Steel steps in to help Moscow's Federation Tower reach new heights and become Europe's tallest building.

# Russia Rising

BY BRAD MALMSTEN, P.E.

Rendering courtesy of NPS-Tchoban-Voss.

The Federation Tower mixed-use complex in Moscow. Tower B on the left and Tower A on the right flank a 1,470-ft-tall mast structure.

**WHILE THE NEVER-ENDING RACE** for world's tallest building has shifted to the Middle East for now, tallest on the continent is nothing to sneeze at. Upon its completion next year, Tower A of the Federation Tower complex in Moscow, Russia will be the tallest building in Europe at 1,181 ft (its architectural central spire will reach 1,470 ft).

The 93-story Tower A is mainly concrete (as is the 62-story Tower B), but major steel framing at multiple crucial areas of the tower—including an atrium at the top—was essential to bringing the tower together and allowing it to vie for the title of Tallest in Europe. Roughly 5,500 tons of structural steel in all made this happen.

## Tower A Structure

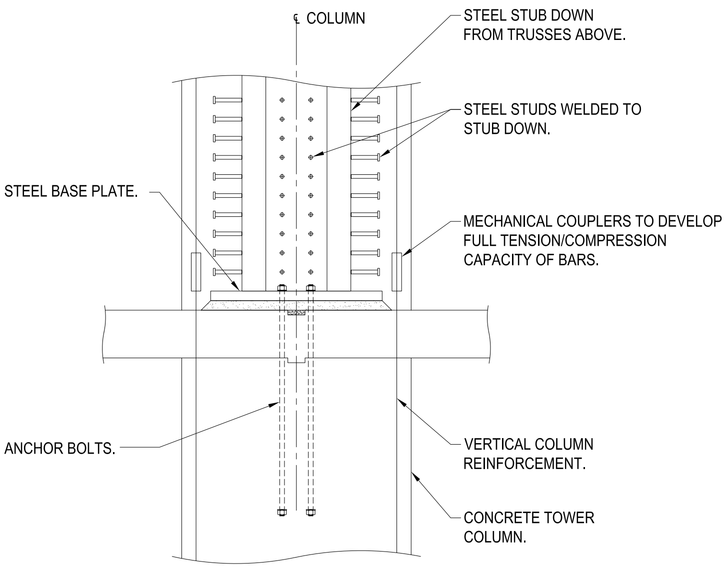
Outrigger levels—complicated structural interchanges involving column transfers, shifting of wind loads from core to exterior, and rebalancing of building weight—are the hubs of the tower's load network. These hubs are built in steel, and the result is open space for equipment, access to fresh outside air, and a system of trusses capable of supporting fully reversed loading.

The trusses link all of the exterior columns together into one giant perimeter "belt" and outrigger trusses link the concrete central core to this belt. This linkage manifests the network of load paths that is the cornerstone of the building's plan to maximize the resiliency of the structure as a whole, stabilize it against lateral loading, and mitigate the potential for progressive collapse.

The steel truss systems are placed at the one-third and two-thirds heights of Tower A and share floor space with mechanical rooms and refuge areas. These areas naturally separate the building into distinct fire protection zones as well as occupancies. Steel framing also allowed clear space—that would have been impossible to match with concrete walls—facilitating the MEP design and the layout of refuge floors.

The complex geometry of the tower also made these particular areas more conducive to steel framing. The extraordinary amount of reinforcing steel that would be required and the curvature of the exterior belt made rebar detailing difficult and execution cumbersome, and thus prone to non-conformance. On the other hand, angle changes were easily handled by steel truss work, with gusset plates carefully detailed and shop-fabricated to bend around the column flanges to make the required curvature.

At about 20 ft deep, the 33rd-floor outrigger system is shallower than the designers would have preferred due to other design constraints, but even more reason to take advantage of the ability of steel to handle




Base of a vertical stub down from steel a outrigger truss.

incredibly large forces in relatively small space. Some outrigger diagonals see design axial forces as high as 3,500 tons, and the belt truss members are designed for up to 1,700 tons. The entire truss system weighs roughly 2,000 tons and is comprised almost entirely of W14 sections connected by flange-bolted gussets. Where trusses intersect, built up box sections were used in order to simplify the connection details.

The 61st-floor truss system is about 43 ft deep and doubles as a transfer truss for half of the perimeter columns. At this level, outrigger diagonals see axial forces as high as 5,400 tons and the belt truss members up to 3,500 tons. This group of outriggers and belt trusses weighs in at about 3,000 tons. Again, W14 sections were used where possible, and the most extremely loaded pieces were built up from 5-in.-thick, 30- to 34-in.-wide plates.

## Load Network

The term "load network" is used above to indicate the level of interconnectivity of the structural elements of Tower A. As in all buildings designed to resist progressive collapse, creation of alternate loads paths was desired. In the case of the Federation Tower, steel trusses allow two levels to be force hubs in the overall load network of the structure, providing not just one load path and one potential alternate load path, but an unlimited number of potential load paths.

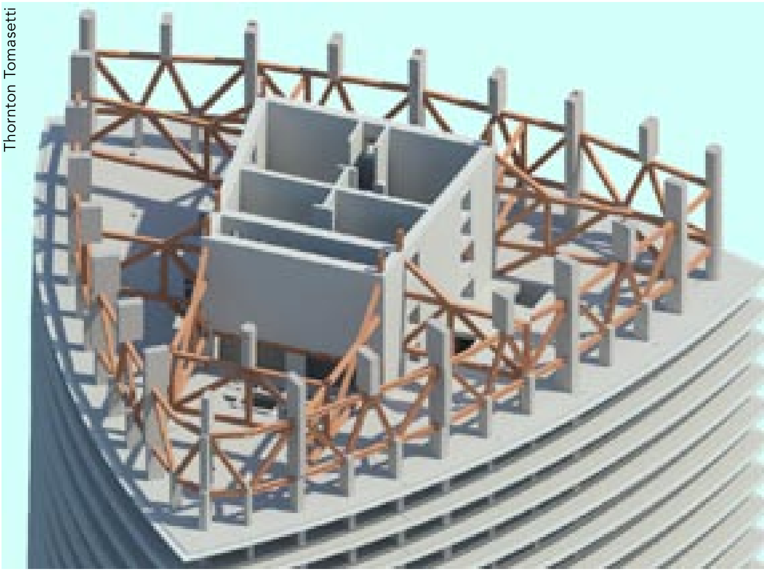
Continuity and ability to handle reversed loading in all of the structural elements in the building is a major theme of the design. With this in mind, the steel trusses were not only encased in the concrete core walls and columns within height of outriggers, but also truss verticals were extended one floor up and down into the concrete structure above and below. This ensures the best behavior of the building as a whole in common or unusual circumstances, as well as ensures that each steel piece is loaded in a manner consistent with the design intent. Stubbing up and down allows the concrete to unload smoothly into the steel trusses, and for the trusses to unload smoothly into the concrete columns and walls.

## Cap Structure

The Tower A cap was destined to be a highlight of the project. Curved sides and roof meet above a five-star hotel lobby and exclusive VIP space, and the opportunity to do something special called. Steel—about 500 tons of it—provided the answer in the form of an integrated, transparent crown.

The stunning glass box that caps Tower A is designed so that the glazing mullions also act as part of the load bearing structure. Integrating the structure, glazing, cleaning, drainage, shading, fire protec-

Thornton Tomasetti



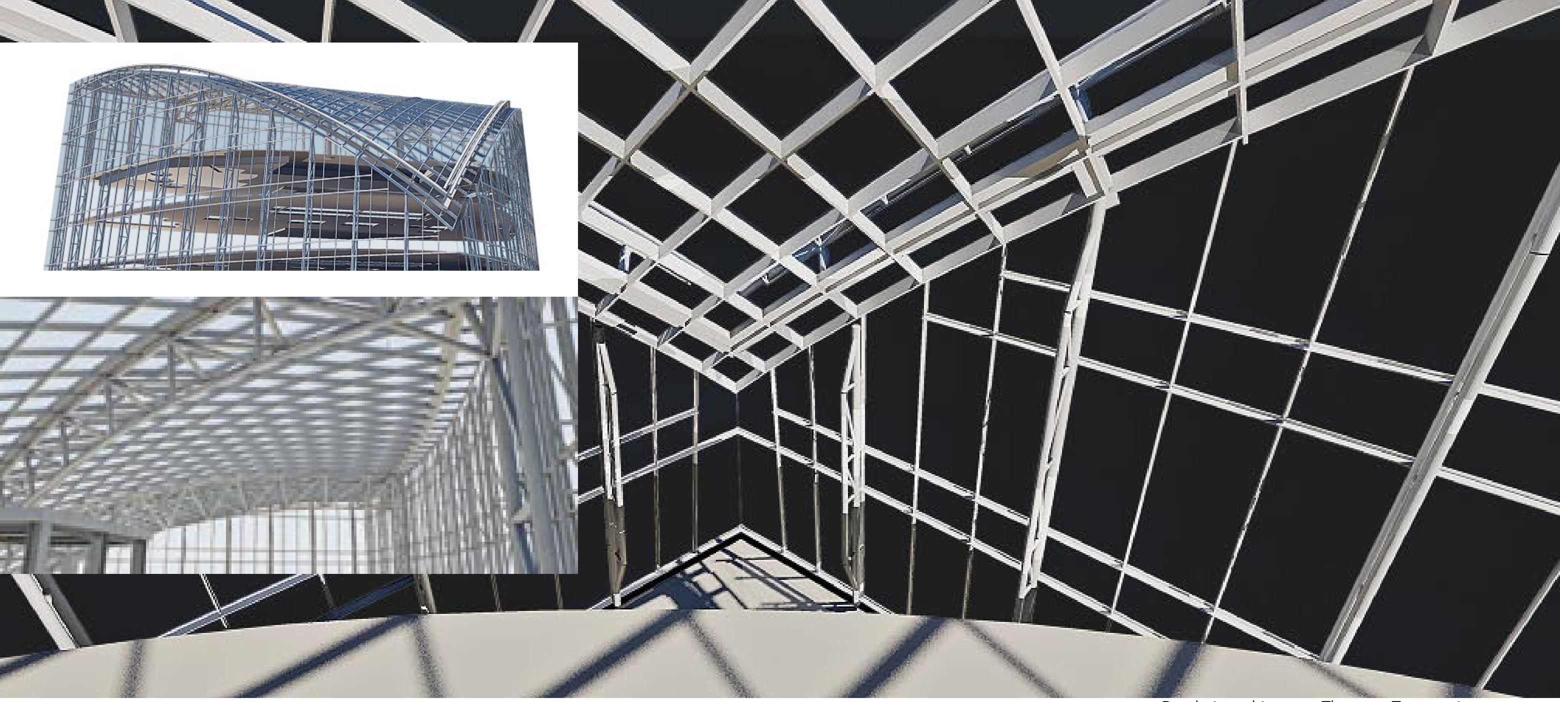
Tower A's 61st-floor outrigger level.

Mario Sokol/Thornton Tomasetti

Looking down on Tower A's 33rd-floor outrigger and belt trusses during the final phases of steel erection.

Sofia Pechorskaya/Thornton Tomasetti

The west section of the 33rd-floor outrigger trusses, linking the belt truss on the left to the central core on the right.



Renderings this page: Thornton Tomasetti

Multiple 3D renderings/views of the Tower A cap.

tion, and MEP systems results in maximum transparency and allows the occupant to realize the openness and beauty of the space instead of its many components, most of which will be fully exposed. The 16,000-sq.-ft open space features built-up façade mullions, solid-plate roof mullions, two central super columns built from 4-in.-thick plates, and exposed triangular super trusses.

Perhaps no building in the world so clearly demonstrates the benefits of hybridization—or how even in a concrete building, there are still areas where steel is the only option. MSC

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