

Lessons in Multi-Story Residential Construction

Challenge convention and consider the benefits of structural steel for your next multi-story residential project.

BY TODD A. ALWOOD

WHAT'S LEFT TO SAY ABOUT MULTI-STORY RESIDENTIAL BUILDING CONSTRUCTION?

This question was answered when I was having dinner recently with an old college friend. A practicing architect in Chicago, he was talking about his current project—a large condominium building on Lake Michigan. When I asked if his project team had looked into steel as the structural material, he answered, “Steel is for offices, concrete is for residential.”

That statement made it clear that there are still many misconceptions about steel-framed multi-story residential projects. Structural steel does accelerate construction schedules and lower overall costs for office structures, but the same is true for steel-framed multi-story residential buildings. Structural steel framing:

- Reduces foundation costs;
- Increases speed of erection and allows for all-weather construction, which generates earlier revenue from earlier occupancies;
- Allows for longer spans with fewer columns, which provide more useable clear space; and

AISC's Steel Solutions Center (SSC) has worked with owners and design teams to create several successful steel-framed multi-story residential projects. Each one holds a lesson in looking beyond convention to see benefits in selecting structural steel.

Keep it Simple

A year and a half ago, the SSC was asked to prepare a conceptual solution for a mixed-use project in Boise, Idaho that featured four levels of parking with seven levels of hotel space. The two uses were designed almost independently of each other, which required a large and very expensive transfer level. The total construction budget was well above the owner's initial expectations.

A staggered truss system was developed as the most effective and flexible structural solution for the two building uses, with minimum modification to the architectural layout. The trusses were designed to span the width of the hotel so that columns would be located only at the building's



Structural steel framing with precast plank floors shaved months from the schedule and decreased floor depths for the 300-unit Alexan at Lenox apartment building in Atlanta.



The Seven Bridges condominium development in Woodridge, Ill. economically maintains low floor-to-floor heights.

exterior perimeter. The 62'-0" truss spans were the same width as the parking configuration (two 18'-0" parking spaces and a 24'-0" drive lane), which eliminated interior hotel columns that had previously interfered when they carried down into the parking layout. This steel reconfiguration eliminated the transfer level.

Column locations were reduced and a transfer level was eliminated by changing the structural system to steel. The number of foundations was also reduced, and the remaining ones decreased in size.

Thin is In

A hotel located in the Midwest was being de-



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signed as a two-way flat-slab with concrete shear walls. Floor-to-floor heights were a major concern, along with tight site constraints.

The engineer and architect explained that the layout was already set, and the column locations could not change. The engineer wanted to keep the concrete shear walls for the lateral system, so they only needed to look into a possible gravity system.

The SSC reviewed the architectural and structural plans. Due to the tight structural depths (8" slab) and complicated column layout, we decided the Girder-Slab system would be the most feasible option. This system would allow us to keep an approximately 8"-slab depth without any soffits interfering with hotel room or corridor areas. The existing column locations would remain the same.

The result was a very simple gravity design, which provided the same structural depth. It also resulted in lighter foundations for the entire building. The steel system eased the limited lay down area, as well, because only the steel being erected needed to be on site.

Different is Better

Las Vegas is known to be a concrete town, but lately this trend has been changing. A project came to the SSC from a Vegas client who requested a conceptual solution in steel to compare with the initial concrete concept. This project also had both parking and residential components, which created several complicated framing transfer areas. For this tall and seismically challenged site, staggered truss was the best option for the gravity system. It would eliminate the majority of the transfers and reduce all the interior gravity columns. For the lateral system, a combined system of moment and braced frames was used around the existing elevator and stair locations, which were consistent in both the parking residential levels.

These changes to the structural system were very different from the proposed concrete system, but when the initial estimates came to the owner, the steel package was several million dollars less than the concrete alternative—not including the reduction in foundation price. By thinking outside the box, the client was able to save millions in construction costs.

Time is Money

When estimates for a project show the costs of a steel system and a competing material are relatively the same, why would developers choose steel, especially if they've never worked with it before? The best reason is that steel framing system can reduce a project's overall erection schedule by as much as half. The cost saved in actual construction time can carry over to savings on general conditions and overall construction loans due to earlier occupancy.

We Can Help

The successes of these projects (and the projects highlighted below and on p. 36) were possible because clients were open-minded and willing to work with AISC towards a better solution in steel. Find the AISC regional engineer nearest you at www.aisc.org/regionalengineers, or contact the Steel Solutions Center directly at 866.ASK.AISC or solutions@aisc.org. **MSC**

The Alexan at Lenox—Atlanta

How can the schedule for a wood-framed multi-story residential project be reduced to meet an owner's aggressive occupancy goals? The answer: redesign it in steel.

The design team for the Alexan at Lenox multi-story residential project in Atlanta was facing roadblocks in reducing the wood-framed building's fast-track construction schedule. AISC member fabricator Universal Steel, Inc. learned about the project and initiated a partnership between the Alexan's design team and AISC's Steel Solutions Center (SSC) to convert the design to structural steel.

A steel in-wall beam redesign with a hollowcore slab, conceived by the SSC, not only shaved months from the schedule by simplifying the erection process, but also provided added flexibility and decreased floor depth for the 300-unit building.

The final design for the Alexan at Lenox uses a steel-framed in-wall beam gravity system, with girders located along the exterior walls and corridor walls. Designers placed the interior girders—typically W18 to W24 that span 25' to 35'—along a double loaded corridor.

Eight-inch hollow core plank spans 32'-0" between the corridor and perimeter. Short planks were also produced to span the 6'-0" corridor. A leveling compound was used for the planks instead of structural topping to provide a smooth surface.

This system improved flexibility for condominium layouts by eliminating soffitted beams between units. It also maximized floor-to-ceiling heights while keeping a tight floor-to-floor height—with the girders enclosed in the units' corridor and exterior walls, the structural floor depth is only 8". In living rooms and bedrooms, the design team was able to provide a 9'-4" finished ceiling height within a 10'-4" floor-to-floor height.

The lateral system proved to be a difficult issue because of the building's unusual configuration. The structural engineer selected braced frames and worked closely with the architect to determine the best locations, which resulted in the least amount of interference with the plan. Both concentric and eccentric bracing were used to account for door openings along the corridors

The owner's previous project, simi-

lar in size and scope but constructed in wood, was completed in 26 months. The Alexan's steel frame was constructed in 13 weeks, and the overall construction time was 14 months.

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BY TODD ALWOOD AND LENA SINGER

The Condominium Residence at Seven Bridges—Woodridge, Ill.

BY A.J. BAYSEK, P.E., S.E., MATT AQUINO, P.E., S.E. AND TABITHA STINE, P.E.

Post-tensioned and conventional cast-in-place concrete and structural steel were all evaluated as possible framing systems for the condominium residence at Seven Bridges in suburban Woodridge, Ill., but structural steel was selected for cost and floor-to-floor height considerations.

A steel frame proved to be most economical when all factors affecting cost of construction were taken into account. Structural steel, with precast plank floors, provided the ability to work through the winter months without significant heat-

ing and housing costs and with minimum impact to the construction schedule.

The complex consists of a 12-story tower offering over 330,000 sq. ft of space: levels three through 12 contain 130 condo units, while the lower levels house a lobby and 175 parking stalls.

One of the challenges of mixed-use construction is developing a column grid layout that is conducive to all building functions. Collaborative architectural layouts framed in structural steel eliminated the need for a transfer level between the condo and parking components. Instead, 28'-8" grid layouts were used for both the condominium floors and the parking levels. The parking levels are also supported by a steel frame with precast plank. This permitted three parking stalls between each bay while allowing girders to be located at demising walls on the condo floors.

The structure is clad primarily with metal and glass above the parking base, with a masonry veneer only at the lower parking levels and at portions of the east elevation. Lighter cladding loads helped accommodate the longer spans. Predetermined locations for mechanical system penetrations allowed the framing to be optimized to maintain the necessary floor-to-floor heights.

The structural system of the building's residential component consists of a structural steel frame that supports a combination of 8" and 10" precast hollow core plank. The floor plank is topped with a 2" non-structural topping.

The lateral loads of the building are transferred through a braced frame system interior to the building in combina-

tion with precast concrete shear walls. This system was used in favor of perimeter steel moment frames in the longitudinal direction.

Interior steel beams did not affect floor-to-floor height because they were mostly located at partition walls. This creative perimeter framing scheme achieved a 10' overall floor-to-floor height while providing 9' ceiling heights in the condominium units.

Recessed and cantilevered balconies were formed of wet-cast solid precast slabs formed with the necessary depressions and curbs. By using these special planks, which also support the exterior wall loads and residential balcony floor loads, the typical steel spandrel beam was eliminated.

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