Avalon Tower

New Residential Towers Employ High-Strength Rebar, Other Efficiencies

By Sheila Bacon Cain

In an economy where every penny counts, it only makes sense to optimize construction materials and processes. At the new Avalon Towers residential project in downtown Bellevue, WA, designers have streamlined traditional ways of designing structural systems and steel placement to make construction quicker and more economically efficient. As a result, the developer of the $120 million, cast-in-place, post-tensioned concrete project is realizing significant labor and material savings.

The two towers, rising 25 and 16 floors, are not only one of the City of Bellevue's first high-rise apartment projects, but also the first construction job in the U.S. to use a high-strength, 90 ksi rebar product in the structure's columns and shear walls for seismic confinement purposes. Cary Kopczynski & Co. of Bellevue, WA, is the job's structural engineer.

The steel, developed by Nucor, is actually ASTM A 615 rebar with enhanced ingredients that push its strength to 90 ksi. While it has yet to be approved as such by ASTM, it was given the go-ahead by the City of Bellevue's building department for use on Avalon after considerable research and product review.

The use of 90 ksi rebar allows structural engineers to more appropriately assign steel strengths to particular structural elements. While most jobs use only one steel grade, Avalon Towers incorporates a palate of choices – grade 60, 75, and 90 – so design efficiency is optimized.

Rebar ties with a 90 ksi yield strength substantially reduced congestion at columns and shear wall boundaries.

Avalon Towers includes 15 and 25 story buildings in downtown Bellevue, Washington.

The introduction of the new, stronger steel comes on the heels of the completion of another Cary Kopczynski & Co. job: Escala. This 31-story condominium tower, recently completed in downtown Seattle, used 100 ksi steel for the first time for seismic confinement purposes. Made by MMFX Technologies of Irvine, Calif., the 100 ksi steel had been initially marketed to the industry as corrosion-resistant rebar most appropriate for use in bridges, parking structures, industrial buildings, and other applications in which water intrusion was a concern. It has been used in mat foundations and bridge decks to add strength, but its use in Escala was the steel's first in a seismic application in North America. The material's chrome content, which provides corrosion resistance, has made the material costly, however.

Nucor's 90 ksi steel does not include the expensive – and for seismic confinement purposes, unnecessary – chrome. Instead, it uses added vanadium and other materials to push up its strength. While the steel is not as inexpensive as lower steel grades, its price is less than 100 ksi steel and, when combined with 60 and 75 ksi steel in other areas, more cost effective. The 90 ksi steel brings healthy competition to the growing market of high-strength steel rebar.

New Steel Grade Brings Considerable Cost Savings

The switch to 90 ksi steel from the Grade 60 bar that had originally been specified in the Avalon project has resulted in a savings of more than $100,000 in steel costs, since less steel is used. Crews had already placed Grade 60 ties in the basement columns and walls when the project team made the transition. Had the decision to use the new steel been made before construction started, the savings would have been even more substantial. Most project teams can expect to save 20 to 25 percent on the cost of seismic confinement steel by using 90 ksi steel in place of Grade 60 bar. While the material cost is higher, overall project cost is lower because significantly less material is used.

The benefits reach beyond the obvious cost savings. The use of stronger steel means fewer ties are placed. This allows for increased spacing between ties, a reduction of congestion in columns and shear walls and less work for field employees, who typically find column tying tedious and time consuming.

The decision to use 90 ksi steel on the Avalon project was financially driven, although some project owners may opt to use stronger steel to facilitate greater height in high-rise towers. While use of high-strength concrete may allow the height of concrete frame buildings to rise, the amount of conventional column and shear wall steel needed

to achieve sufficient seismic confinement becomes too great, creating significant congestion in columns and shear wall boundary zones. The use of 90 or 100 ksi steel frees up space and allows for construction of taller buildings.

Boosting Productivity with Detailed Designs

Beyond the use of the stronger 90 ksi rebar, the design team worked carefully to further drive down costs and increase jobsite productivity by detailing pre-tied rebar cages. On jobs with considerable steel and heavily reinforced columns and shear walls, the physical placement of steel is on the job's critical path of construction. In other words, other construction activity cannot start until all steel is placed. Anything that can be done to speed up rebar placement will help speed up the job as a whole. One of the best ways to accomplish this is to detail the layout of the rebar to allow as much of it as possible to be pre-tied and prefabricated.

Avalon designers detailed all steel-heavy shear wall boundary elements so they could be prefabricated and brought to the jobsite in two pieces. The two legs of each L-shaped unit at the corners of the towers' cores are tied together in the field and spliced into the wall mats. This eliminates time consuming rebar tying onsite.

Contractors are also able to take advantage of concrete formwork designed to maximize productivity. Designers kept the layout of the tower cores as simple as possible: essentially four straight walls with no re-entrant corners. The simple design allows for use of off-the-shelf forming systems. The floor layout is also standardized, minimizing wandering columns by keeping as many columns as possible aligned across the floorplate. Consciously simplifying layout of the core and floorplates eliminates the need for custom formwork, which can increase costs and slow production of the contractor.

A small design detail in the placement of post-tensioning cables at the shear wall cores further speeds up construction productivity. In most cases, the post-tensioning cable is pushed into the wall cage where it meets the core. This requires threading the cable up through the heavy mass of steel in the rebar cage. Much time can be saved if the post-tensioning anchor is located *outside* the core walls, eliminating the need to weave the cables into the dense rebar cages. Extensive testing and prior use validates the faster and less expensive method.

Slabs are typically 8-inch thick with a combination of post-tensioning and mild rebar. Note that exhaust ducts were buried in the slabs, along with most electrical conduit.

Shear wall rebar was detailed to allow pre-tying of cages offsite. This minimized field labor and accelerated construction.

Cooperation is Key

Design teams can have the best of intentions when detailing a structural system to be quick and easy to build, but without early involvement of the general contractor and subcontractors, few of these efficiencies can be realized. Avalon designers had the good fortune of a cooperative developer and general contractor who was agreeable to hiring subcontractors early. The design team was able to work closely with the steel placers in the preconstruction phase to incorporate their input before heading to the fabrication shop. This level of communication and teamwork allowed the designers to create a plan that would cut costs and speed construction.

Completion of Avalon Towers is scheduled for August 2010, one-and-a-half months ahead of schedule.▪

Project Team

Owner: Avalon Bay Communities Inc., Bellevue, WA
Architect: Ankrom Moisan Associated Architects, Seattle, WA
Structural Engineer: Cary Kopczynski & Co., Bellevue, WA
General Contractor: Avalon Bay Communities Inc., Bellevue, WA

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