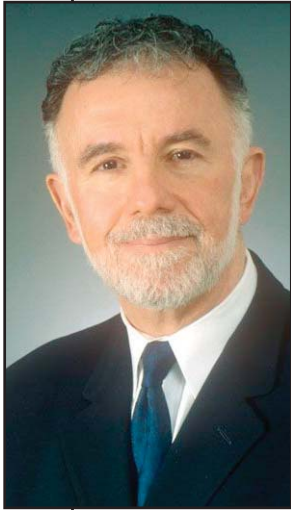


Novel Advantages of Composite Construction



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There are many novel advantages to combining concrete and steel in the design of the primary structure for a high-rise building. Using the best properties of both materials to solve the design challenge can result in a cost-effective solution that best meets a project's architectural and functional requirements.

In many parts of the country, concrete cores are used within an otherwise steel-framed office tower to achieve cost and scheduling benefits. These benefits are maximized when the concrete core construction, by slip or jump forming, can lead the steel erection, while the steel is still being fabricated and eventually erected below the concrete. Unfortunately, to date, this is not done in New York because of unresolved union and safety issues. The concrete industry needs to focus on resolving these issues. It has successfully been done just about everywhere else in the country.

Two examples in Chicago are the 31-story ABM AMRO office building designed by architects DeStephano & Partners (Fig. 1) and the 50-story UBS Tower designed by architects

Lohan Caprile Goettsch (Figs. 2, 3, 4). Both rely 100% on the stiff concrete core for lateral and torsional wind resistance and acceleration control without outriggers. Accomplishing this with a relatively slender core for the 50-story UBS Tower exemplifies the advantages of the concrete core's greater stiffness and damping characteristics, compared to a steel core design.

Also, this approach results in simplified steel fabrication and erection by eliminating cross-bracing and moment connections, while providing economical long core-to-perimeter spans. In addition, composite columns facilitated long unbraced lobby heights.

On the concrete core, steel-framed 191 North Wacker, also in Chicago and designed by KPF Architects, the lower floors are a concrete garage. This concrete construction also facilitated an eccentric cantilever for the entire building, using stepped sloping columns, to accommodate a road clearance constraint (Figs 5, 6).

Often, mixing concrete and steel is motivated by the mixed-use requirements of a project, such as combining residential and office spaces in the same building. A good example is 731 Lexington Avenue in New York, designed by Cesar Pelli Architects (Fig. 7). Twenty-four residential floors of flat-plate concrete construction sit on top of 30 commercial floors of long-span steel construction with a retail steel base. The design required an innovative transfer floor to accommodate the totally different column spacings of the residential and commercial spaces (Fig. 8). The advantages of the concrete residential design more than justified the cost of the transfer. They are: reducing floor-to-floor heights with subsequent reduction in lateral forces, riser and curtain wall height, and cost; and providing both residential and office spaces with optimal



Fig. 1. ABN-AMRO - Concrete core, steel frame, with post-tensioned garage at base.



Figure 2. UBS Tower - 50 stories, concrete core, steel frame.

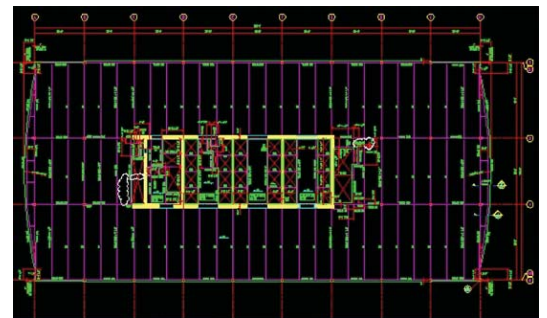


Figure 3. UBS Tower - Typical floor plan.

column spacing for their functions.

A similar approach was used on the 675-foot-tall Random House building in New York. Both 731 Lexington and Random House incorporated a tuned mass damper in their designs. It is interesting to note that Random House has the first building-related tuned liquid column dampers in the U.S. The dampers were the most cost-effective option for providing tenant comfort on these composite structures.

Another unique use of combining concrete and steel was for the eight concrete-filled super columns of the now-tallest building in the world, 101 Taipei, designed by C. Y. Lee Architects (Fig. 9). Filling the major columns (Fig. 10) with concrete was a more economical solution for drift control, seismic resistance, and strength than providing additional steel to this primarily steel-framed structure. Additional composite columns and composite shear walls were also used below the 26th floor to meet the project's severe wind and seismic criteria.

In summary, numerous innovative ways of combining the best properties of steel and concrete can be utilized for the design of cost-effective structures and to increase market share of concrete construction in buildings that have typically been perceived as steel-only construction. The use of concrete mass, strength and fire resistance for protection against certain types of security threats in today's modern age has been an additional motivation to consider novel approaches to composite construction.

- **Concrete Core Wall**
 - High Strength Concrete
 - 12,000 psi < 27th Floor
 - 8,000 psi > 27th Floor
 - Resists Total Wind Forces
 - Core Wall Flanges Vary from 39" to 15" Thick
- **Creep & Shrinkage Analysis**
 - ACI Committee 209: B3 Concrete Model
 - Accounted for time dependant values of load, concrete strength, and concrete modulus of elasticity
 - Predicted core shortening relative to steel columns
 - Adjusted concrete core height during construction

Figure 4. UBS Tower - Concrete core.

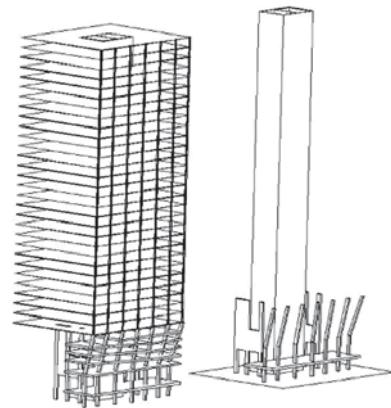


Figure 5. 191 North Wacker -Sloping columns.



Figure 6. 191 North Wacker - Stepped sloping concrete columns.

- Encompasses entire city block. Two separate structures at each avenue, with three cellars. Totals 1.4 million sq.ft.
- 815 ft tall tower with 55 flrs
- 30 steel commercial flrs with retail at base & Bloomberg HQ above
- 24 concrete residential flrs at upper part
- 6-story atrium with glass walls overlooks public plaza

Figure 7. 731 Lexington Avenue - Project description.



Figure 8. 731 Lexington Avenue - Transfer truss about to be encased.

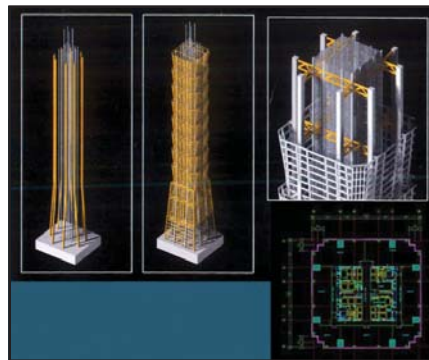


Figure 9. Taipei 101 - Eight concrete-filled super columns.



Figure 10. Taipei 101 - Super-column fabrication.