Keeping all of the stores open was critical during renovation and vertical expansion of the this 40-year-old mall

By Howell A. Gordy, R.A.

Though still successful, the 40-year-old South Shore Plaza in Braintree, MA, was beginning to show its age. Rather than wait until the property began sliding downhill, the owners instead decided to invest in a $100 million vertical expansion and renovation.

Sumner Schein Architects and Engineers, Inc. provided site planning and full architectural and engineering services for the 200,000-sq.-ft. project. Operating within a highly condensed, fast-track design schedule, construction was completed while the mall remained in operation. Complicating the project was a basement running under almost the entire mall footprint and a 33'-wide truck delivery tunnel located under the mall concourse. Finally, the design of the original center itself proved difficult. Rather than being one large building, the mall evolved from an open-air plaza consisting of a number of separate buildings that were inter-connected and roofed over in several stages more than 25 years ago.

How would an Architectural/Engineering firm ideally approach such a project? Typically by: 1) performing an extensive survey of the existing structural conditions using as-built structural drawings as a guide; 2) using as a base the survey work and completed architectural design, prepare design drawings and specifications for bid for an existing foundation and column enhancement, and new second level steel framing; and 3) analyzing the bids and making an award to the steel contractor/erector.

Unfortunately, ideal conditions seldom exist and did not exist here. In this case, due to

the extensive nature and cost, neither survey nor design work was authorized to start until the developer was assured of project approvals from the state and local levels. In late 1994, the "starter pistol fired" and everyone was off and running for an early 1997 project completion. And everyone means everyone! Structural Design, Architectural Design and Construction all started at the same time! And running meant running...the construction schedule called for column upgrade work to support the new second level to begin immediately in the basement area only; because of the 1994 Christmas shopping season, work on the mall level could not start until after the first of the year.

The structural engineering approach was to design footing and column upgrades and determine recommended shear wall locations at the basement and existing mall levels, and design second level floor and roof framing. Since very little architectural design work was complete, the structural engineers used a conceptual master plan previously approved for permitting/development to determine which existing columns would be upgraded to carry additional loads for the new second level and where shear walls would be located to minimize tenant impact. Because architectural design information was preliminary, structural engineers were conservative in load estimates.

Basement and existing mall level columns were categorized in four ways: 1) plating existing columns to carry added loads; 2) replacing existing columns with new, heavier sizes where access and constructability allowed; 3) removing existing columns altogether where required; and 4) leaving existing columns as is where possible. Additional loading also dictated upgrading footings for each affected basement column.

When existing basement columns were to be upgraded,

(Top) Typical basement area work scene for column/footing upgrades

(middle) Basement excavation for column footing removal for new escalator pit

(bottom) Shoring existing column to replace existing footing

Shown above is the interior of the new food court on the second floor expansion. Pictured opposite is the center during construction with all retail spaces remaining open and occupied.

shoring was installed to remove the load from the columns, the column was plated or replaced, and the existing footing was excavated, evaluated as explained below, and upgraded appropriately. The shoring was removed and the affected column was reloaded when the new concrete footing had cured properly.

Details of the original mall foundation design were sketchy at best, so each time a footing was excavated, the soils testing consultant confirmed bearing capacity. As design and construction progressed, incoming field information was consistently showing that the soil bearing capacity could be increased by a factor of two. Concurrently, the structural design for the new second level was indicating loads at existing column locations also increasing by a factor of two. Therefore, in a cost savings effort and in support of the construction schedule, the structural engineer reviewed on a column-by-column basis the state of the structural design at that time and analyzed field information gathered for footing properties and soil bearing capacity. To complicate matters, this information could only be obtained in random order when the client was able to get tenant agreement allowing access to the various spaces. The structural engineers would then design reinforcement of the existing footing or decide to replace it. Likewise, not all the structural steel framing conditions encountered were built as shown in the original mall drawings. A structural engineer was assigned the task of evaluating information and reinforcement for the existing steel when necessary where actual field conditions differed from original design information. Design sketches were issued to the contractor immediately and these sketches were literally placed on the affected column to guide necessary construction modifications to resolve latent field conditions prior to formal issues of a new document. This

procedure was used for each of the approximately 400 basement columns affected. As for the shear walls, all locations were reviewed and approved by the owner's representative in coordination with the owner's leasing department. As plans and leasing efforts progressed simultaneously, shear wall placement was adjusted or eliminated according to final lease agreements. As changes in shear wall placement also affected structural steel design, the engineer was required to coordinate all of these factors while still providing drawings and guidance to support construction progress.

As steel design progressed, still another complicating factor appeared. A portion of the second level lease space was over a large mall tenant space that was previously a grocery store, and original roof steel heights were significantly higher than the new second level mall floor. It was determined that the roof height of the space could not be lowered by modifications to the existing steel. For constructability, cost savings and scheduling, a decision was made that the entire store frame would be demolished one level down to the grade level floor slab and new structural steel was erected to coincide with the second level concourse area.

As basement column and foundation construction upgrades progressed linearly down the mall, the contractor began to work on existing mall level column upgrades immediately after the holiday shopping season. Work had to be coordinated with the owner's ability to gain access to the various tenant stores, and column upgrade work was handled on a tenant-by-tenant basis. Existing columns were plated or replaced by new columns and a stub column bearing on the reinforced or new steel was installed through the existing roof to accept future new second level columns and framing. Again, existing condition modifications were resolved

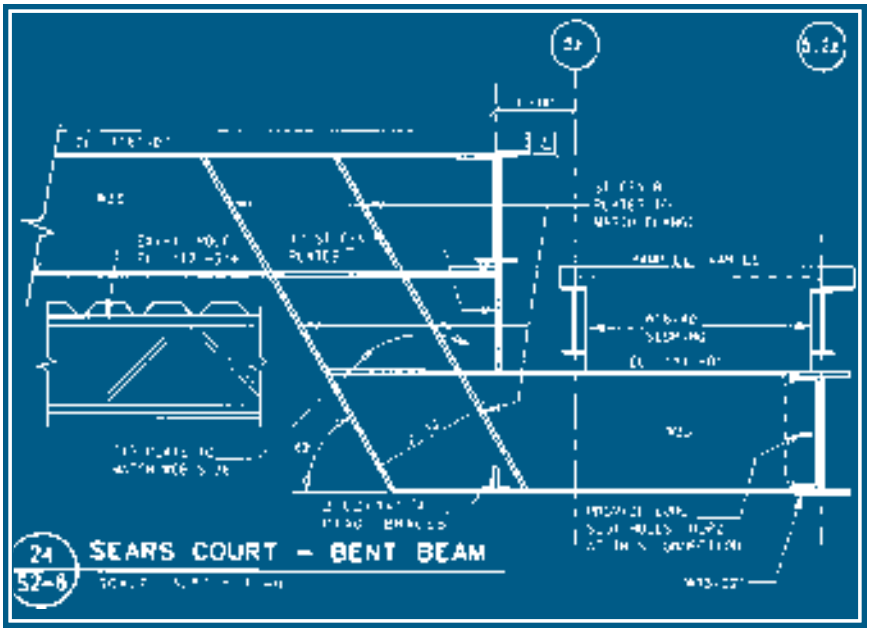
Shown is the second level framing and skylight above a workplatform installed over the existing mall first floor

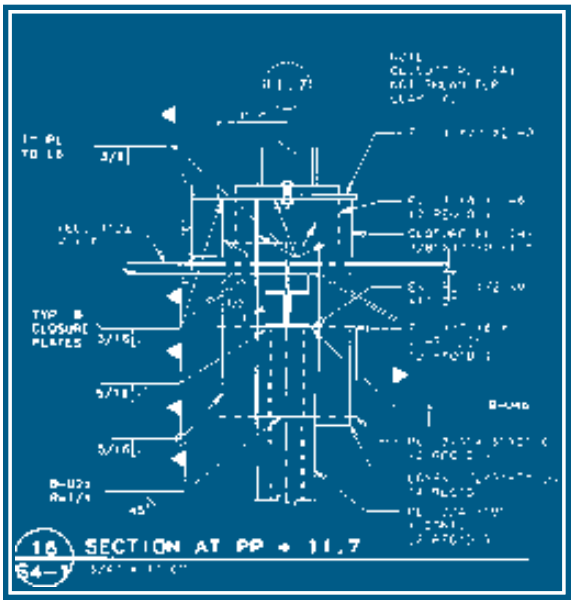
Shown are the column stubs and the new second level columns and framing in progress above the existing roof

as quickly as possible to support construction progress by assigning an engineer specifically for this task.

Although the new upper-level floor and roof design was relatively uncomplicated on paper, construction sequencing called for special structural considerations. The installation of the new roof and enclosure of the upper level progressed prior to placement of the upper-level slab. The floor slab could not be poured until all new utility systems and tenant mechanical systems were in place for the existing first floor tenants; the existing roofing material also had to be removed per fire code requirements prior to pouring the new slab. Since the new slab diaphragm was key to distributing the lateral loads from the new structure into the diagonal braced frames and shear walls which constituted the lateral load resisting elements, stability issues had to be addressed. The structural engineer worked with the client, the construction team and their bracing design engineer to develop a temporary horizontal bracing system that stabilized the structure until the new slab was installed. The bracing was then abandoned in place when the new composite slab was installed.

A key part of the architectural design for the renovation was to align the east-west axis of the mall. The structural engineers devised a new column line, which was installed to support the upper level and edge of the mall skylight. This new line was located directly over the truck tunnel. To avoid placing obstructing columns within the tunnel, and to maintain a minimum height clearance, a series of shallow built-up transfer girders were designed and installed under the grade level concourse slab. New escalators and elevators added to the concourse called for mechanical pits under the mall level to be within the truck tunnel, which necessitated close coordination with the archi-





Above: Shop fabricated "bent" beam, which spans 48', allowed ramp and upper level framing construction to occur within mall concourse space at anchor store courts. Upper portion of beam remained above existing roof construction and outside of tenant space (seven of these were used throughout the mall).

Left: Top of column splice and reinforcing detail between existing and new columns. Detail occurs at existing columns supporting joist girders.

tects. New piping for plumbing and a new central chilled water system for the mall concourse and tenants had to thread under, over and sometimes through existing and new framing members. A standard detail for steel reinforcement at variable penetrations was developed.

Throughout the steel design process, the structural engineers maintained a constant coordinated team effort with the owner's representatives and contractor to accommodate individual tenant requirements for column placement to minimize impact to storefronts, and day-to-day retail operations. There were also continuing modifications to accommodate architectural design development and mechanical systems design as that work received client approval and could be completed in accordance with a complex and integrated schedule.

The lead structural engineer maintained daily contact with the steel fabricator's detailers, to inform them of any modifications to design where steel shop drawings and/or fabrication were in progress.

In effect, the structural design was the driving factor for the project, with continuous coordination, communication, flexibility, and a large dose of patience and positive thinking as the essential ingredients. The results of the hard work are evident in the finished product, opening on schedule, with participants still speaking with each other, recognizing the dependency of each on the other.

As a result of this process, the project was complete within 27 months, allowing the new retail tenants 6 - 9 months of additional operations, in comparison to a normal schedule of 36 months for this type of work.

Howell Gordy, R.A., is a vice president and project manager with Sumner Schein Architects & Engineers, in Cambridge, MA.

PROJECT TEAM

Architect & Engineer:
Sumner Schein Architects and Engineers, Inc.,
Cambride, MA

Owner:
Corporate Property Investors,
New York City

Fabricator: (phase I new upper level & roof)
General Steel Fabricators, Inc.
Latham, NY

Fabricator (braced frames):
East Coast Steel,
Greenfield, N.H.

Fabricator (misc. existing structure upgrade and parking structure bridges):
American Architectural Iron,
Boston, MA

Erector:
Prime Steel Erecting, Inc.,
N. Billerica, MA

General Contractor:
Beaver Builders, Inc.,
Newton, MA