. The studies also included typical clear ceiling heights between floor beams and under the soffited beams, steel tonnage comparisons and total piece counts. After a careful review, the final choice consisted of 3¼ in. of lightweight concrete over 2 in. composite metal deck. Beams are typically 1¼ in., cambered W16 sections with three equal spaces at the north and south sides of 8 ft, 9½ in. The center span at the corridor is 11 ft, 7 in. The spacing was carefully scrutinized during development to maximize the tallest ceiling heights and reduce conflicts with vertical shafts. Again, extensive communication and coordination among the design consultants resulted in a mutually agreeable framing system that was able to maximize ceiling heights, unit layout, and structural efficiency.

The trusses span the short width of the building and are supported by W14 columns along the north and south facades. These columns are oriented with their webs perpendicular to the longitudinal axis of the trusses and serve as a part of the ordinary moment resisting lateral load system in the long direction of the building. In a staggered steel truss building, the substantial accumulation of dead and live load in the trusses is the predominant load case. In only a few instances were the columns required to be increased in size for additional lateral stiffness requirements or to eliminate panel zone detailing requirements due to seismic forces.

During initial project analyses and drawing production, SGH used the equivalent lateral force procedure for seismic analyses. However, steel prices changed as the project moved forward and, as a result, the perceived structural costs began to adversely impact architectural items on the project. An evaluation of the structural analyses indicated that a significant portion of the lateral seismic loading in the upper 11 stories of the steel frame was due to the mass of the three-and-one-half-story concrete garage structure. SGH used the RAM Structural System models already developed to perform a dynamic analysis of the building, resulting in a reduction in lateral loads at the residential level, a subsequent reduction in material quantities, and the return of the steel pricing to previously budgeted levels.

The design team performed the analysis and design of the gravity steel framing members and lateral load distribution of the full building, including the reinforced concrete shear walls in the garage, using the RAM Structural System. RISA 3D was used to design and optimize the steel trusses as well as study the impact of various truss boundary conditions to represent diaphragm flexibility in the plane of the lateral loads. RISA 3D, Microsoft Excel, MathCAD and hand calculations supported the analysis of the many secondary structural steel members required to support the various façade details and landscape structures.

Structural Design and Detailing

The aggressive owner-driven goals for this project, including the architectural and environmental strategies, provided for some unique design and detailing conditions not typically encountered in multi-family residential projects. The roof of the building beginning at the sixth floor at the east façade slopes up at approximately 18 degrees to the roof of the 11th floor. The sloping roof is covered by a garden roof system. Additionally, 11 private terraces are "sunken" into the roof, resulting in unique multilevel living spaces for the penthouse triplex units.

Working closely with Burt Hill and Office dA, SGH was able to develop a system of W6 steel beams to support composite metal deck on the bottom flange and be cast into the depth of the sloped-to-drain concrete terrace slab. This allowed the finished wood decking to be flush with the adjacent interior finish floor and be properly waterproofed, while maintaining the ceiling heights required in the units below.

Other designs, details, and coordination for the building included numerous relieving angle support details for the staggered brick panels at the east façade, cantilevered steel framing for the north and south wing walls adjacent to the brick façade, steel railing supports at the 17 balconies on the south façade, steel framing at the fifth floor continuous glass railing, design and detailing of exterior exposed structural steel for the terrace pool deck and cooling tower enclosure, design and detailing of the private penthouse pool and 45-ft operable skylight, and even designs and details of HSS tube cantilevers from the light gage partition walls for support of the bathroom vanities.

Fast Track Structural Packages

During the design phase, the developer determined that a fast track issue of the structural packages was necessary to maintain the completed construction delivery date. Such a process puts extreme demands not only on the structural engineer, but the entire design and construction team. Office dA had already embedded employees full time in the Boston office of Burt Hill. Additionally, the entire team was regularly attending almost full day meetings every Monday. In an effort to expedite and improve coordination on the project's complex detailing, SGH worked at least one additional full day with the architects each week in the offices of Burt Hill. This combined effort allowed designs and details to be expedited and improved overall coordination in response to delivering early structural packages.

SGH issued foundation and superstructure packages five months in advance of the final issue of the construction documents. With some items, including the penthouse pool and operable skylight, the terrace pool, and miscellaneous façade issue on the south elevation, still developing, SGH clearly marked these areas of the structural drawings "for pricing only" with additional scope notes to supplement the remaining coordination and detailing. SGH issued monthly addenda during the period between early structural packages and the construction documents so as to continually update the drawings and increase the areas released for fabrication and construction. The team effort in physically working together to coordinate the details and keep each other apprised of potential changes resulted in minimal change to the final steel price and no structural change orders after the construction documents were issued.

Shop Drawings and Construction Administration

Part of the success of any project is the continuation of the team effort in communication and coordination into construction. The New England division of Cives Steel was selected by the Construction Manger, Bovis Lend Lease, to fabricate the almost 1,800 tons of structural steel for this project, including the numerous steel details noted previously. SGH and Cives opened a direct line of communication early in the project and worked quickly to prepare, submit, review, and return shop drawings for fabrication.

Structural addenda, regularly issued in the period leading up to the issue of construction documents, reflected not only the updated details of the previous unreleased areas, but also incorporated the responses to RFI's so as to reduce confusion. SGH answered and returned RFI's during the steel fabrication process, on average, in less than 2½ days from time of receipt. This included weekends. Phone lines in both directions were always open and used to keep the process moving forward. Continued coordination with the architects and the fabricator was critical to keeping the process moving quickly and accurately. This effort paid off when the structural steel was topped off weeks ahead of schedule. The completed building is on schedule to open to the first residents in January of 2007. MSC

Owner
Pappas Enterprises, Boston

Structural Engineer
Simpson Gumpertz and Heger Inc., Boston

Architect of Record
Burt Hill, Boston

Design Architect
Office dA, Boston

Construction Manager
Bovis Lend Lease, Boston

Steel Fabricator
Cives Steel (AISC member)

Structural Design Software
RAM Structural System
RISA 3D