Making Spaces

Innovative Structural Design Increases Floor Spans in High-Rise Condos

By Sheila Bacon

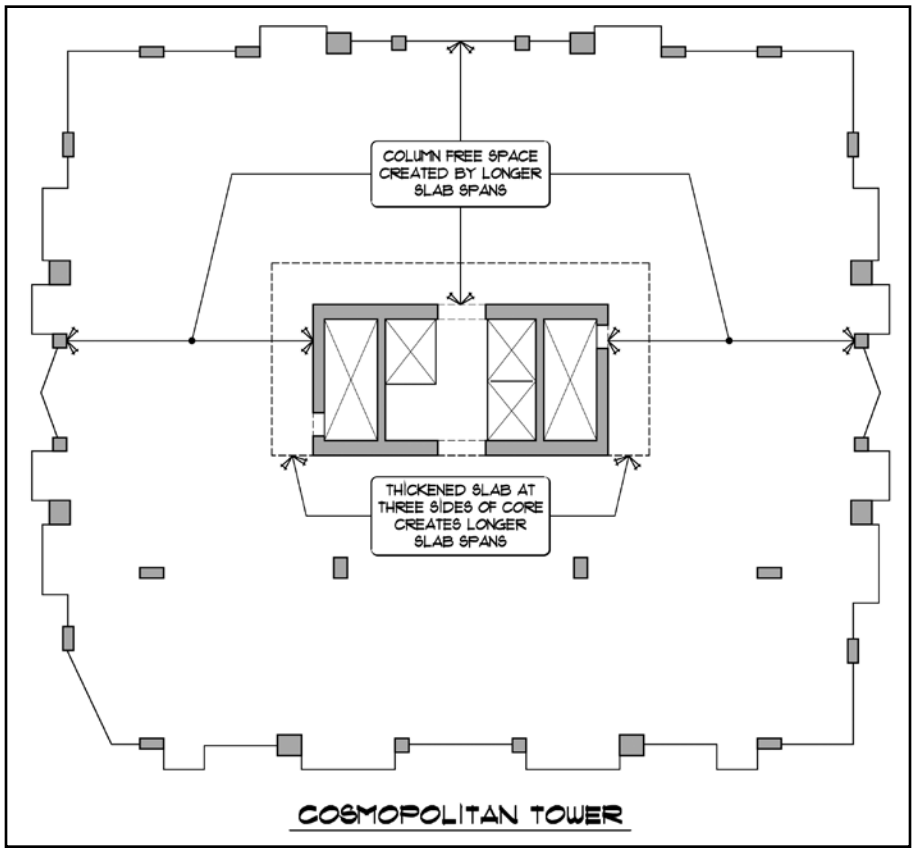
A new method of designing residential towers' structural systems is resulting in longer floor spans — and more usable space inside the living units.

Implemented in two downtown Seattle condominium projects currently under construction, the 34-story Cosmopolitan Tower and the 22-story Madison Tower, the technique eliminates a ring of internal columns that typically shorten the floor spans and limit space planning options. Designed by engineers at Bellevue, Wash., structural engineering firm Cary Kopczynski and Co. (CKC), the method involves thickening up the concrete floor slabs in the corridors surrounding the core where floor-to-ceiling height is less critical. The design improves the efficiency of the core and allows for post-tensioned floor spans to continue from the core to the exterior of the living units without additional internal support.

The character of these slabs differs significantly from that of conventional post-tensioned flat slabs, which typically have a span capability of around 30 feet. With most core-to-exterior-wall floor spans ranging between 35 and 40 feet, residential tower designs usually dictate a row of support columns between 5 and 10 feet from the core walls. Using beams in place of columns isn't a much better solution: since the post-tensioned slab doubles as the ceiling of the unit below it, there's no space to hide horizontal support.

How it Works

This systems works by borrowing corridor ceiling space where electrical wiring and sprinkler systems are typically housed and using it instead for more concrete. Ductwork is redirected from the corridors to the dropped ceilings in the units' entryway foyers, and the slab thickness is increased from a typical 8 inches to up to 18 inches for the width of the corridors. The additional thickness around the building's center puts more of the structure's vertical load on the core, which, in turn, supports the longer floor spans.



Because the floor spans are longer, additional post-tensioning cable is needed to stress the floors from a typical 200 psi to around 275 psi. While the additional cable does add to the project's bottom line, monetary savings are returned by the removal of the internal columns.

Eliminating these columns provides a number of benefits, the additional flexibility gained inside the units being the most obvious. Architects are free to design the living units without structural columns limiting floor plan options. The tenant benefits as well, since columns are not blocking views or getting in the way of furniture, appliances and decor.

Fewer columns also mean fewer space allocation challenges in the building's lower levels. Eliminating the interior columns removes the need to run them down through the lobby and parking areas. In a building with a relatively small footprint, numerous columns in a lower level or below-grade garage can create circulation and space planning issues.

Thicker floor slabs surrounding the core also result in a more structurally efficient building overall. Depending on the building size, the technique places more than 40 percent of the total weight on the core. By transferring the load from the perimeter columns to the core, the shear walls become more efficient

in resisting seismic and other lateral forces. It also cuts reinforcing steel requirements in the core. Core steel can be reduced by 10 to 20 percent; a bonus, as steel prices have nearly doubled in the past few years and show little sign of dropping.

A robust connection between the floor slab and the core walls is critical to achieving acceptable performance of the longer floor spans. The connection must be augmented with additional steel at that critical point to carry the high bending moments.

Already in Use

CKC first used this design on the Cosmopolitan Tower in 2000, working closely with Seattle architecture firm Mithun and the developer, Continental Properties. The project was put on hold, but recently resumed and is now under construction. Mortenson of Bellevue, Wash., is the general contractor. Construction is expected to be complete in early 2007.

CKC has also used this method in Madison Tower, a hotel/condominium tower that topped out in October. Here, the thicker slabs in the corridors are used on two sides of the core. Designed by Seattle's Weber + Thompson and built by Bellevue general contractor/developer 1000 First Avenue Properties, LLC, the tower will be complete in mid-2006.

Since the use of this system is relatively new, CKC designers have closely tracked its behavior in their projects under construction. Field measurements have indicated that the longer floor plates' deflections are within the predicted range. As with most residential high rise projects, CKC engineers designed to limit the deflection to roughly half of what the building code allows, and the structure is performing within those limits.

The practice of increasing residential tower floor spans is most effectively used on residential buildings designed with flat-slab construction and corridors wrapping around the core. However, even projects that are not originally conceived to follow this layout can be altered to fit the bill. Close communication between the structural engineer, architect and owner at the beginning of the design process can result in minor design changes that move off-set corridors to the core and allow for use of the column-eliminating design.▪

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