Sky high in Dubai

By Max Rust and Phil Geib | TRIBUNE GRAPHICS

Opening Monday and soaring half a mile into the sky, the Burj Dubai is both the world's tallest building and its highest free-standing structure. Designed by Chicago architects Skidmore, Owings & Merrill, the mixed-use skyscraper required innovative engineering solutions to achieve its record-shattering height and support its enormous weight. Here is a detailed look at the making of the Burj Dubai:

Towering concrete

More than 2,600 feet tall — its actual height is a closely guarded secret — the Burj Dubai is essentially a giant concrete beam cantilevering out of the ground. But achieving such a precise protrusion nearly half a mile upward involves complicated engineering.

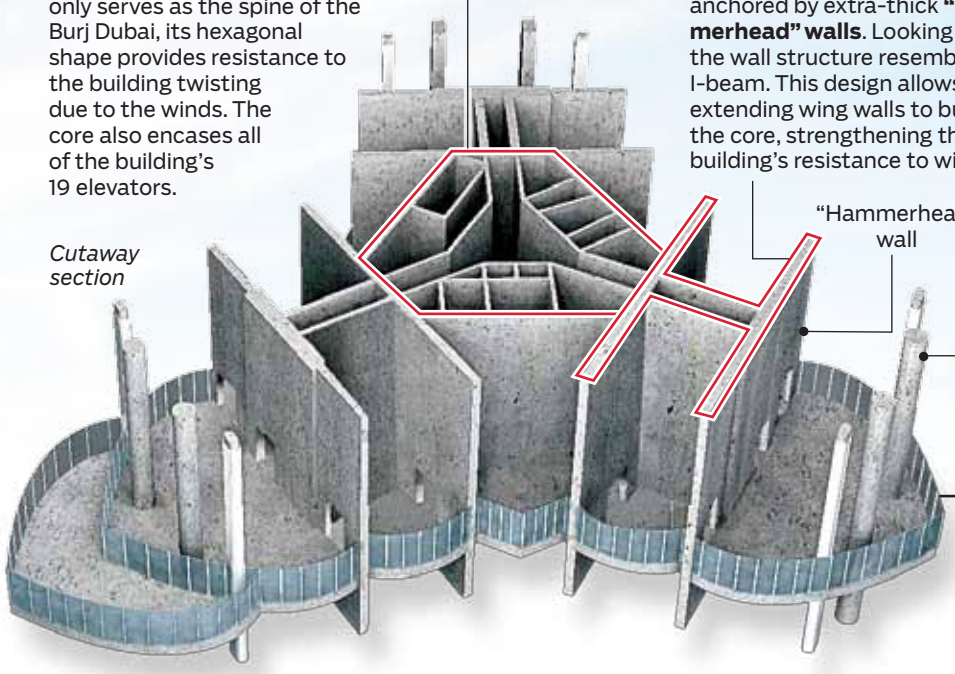
A giant axle
Central to the structure is a **concrete core** rising from the base to floor 156. The core not only serves as the spine of the Burj Dubai, its hexagonal shape provides resistance to the building twisting due to the winds. The core also encases all of the building's 19 elevators.

Buttressed core
Through each of the Burj Dubai's three wings, concrete walls extend from the core and are anchored by extra-thick **"hammerhead" walls**. Looking down, the wall structure resembles an I-beam. This design allows the extending wing walls to buttress the core, strengthening the building's resistance to wind.

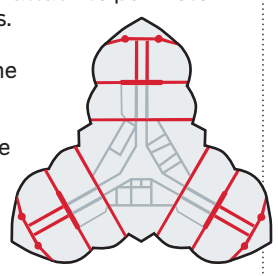
Cutaway section

"Hammerhead" wall

Exterior columns

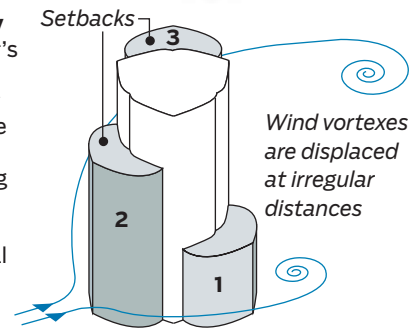


Extra support
On the building's five mechanical floors are thick concrete walls, called outriggers, that extend from the core and attach to perimeter column walls. These help transfer some of the building's weight to the exterior columns, further strengthening the structure.



Outriggers

Twisting away
The skyscraper's three wings gradually taper as they rise, the result of the floors recessing every few stories in a clockwise spiral to create setbacks. This pattern helps reduce the impact of wind vortexes — small tornado-like spirals created as wind curves around the structure — by displacing them at irregular distances.



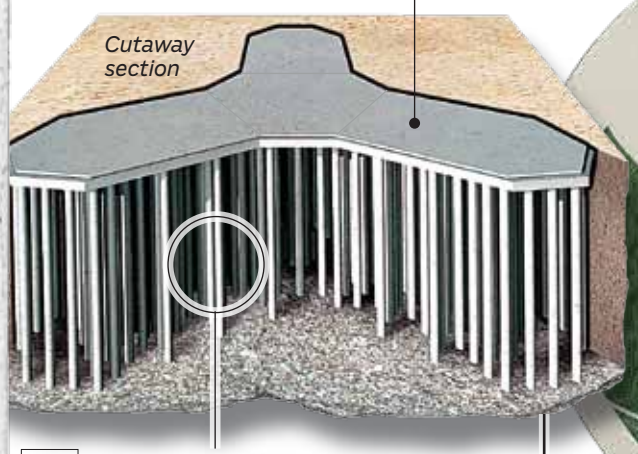
Solid footing

Unlike the dense bedrocks of New York or Chicago, Dubai's subsurface is made of small pieces of rock that cemented themselves together over time. To solidify the foundation, engineers utilized reinforced concrete piles. Once the piles were in place, a concrete mat was poured in the "Y" shape of the building's floor plan.

Concrete
Because Dubai groundwater has high levels of chloride and sulfates — which can eat concrete and corrode metal rebar — the concrete used in the piles and mat is extremely dense to limit the areas where water can invade.

Mat
- 12-feet thick
- Reinforced concrete poured in three separate stages (three wings and center). Each pour lasted at least 24 hours.

Cutaway section



Piles
- 194 total
- Positioned primarily beneath the three wings and near the edges to aid in distributing weight away from the core.

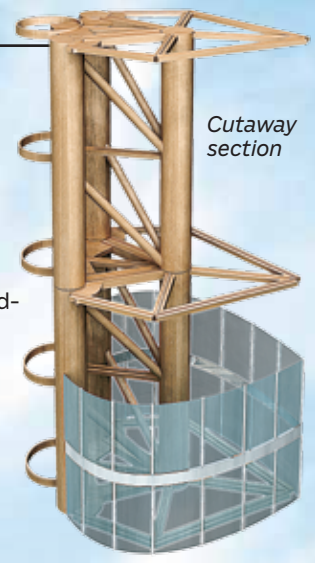
Rebar inside

Diameter: **5 feet**
Height: **150 feet**

At the top

At floor 156, the concrete ends and a more traditional steel beam structure begins. The lower portion of these upper levels are used primarily for broadcast and mechanical purposes. A steel spire — a giant metal pipe — extends through the unoccupied middle of the structure up to the final height. Outside the building at these levels, the temperature is noticeably cooler than at ground level.

Cutaway section



Floors 155 to the top
Mechanical, broadcasting and non-occupied areas

Floors 112-154
Offices

124
Observatory

122
Restaurant

Floors 18-108
Residential (Includes apartments, hotel suites, regular and luxury residences)

Floors 1-16
Hotel

Entrance pavillion

Spa

Office annex

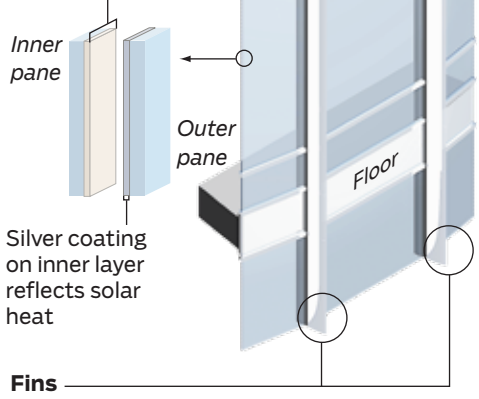
Keeping cool

The Burj Dubai's exterior resembles that of Chicago's Trump International Hotel & Tower, which was also designed by Skidmore, Owings and Merrill.

Double-paned glass walls are designed to keep out the searing desert heat while allowing for expansive views.

Glass wall cross section

Special coating on outer layer controls heat transfer through windows

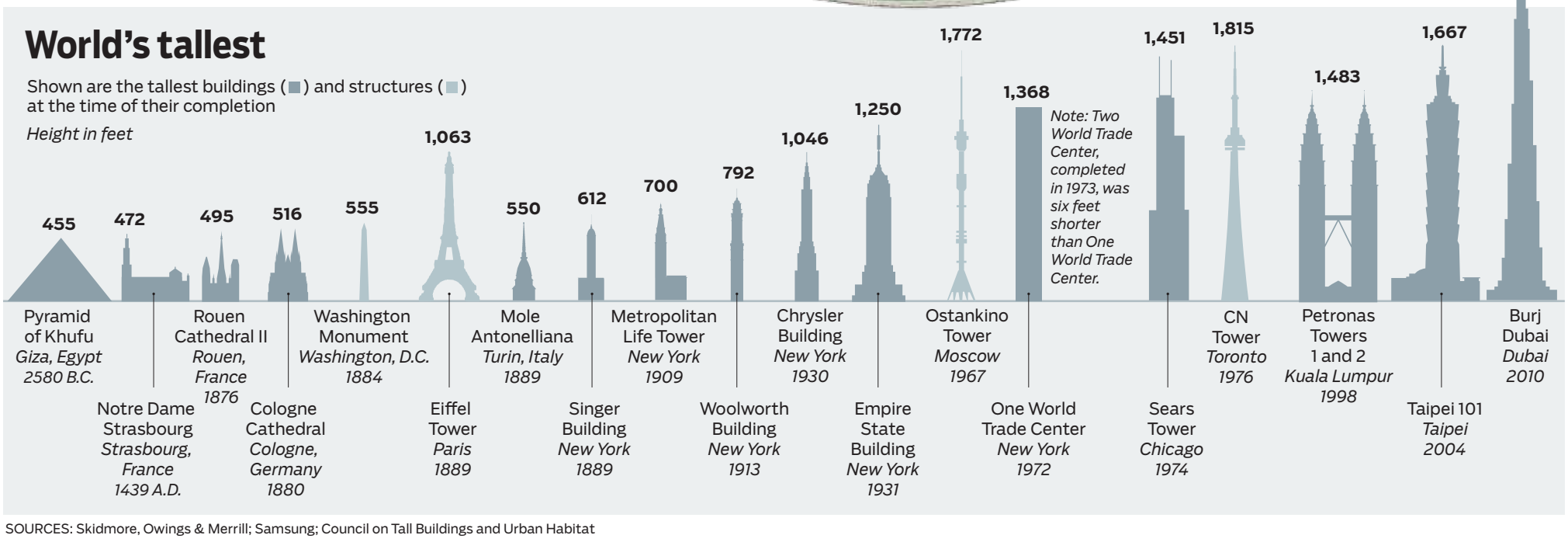


Fins
These stainless steel features rise vertically to accentuate the tower's height and help reduce the wind's effect on the building, much as dimples cut down on the drag of a flying golf ball. The design also sought to eliminate any horizontal surfaces that could collect fine-grained desert dust or sand.

World's tallest

Shown are the tallest buildings (■) and structures (■) at the time of their completion

Height in feet



SOURCES: Skidmore, Owings & Merrill; Samsung; Council on Tall Buildings and Urban Habitat