Massachusetts **Mid-Rise**

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Photo by Robert J. McNamara III.

Creative use of steel framing permitted a tight site in Cambridge, MA to accommodate 315 apartments, 235 parking spaces, and on-site flood-water storage.

Cambridge Park Place in Cambridge, MA is a 315-unit market-rate apartment complex located directly on Boston's "Red" commuter line, three stops from Harvard Square. Fifteen percent of its units are reserved as affordable units and 235 parking spaces exist under the footprint of the building. The complex includes retail space, common-use space and a 35′-by-50′ swimming pool within the outdoor recreational area located on a plaza above the parking level. Because it is built within a flood plain, space for 70,000 cubic feet of flood-water storage had to be found below the building footprint

Steffian/Bradley Associates of Boston successfully negotiated Cambridge's complicated zoning laws regarding set backs, site coverage and an 85′ overall height limit to provide the maximum desired program for Cambridge Park Place, LLC. In doing so, eight levels of housing were fashioned within two adjoining wings, giving approximately 458,000 sq. ft total. Each wing is served by a double-loaded single corridor.

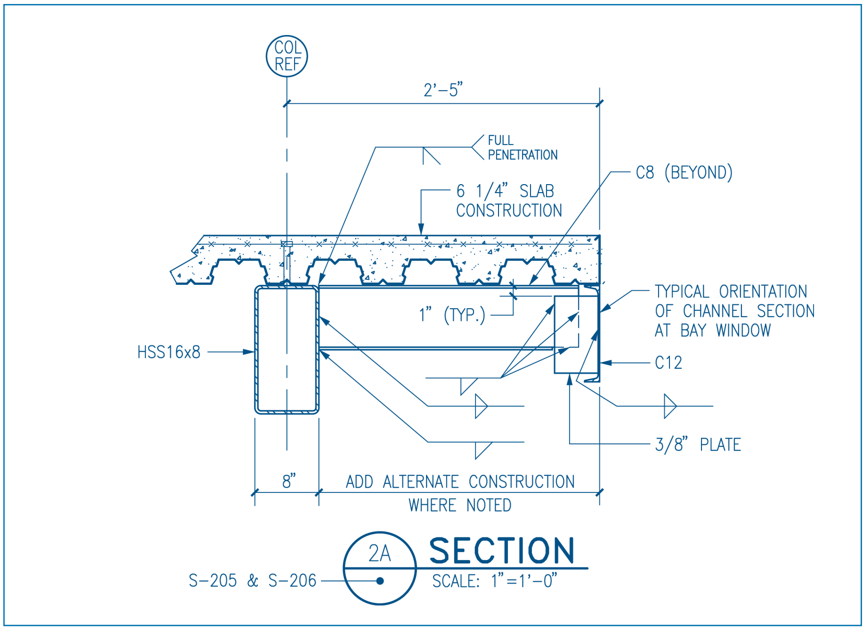
SYSTEM SELECTION

To meet program requirements, a floor-to-floor height of 9′-0″ and a 25′-6″ room module were established prior to schematic structural design. A system of precast concrete plank with CMU bearing walls was priced. The weight of this system added substantially to the foundation costs. Also, the owner could choose to extend the numerous walls into the parking area or transfer them at the plaza level.

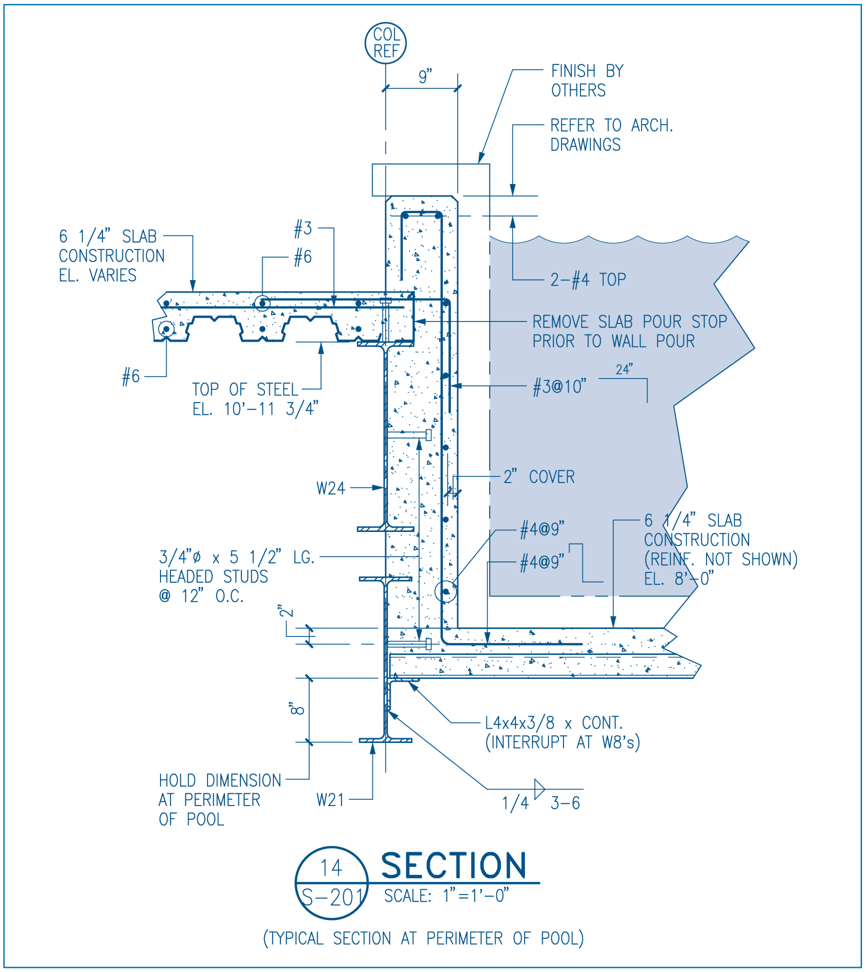
A system which used staggered steel trusses with a precast-plank flooring was also studied. The steel trusses virtually eliminated transfers, lightened foundation requirements, and provided a very efficient lateral-load resisting system. However, the irregular plan layout which resulted from the zoning vs. program exercise favored a more traditional steel framing design. The preliminary pricing provided by Corjen Construction showed that the tight budget and phased construction requirements could be best achieved with a complete structural steel design. The building is supported by 461 134-ton, 14″-square precast concrete piles driven to glacial till or bedrock. Their average length was 110′.

A TIGHT FIT EVERYWHERE

With only 9′-0″ floor-to-floor, maximizing ceiling height was a primary concern. Each "wing" of the building was framed using compositely designed W12 members at 12′-9″ on center. The two-hour fire-rated floors consist of unshored 3″ by 18 ga. composite metal deck with 3¼″ lightweight concrete cover. The framing members align with the primary partitions, giving a 8′-4″ ceiling in the room "bays" between members. McNamara/Salvia, Inc. worked very closely with Steffian/Bradley Associates to coordinate the main mechanical runs within the ceilings. The routing of every pipe and duct was studied to minimize crossing under framing. Each plan reflects this route, where W10 members were substituted for W12s. Only two beam penetrations per floor were required. Those and every floor penetration requiring framing were shown on the plans prior to the steel bid. All the floor openings framed or otherwise were input into McNamara/Salvia Inc.'s RAM Structural System models to obtain the effect



With only 9'-0" floor-to-floor heights, cantilever bump outs for the rooms were framed with channel sections (chosen to accommodate façade detailing), shop-welded to 16"-deep HSS spandrels.



A 3'-6"-deep swimming pool is framed into the plaza level. By "upsetting" the perimeter beams for the pool-bottom framing, there was enough clearance below the pool for a bicycle storage area.

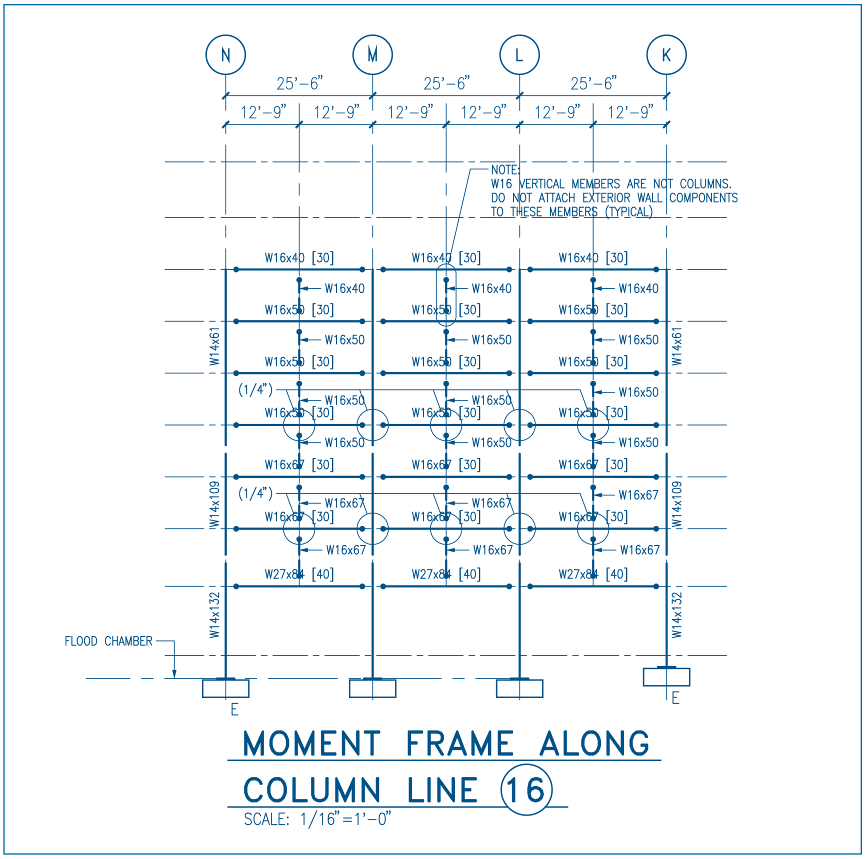
on beam cambers and composite beam action.

The 25′-6″ room module allowed for an 8′-6″ parking stall layout that when completed, required only two column transfers between the apartment footprint and the parking level below.

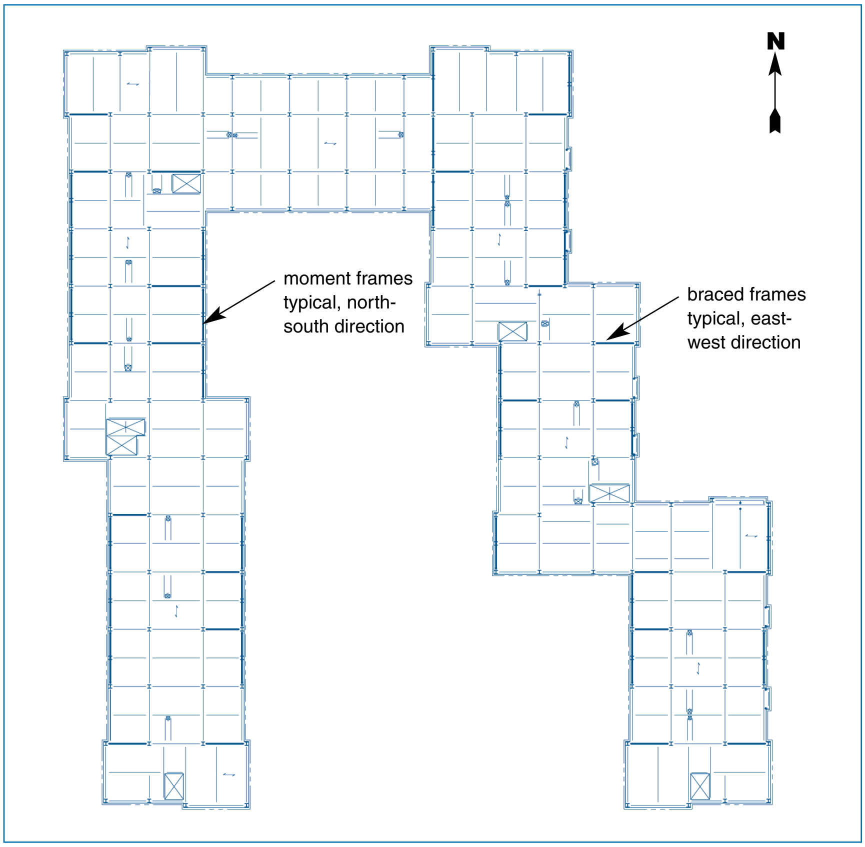
In the direction parallel to the room partitions, each wing was framed in approximately three equal spans. This located the center columns near to the end of a parking stall below, but free of the drive lane. The short spans resulted in a typical gravity floor steel weight of under 4.2 lb./sq. ft. Cantilever bump outs for the rooms were framed with channel sections (chosen to accommodate façade detailing), shop-welded to HSS spandrels.

At the second floor, the wings are inter-connected by a 51′ pedestrian bridge hung from the third floor at two places along its span. Diagonal "bracing" rods were added to give the appearance of structural support, but were installed into oversized holes after the slab was poured. All the gusset plates were detailed to show identical proportions below the ceiling line.

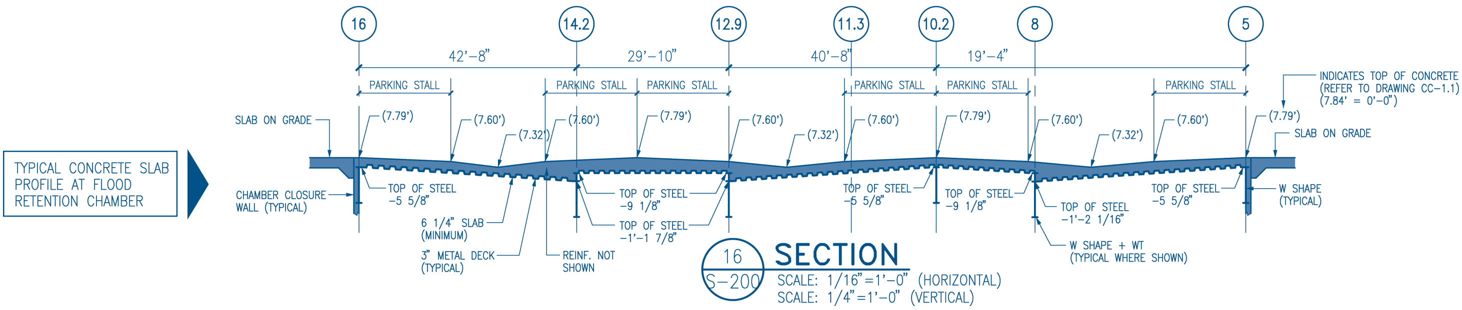
The plaza-level landscaping has planting material up to 4′ deep. Below, an 8′-2″ clear height was required to accommodate handicap parking access. To maximize efficiency of the framing sizes, this clear height was provided at a specifically marked route from the garage entrance to the handicap parking stalls near the lobby elevator. The plaza level was also designed using composite steel framing and galvanized unshored steel deck. Slab reinforcing was added and designed considering the deck as a form only. The steel was sloped to drain, and fire-protected with a medium-density cementitious coating where it was outside the conditioned space. Also within the plaza, a 3′-6″-deep swimming pool was framed in steel using composite metal deck as a form with a 6¼″ reinforced concrete slab. The pool was laid out to be framed between columns arranged for the parking layout. The perimeter girders of the pool were upset into the concrete side walls. Then, by using composite W8 members at 6′ on center, a minimum usable clear height of 6′-8″ could be provided below the pool for tenant bicycle storage.



Shear links allowed moment frames to work with the 25'-6" framing module and W16 beams.



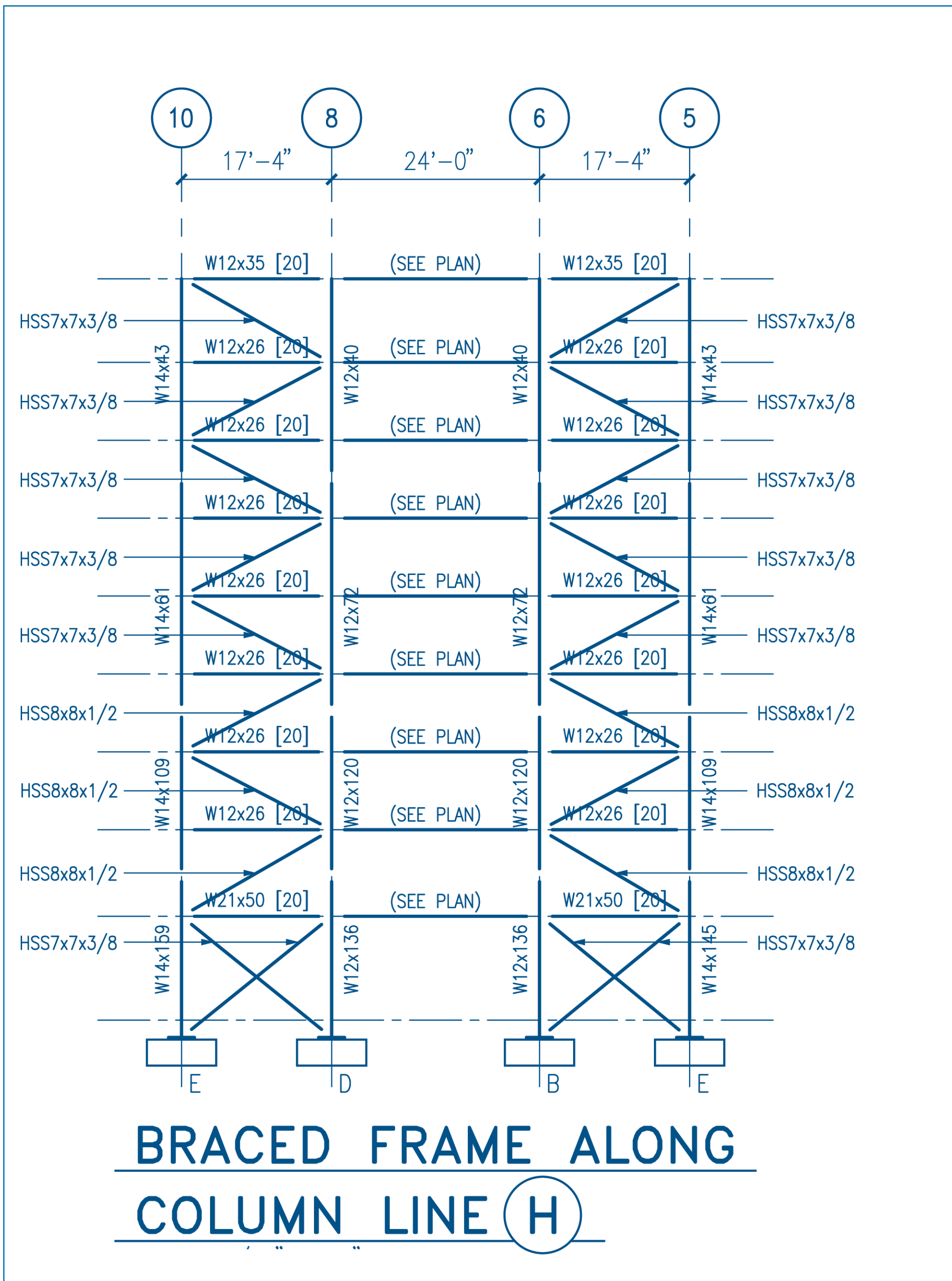
Braced frames were used when they could be concealed within permanent partition walls. Moment frames were used around the building perimeter to allow for window openings.



Above: The complex profile of the parking garage floor, which serves as the roof of the flood chamber, was more easily framed with a composite concrete slab than with concrete plank.
Below: An elevation of a typical braced frame.

70,000 cubic feet of storage space for 100-year-flood waters had to be provided below-grade on the site. At the ground level, poor soils required framed structural slabs at all "interior" spaces (e.g. elevator lobbies and mechanical rooms). At parking areas, a moderate amount of potential settlement was deemed acceptable and a 5" slab on grade was provided. The "flood chamber" was best located under a portion of the parking area within the building footprint. The shape of the chamber was conceived by the structural engineer to eliminate "extra" foundation elements and minimize the framed area. Also, by raising the top of pile caps above the base chamber grade, and using the steel framing for pile cap seismic ties, concrete grade beams were eliminated and the chamber volume maximized. Column anchor bolts were designed for the required horizontal bracing load. A composite steel and reinforced concrete slab on metal deck system was used. The possibility of a precast plank and girder system was considered but abandoned due to the complicated grading requirements of the surface. All steel members and connection materials were hot-dip galvanized. All reinforcing within the slab was epoxy-coated, and a traffic-bearing membrane was added on the driving surface. The steel elevations and overall slab thicknesses were carefully coordinated with the site grading to obtain the required storage volume below without overstressing the metal deck form. Flood waters flow into the chamber from one open end (fenced for security) at the back edge of the building.

Gravity columns were studied using W10, W12 and W14 sizes. Three different splice scenarios were exam-



ined. Due to the heavily loaded plaza level, the most economic design resulted in a splice just above the plaza with three-story tiers above. By using W12 columns in the garage, the concrete-encased columns could fit between parking stall stripes.

MAKING ROOM FOR BRACING

The building is located in a Seismic Zone 2, but the site soils are classified S4 (S = 2.0). Wind loading is based on a 90 m.p.h. wind speed with a suburban exposure. Seismic base shears are three to four times the maximum wind loads. The massing of the floor diaphragms required multiple analyses to reflect proper lateral load distribution. Each wing was analyzed separately and the results enveloped with a complete building model. McNamara/Salvia used RAM Structural System software for all the gravity and lateral framing design. The lateral load resisting system consists of perimeter ordinary moment frames perpendicular to the rooms and concentric bracing located in partitions between rooms. Because a depth limit of W16 was necessary at the apartment windows, a moment-frame system could not be reasonably provided on a 25′-6″ module. Vertical W16 "shear links" were added at the room partitions, located at 12′-9″ centers, to reduce the frame portal dimension. These members give the appearance of columns in plan but carry no gravity load. A 2″-vertical slip joint occurs at mid-height between floors for these members. The W16 girders and vertical links were shop fabricated in "horizontal trees" to minimize field welding.

McNamara/Salvia has used this system successfully on many types of projects, but the system adapts best to the module layout of housing or hotel-type buildings. If the module is short enough, the "trees" can be fabricated in two-story vertical sections. However, in most cases, one-level horizontal trees are required due to shipping constraints.

Regularly spaced and immovable room partitions provide a convenient location for lateral bracing. HSS members fit best within the partitions and met the slenderness requirements of the AISC seismic provisions for the low floor-to-floor height of housing projects. "N"-type bracing was used in lieu of chevron type to eliminate mid-span out-of-plane bracing of the beam and to minimize the piece count. Both bracing and columns were encased in concrete where exposed to automobile traffic in the garage. In two locations, the bracing was transferred laterally at the plaza level to avoid pedestrian traffic in the garage. Additional one-level concentric steel bracing was added to accommodate the local mass of the plaza landscaping.

Approximately 1,605 tons of steel were used. McNamara/Salvia Inc. has, on many projects, found this overall approach to mid-rise housing to price out less than many non-steel and partial-steel systems. Significant coordination and attention to detail resulted in the most efficient use of space and material—and a successful project. ★

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Engineering Software
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