Zhengzhou Greenland Plaza
Zhengzhou, China
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Zhengzhou Greenland Plaza
Zhengzhou, Henan Province

Completed in 2012, the 56-story (280 meters) Zhengzhou Greenland Plaza tower is the tallest building in central China. SOM architects and engineers designed the tower to prioritize sustainability and optimize performance within Zhengzhou’s humid subtropical climate.

Key design elements include:

- Structural system inspired by traditional masonry and timber pagodas throughout the region.

- A low-E glass curtain wall

- A high performance shading screen that protects the curtain wall from solar heat gain.

- A 20-meter heliostat that crowns the building and reflects sunlight down into its atrium, saving energy on artificial light and cooling.

- A control system which harnesses the building’s internal stack effect in tandem with external wind pressure to achieve maximum natural ventilation and energy-efficient heating and cooling.
Site Context

The tower stands on a prime site in the heart of Zhengzhou’s thriving Central Business District (CBD), abutting a large lake, The Henan Art Center, and the city’s main convention center.

A ring of commercial, office, and residential buildings encircles the district.
Structural System

THE PROBLEM

Zhengzhou is located in a region of moderate inland winds and earthquake activity.

AN INSPIRED SOLUTION

The tower’s structural system draws upon the structural systems found in traditional pagodas throughout the region.

It is composed of a highly efficient assembly of two distinct, but attuned systems:

- Concrete core
- Steel moment frame
Concrete Core

The tower’s reinforced concrete core functions similarly to the brick walls in masonry pagodas, minimizing the impact of lateral loads.

The concrete core is designed to resist 100% of lateral seismic and wind loads without the need for outriggers or other supplemental systems, traditionally located on mechanical or service floors.

Steel Moment Frame

The exterior moment frame harnesses the ductility of steel to further dissipate these loads, echoing the function of timber frames found in naturally seismic-resistant wooden pagodas.

The moment frame is designed to resist at least 25% of the gravity loads and the minimum seismic shear force, as required by Chinese code.

This approach maximized the utilization of the concrete core and minimized the steel weight, resulting in an efficient, simple-to-erect steel frame.
The tower also sits atop a thin layer of powdered sand that covers silt-based soil. A tower, which places an enormous load on a relatively small footprint, sited on such weak soil could potentially cause severe settling and tilt.

Without compressive strength in the soil, skin friction between the piles and soil must support the tower foundation. As a result, 295 cast-in-place reinforced concrete piles, each 1m diameter and 60m deep, support the tower’s mat foundation.
Exterior Shading Screen

A high performance shading screen cants out and up away from the tower’s exterior glass curtain wall, protecting it from solar heat gain.

Aluminum panel assemblies, typically four stories tall, make up the screen and attach to the curtain wall via stainless steel struts.

Their precise outward cant enhances interior day-lighting through scientifically calculated reflections and reduces the need for artificial lighting.

To maximize energy efficiency, the shading system should block out solar radiation during the summer, while allowing it to passively heat the space during the winter.
High-Performance Envelope

Shading screen blocks direct solar radiation

Low-E Glass reduces solar gains

But what about occupant views?
Creating A Pleasant and Efficient Work Environment

Today’s building tenants demand spaces that are both pleasant and efficient. Zhengzhou Greenland Plaza offers unsurpassed views of the Central Business District, and provides tenants with highly efficient spaces.
Building Crown Heliostat

The tower is crowned by a 20m heliostat made from four “petals” which cantilever from a central frame. Its computer-controlled solar reflector focuses sunlight down into the hotel-level atrium, and dimmer-controlled sunshades modulate light levels and enable the atrium to be bathed in glare-free light that is adjusted to the time of day.

The system also saves energy on artificial lighting and cooling. Overall energy savings are projected to be 20% below ASHRAE 2007. The entire system is hung from the roof structure by steel cables, minimizing the heliostat’s structure, thereby maximizing the amount of light that reflects down into the atrium.
Natural Air Circulation & Ventilation

The tower’s atrium also features a smart control system that harnesses the internal stack effect in tandem with external wind pressure to achieve maximum natural ventilation.

By moving large volumes of fresh air naturally through the building’s interior, energy-efficient cooling and heating systems will adjust to Zhengzhou’s changing seasons and achieve substantial energy savings.

In order to maximize the benefit of this type of system, three key aspects of the wind must be understood:

• Seasonal wind patterns
• Height / Wind relationship
• Prevailing wind temperatures
Wind speed increases in transition seasons
Wind speed increases with altitude.
Prevailing Winds

Average Wind Temperatures
Location: Zhengzhou, CHN (41.7°, 113.7°)
Date: 1st January - 31st December
Time: 00:00 - 24:00
© Weather Tool

Cooler Wind Comes from the Southwest
Wind Flow Pattern Through Building

Inlet

Outlet

86 m

36 m

Prevailing Winds

But How Should We Orient the Openings?
Optimizing Orientation for Natural Ventilation

- Wind speed: 4.5 m/s
- Wind Direction: 0 and 45 degree
- Inlet and outlet: 10 m²
- Two cases were studied:

**Case 1**
0 degrees from Prevailing Wind

**Case 2**
45 degrees from Prevailing Wind
Case 1: Inlet Velocity Vector Map (Top View)
Case 2: Inlet Velocity Vector Map (Top View)

Velocity Vectors Colored By Velocity Magnitude (m/s)
Natural Ventilation Airflow Rates

**CASE 1**

100800 m$^3$/h  
(59,300 ft$^3$/min)

**CASE 2**

20736 m$^3$/h  
(12,200 ft$^3$/min)
Zhengzhou Greenland Plaza

Traditional Regional Form

Cutting-edge Sustainability