LIVING **LARGE**

by Sheila Bacon

Tapered Columns Offer Residential Tower That's Bigger at the Top

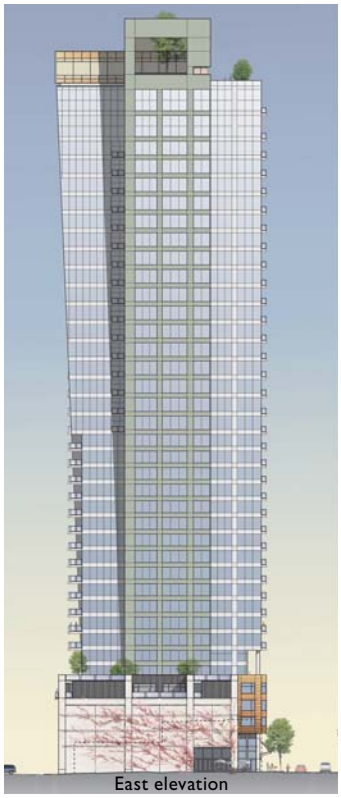
They say life's better at the top. At a new high-rise residential tower under design in Seattle, it's also much bigger there.

Three sides of the new 40 story, 440 sq. ft. tall Kinects residential tower gradually slope outward as the building rises, resulting in a top floor approximately 1,600 sq. ft. larger than the bottom floor. The design not only adds an architectural vibrancy to downtown Seattle, but also capitalizes on the additional upper-level real estate. Construction is expected to begin in the Spring of 2009.

The tower – which will be introduced to the market as apartment units – also features a number of structural nuances that set it apart from towers that follow a more traditional design scheme. Each floor of the tower is six inches larger on a side than the one below it, presenting a number of structural challenges ranging from seismic design to formwork efficiency.

MORE TO MOVE

The higher any building rises, the greater the effect of seismic forces on the upper floors. With the Kinects project, structural engineers were faced with an additional challenge: designing a structure that would accommodate the additional floor space at the building's top in the highly seismic Pacific Northwest region.



East elevation

South elevation

"Basically, when you put more weight at the top of a building, it wants to sway farther," said Joe Ferzli, senior project manager with structural engineering firm Cary Kopczynski & Co. (CKC) in Bellevue, Wash. "It makes carrying seismic forces that much more challenging."

The project incorporates a performance-based seismic structural design with a shearwall concrete core for seismic resistance. While U.S. building codes along the West Coast suggest redundant framing in addition to a shearwall system for buildings over 240 sq. ft., CKC designers proved to the city through studies and peer reviews that Kinects' design would meet the strength and safety requirements outlined in the code without additional framework.

The building's flared exterior columns work in conjunction with the floor slabs to support the structure. The floors will be supporting not only the building's vertical loads, but the rotational forces imposed upon them by the sloped columns. Additional steel is designed into the floor slabs to restrain the columns' rotational forces. This steel carries the thrust forces from the sloping columns back into the shearwall core. The cost premium for this added steel is slight relative to the floor space gained.

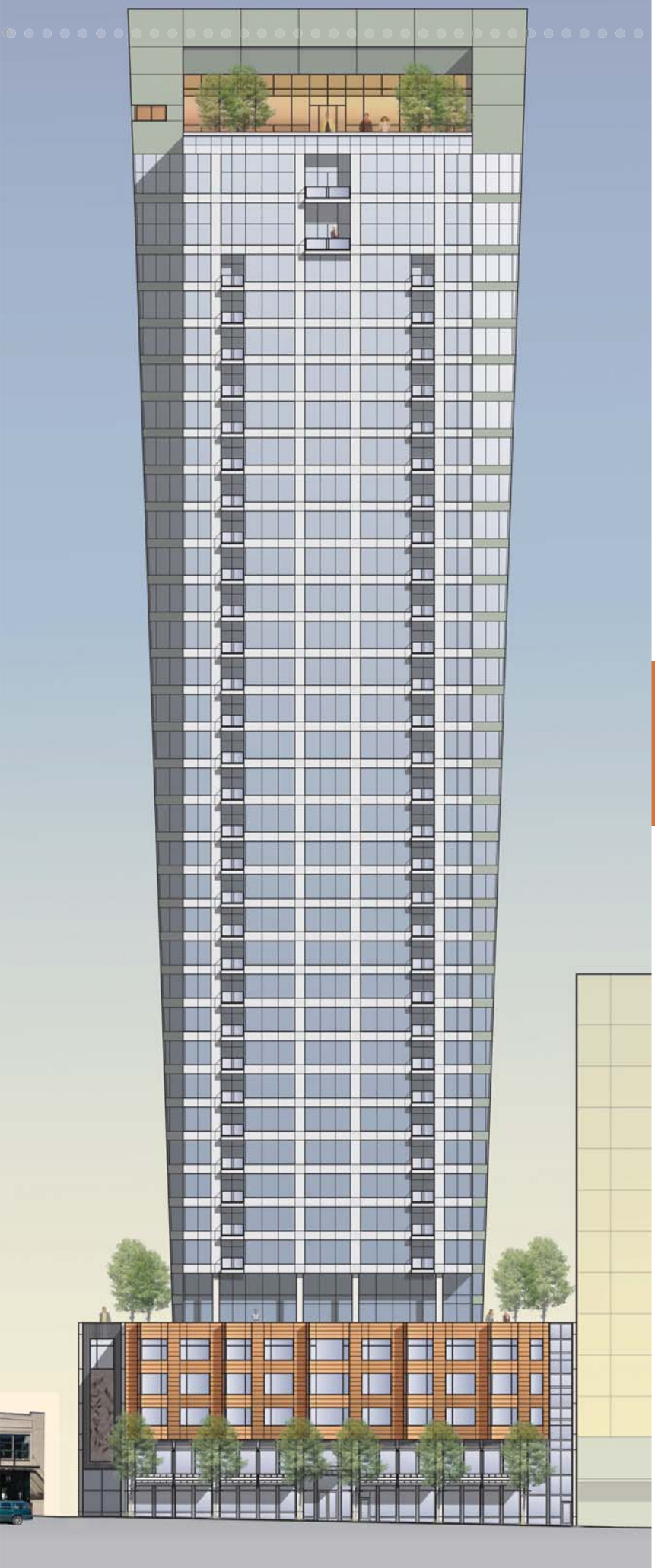
UNORTHODOX ANGLES

Kinects' project team long debated how to design a building with floor plates that would grow incrementally in size as it rose. Much of the focus was on the exterior concrete columns. While portions of the building at every floor level are held by interior vertical columns, 10 exterior columns – four on each of two sides and two on another – are sloped. Designers considered creating these exterior columns as vertical units as well; stair-stepping the columns out six inches at each level. Keeping the columns' reinforcing steel elements connected as they shifted outward at every floor, however, proved to be structurally complex. Designers would have had to splice or bend the steel from the column above to the column below to keep the columns in physical contact.

"We came to the conclusion that even though construction would require the use of tipped forms, it would still be easier than bending or splicing the steel," said Cary Kopczynski, CKC president and senior principal.

Concrete formwork was also an issue in the structure's floor plates. Since each floor was bigger than the one above it, designers had to create concrete formwork that would accommodate the floor size changes without requiring the construction of new forms for each level. Otherwise, crews would be unable to jump the formwork as their tower progressed. Since the floor plates' sizes increase in only one direction as the building grows, the slab forms will be built long enough to accommodate the largest floors. When the lower floors are poured, the unused portions will simply project out the sides of the building.

> "KEEPING FORMWORK CONSISTENT IS KEY TO A BUILDING'S CONSTRUCTABILITY."
>
> Kopczynski



"It's the cardinal rule in the construction of cast-in-place concrete towers," he said. In the United States, Canada, and other high-cost labor markets, formwork can be as much as one-third to one-half the total cost of a completed cast-in-place concrete structure. Keeping the structural design consistent from floor to floor keeps costs down and speeds up construction.

PT-REBAR HYBRID

The Kinects design team is incorporating a hybrid floor design. The hybrid design involves moderate quantities of post-tensioning with larger quantities of reinforcing bar. Sufficient PT is used to provide the benefits it imparts – flatter and thinner floors – without the drawbacks that can result from its overuse. Instead of exclusively using conventional reinforcing bar or post-tensioning cable, the two materials are blended into one unique but effective system.

The approach works to incorporate a proven slab-strengthening method without the usual drawbacks.

> "WE BELIEVE PT IS A GOOD THING, BUT ONLY IN LIMITED QUANTITIES."
>
> Ferzli

Too much post tensioning cable has a tendency to create excess shrinkage in the floors, said Ferzli, and field placement can be difficult for a crew with limited PT experience. Also, post-tensioned floor layouts are difficult to modify once the building is occupied. If a cable is accidentally severed, for example, it can cause structural problems in the area.

In this application, PT cables are spaced approximately 36 inches on center, with conventional rebar filling in the spaces in between.

When construction is complete in early 2011, Kinects will include approximately 6,000 sq. ft. of ground-floor restaurant and retail space; a rooftop lap pool; and 325 above- and below-ground parking spaces. The tower's 330 residential units average 900 sq. ft., with some smaller studio units measuring 500 sq. ft. and larger penthouse apartments reaching 3,000 sq. ft.