

CIVIL ENGINEERING NEWS

STRUCTURAL ENGINEERING

Design of Shanghai Skyscraper Altered

The distinctive round opening at the top of the Shanghai World Financial Center (WFC)—which could be the tallest building in Shanghai when completed in 2007—has been reconfigured into a trapezoidal shape to avoid any resemblance to the Japanese flag and to impart a “fresh” look to the sometimes troubled project, according to David Malott, an associate principal of Kohn Pedersen Fox Associates PC (KPF), of New York City, the structure’s architects. Malott, the senior designer of the structure, says that the 53 m diameter void at the top of the structure, which is located in the Lujiazui district of Pudong,

Shanghai’s financial center, will now be a 50 by 36 m trapezoid.

The resemblance of the circular opening to the Japanese flag served to remind some officials that the skyscraper will be owned by a Japanese developer, Mori Building Development Company Ltd., of Tokyo. The fact that much of China, including Shanghai, was invaded and occupied by Japan during World War II also was a factor in changing the design. KPF had previously tried to allay Chinese concerns by proposing a bridge to bisect the lower portion of the circle, but ultimately a complete redesign was decided upon in October 2005. Construction of the tower began in 1997 but was suspended during the economic downturn following the Asian financial crisis. Construction resumed in 2003, by which time the owner had requested a taller structure.

The WFC tower resembles a square prism intersected by two sweeping arcs that taper to a single line at the apex, according to a description given on KPF’s Web site. There is essentially no roof, just a straight edge at the top, one floor above the void, says Malott.

Malott describes the structure as a square in plan that has its corners “carved away” as it rises, its four sides becoming six. The structure also narrows as it rises, employing diagonal bracing that decreases in size as the tower itself narrows. “It’s a nice example of the way a structure can work with the architecture of a building,” he says.

In contrast to other buildings in Pudong—which often feature colored glass and ornamental rooftops—the WFC will be clad in silver reflective glass, making it “a sort of monochro-

matic building with a very sculptural, simplistic geometry,” Malott says. “Everything else [in Pudong] is quite elaborate . . . so we felt we needed a sort of understated simplicity, sort of a calming factor, if you would.”

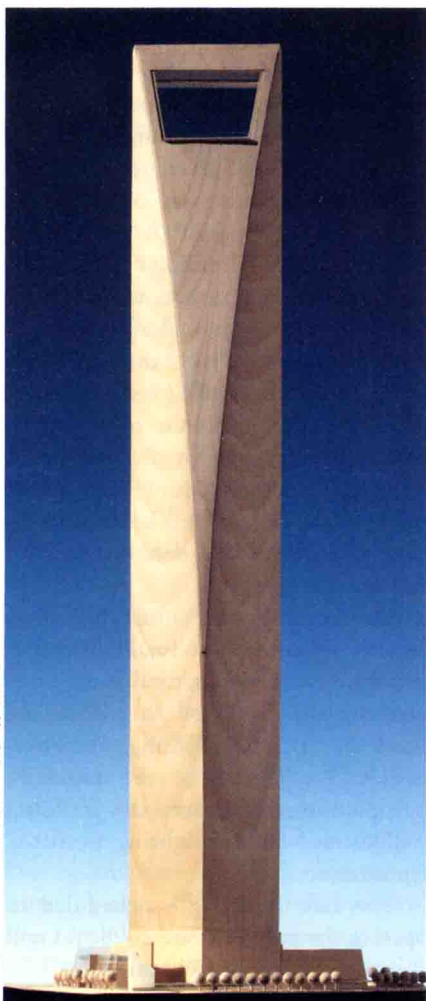
In addition to retail and office space, the building will feature a 12-story hotel near the top; the hotel’s restaurants and an observation deck will be located just beneath the void, and another observation deck will be situated above it. The void itself will incorporate a roughly 14 m wide bridge near the bottom for visitors who want to venture out into the space; the bridge will include glass walls and have a functional glass roof.

When completed, the WFC may be the tallest building in Shanghai—72 m taller than the current record holder, the 420 m Jin Mao Building, which is located nearby, says Malott. It will also feature the tallest occupied floor in Asia, at a height of 488 m. The highest occupied floor of the current record holder, Taiwan’s Taipei 101, is located at a height of 438 m. (See “Reaching for the Sky,” *Civil Engineering*, January 2004, pages 54–61.)

Leslie E. Robertson Associates, RLLP (LERA), of New York City, performed the engineering work for the taller structure, creating a system that would be lighter and faster to build and that would accommodate a taller building on the foundations that had already been constructed. The foundation consists of hollow pipe piles, says Leslie E. Robertson, P.E., S.E., F.ASCE, the director of design for LERA.

The new structural design improved the strength and stiffness of the outer walls by replacing a planned moment-resisting space frame with diagonal perimeter bracing that “zigzags” up the faces, connecting the structure’s large perimeter columns vertically and connecting steel belt trusses horizontally. This transferred much of

The distinctive opening at the top of the Shanghai World Financial Center has been reconfigured from a circle to a trapezoid. The opening will measure 50 by 36 m and will include an enclosed walkway.



Model by Rod Wiener and Krisler Hui/Photograph by Jack Butler

CIVIL ENGINEERING NEWS

the overturning moment and shear away from the building's reinforced-concrete service core, which made it possible to lighten the core, the floors, and the exterior walls, says Robertson. This decrease in weight also made it possible to "put the larger, taller building on the foundations for the smaller

building," Robertson says. Additionally, the outrigger trusses pass around the service core rather than through it, says Robertson.

The service core and the braced outside walls also provide the wfc with two lateral force systems to protect against seismic events. The structure

is designed to withstand an earthquake with a return period of 1,000 years and a windstorm with a return period of 200 years, Robertson says.

Construction of the privately funded, \$910-million wfc should be complete by the end of 2007.

—Robert L. Reid