



Small Footprint, Big Results

BY ANJANA KADAKIA, P.E.

Philadelphia's Comcast Tower maximizes its small footprint with a narrow core that gets a little help from a tuned liquid column damper.

NOT LONG AGO, THE BLOCK BETWEEN 17TH AND 18TH STREETS ON JFK BLVD. IN DOWNTOWN PHILADELPHIA WAS A PARKING LOT. But thanks to positive market conditions and an increased demand for top-tier commercial development in this vibrant office district, the site was ripe for a world-class office building.

The site's new resident, Comcast Tower, will be the tallest building in Philadelphia at 975 ft and the tallest between New York and Chicago. Set for occupancy in 2008, the building features 58 stories of steel floor framing and a concrete core. Design elements include an 80-foot glass cube tower top, which accommodates high winds and wind-related sway, and a nine-story winter garden at the base. The building also contains three levels of below-grade parking, and a plaza and food court supported on the below-grade public transportation system.

Challenging, Yet Exciting

Comcast Tower was an exhilarating project from the start, but the tower's design features, such as the glass cube, column-free lobby area, and slim shape—not to mention the inherent challenges posed by building on a small footprint—presented some challenges.

How would we create an attractive, column-free lobby, encompassing three stories, and a nine-story winter garden if the main tower columns penetrate the base? How would we address the proximity of the existing subway line beneath the plaza when constructing the tower and a deep basement? How could we economically provide the luxury features, such as 15- and 17-ft ceiling heights, that the upscale project required? How would we address the wind pressures that skyscrapers experience, especially given the tower's height to width ratio?



Anjana Kadakia is a principal with Thornton Tomasetti's Newark, N.J. office and was the chief engineer for Comcast Tower.



At 975 feet, Philadelphia's Comcast Tower is the tallest building between New York and Chicago.

And perhaps most challenging: How would we build Philadelphia's tallest tower on a relatively small and irregularly shaped footprint?

To address the footprint issue, the design employed 18- to 54-in.-thick, 6- to 10-ksi concrete core walls as the lateral load resisting system, and composite concrete-on-metal-deck floor construction supported on composite steel beams spanning from core to steel columns at the perimeter. A ten-ft-thick concrete mat forms the foundation for the concrete core while 6- to 10-ft-deep caissons support the perimeter columns to keep the structure within the property lines.

Comcast Tower's lateral system is quite slender: While the building's height-to-width ratio is 8, the height-to-concrete-core-width ratio is 21. The narrow core was necessary to provide the owner with a 45-ft column-free rentable space between the core and façade. At the same time, the tower height was set to provide the required square footage of office space.

With a slender core, wind-related sway issues were expected, so the structural engineers designed a TLCD (tuned liquid column damper) at the 950-ft level within the concrete core. The TLCD enables the building to meet acceptable acceleration limits for human comfort. The water col-

umn reduces sway by applying inertial and damping forces opposing building motion. The U-shaped column is proportioned to cause the liquid to oscillate freely at a frequency that matches one or more of the structure's natural frequencies. Damping is created by generating turbulence in the water as it moves through vanes or grates, transforming motion into heat.

With a building core of 10 to 20 ft wider, the tower wouldn't have required this damper. But again, the project's design was driven by its relatively small footprint. Even with its slender proportions, Comcast Center will be the largest building in the world with a TLCD.

One of the most interesting challenges as structural engineers was the three-story open lobby entrance. Creating it required interrupting two major building columns above. To transfer these columns, we created a 90-ft span Vierendeel truss between the 6th and 17th floors. It features 48-in. by 30-in. by 8-in.-thick built-up columns and 40-in.-deep wide-flange beams. In addition, to create a three-story, 30-ft-wide column-free atrium, perimeter columns at the top of the Vierendeel truss were sloped 15 ft inward towards the core. Redirecting the gravity load this way required large tension and compression struts at the 19th and 17th floors. A trellised plaza leads into the 120-ft-high, 110-ft-wide, 40-ft-deep glass-enclosed winter garden and the tower's lobby.

The height requirement also posed challenges, especially on the upper floors. Comcast Tower's floor heights are 15 ft up to the 43rd floor, then increases to 17 ft from that point upward. This required specialized support framing to keep clear spans of the curtain wall system and elevator guide rails within practical limits. In addition, cantilevered framing at the signature sloping corners of the tower was designed to meet a tight ½-in. deflection limit. The highest occupied floor is 100 ft below the tip of tower.

Not Just the Tallest

In an effort to create not only Philadelphia's tallest, but also its safest, office tower, the team incorporated new building hardening criteria, including reinforced concrete walls enclosing the egress stairs; a stair pressurization system to keep smoke out of the stairwells; and the most advanced elevator, sprinkler, and communication systems technologies.

As Philadelphia's real estate market boomed, Comcast Tower's design followed suit, expanding from the initial design of

760 ft in 2001 to the current height of 975 ft. Such design changes, along with the overlapping design and construction schedules associated with all fast-track projects, made the timely completion of Comcast Tower a major challenge. As the project nears completion, we are thrilled with the result. It makes the extraordinary effort worthwhile.

MSC

Owner

Liberty Property Trust, Malvern, Pa.

Design Architect

Robert A. M. Stern Architects, New York

Architect

Kendall/Heaton Associates, Inc.,
Houston

Structural Engineer

Thornton Tomasetti

Steel Fabricator

Cives Steel Company (AISC Member)

Construction Manager/General Contractor

L.F. Driscoll Co., Bala Cynwyd, Pa.