Title: **Design for Vertical Habitation**

Authors: Jun Xia, Gensler
Elizabeth Michalska, Gensler
Wendy Wong, Gensler
Raymon Chen, Gensler

Subjects: Architectural/Design
Building Case Study

Keyword: Vertical Urbanism

Publication Date: 2014

Original Publication: Suzhou Zhongnan Tower: In Detail

Design for Vertical Habitation

垂直人居环境设计

Jun Xia (夏军), Elizabeth Michalska, Wendy Wong (黄玮儿) & Raymon Chen (陈黎明), *Gensler*

This chapter describes the main principles behind the architectural design of the building. Its architectural expression and functional organization achieve not only iconic landmark status, but also fulfill its owner's investing strategies by creating a modern business model in which performance-based measurements can be closely monitored. The ultimate objective of the design is to create livable spaces for daily life, work and play. The tower is on track to become the tallest building in China upon completion in 2020.

本文阐述了苏州中南中心采用的主要设计原则: 其建筑表达及功能组织不仅达到了城市地标的要求，还通过成功的现代商业模式 (在该模式下，其基于性能的测量可密切监控) 的营造满足了业主的投资战略预期。设计的终极目标在于营造出适宜日常生活、工作及休闲的宜居空间。该多样化的垂直社区有望于2020年建成时成为中国最高楼。

Site

The main entrance to the site is located at Suhui Road and Xingyang Street. The podium overhangs above the main entrance to the plaza and provides primary access to retail, the hotel ballroom and offices. The office drop-off is located along the south edge of the tower. The north entrance of the tower, across the street from Century Plaza, will provide access to the seven-star hotel. The apartment drop-off is situated along the west edge of the tower. Freight access is located at Xingzhou Street to the east (see Figure 2.1).

Concept and Tower Geometry

The vision is to transform the tower into Suzhou's most iconic destination, at the heart of the urban fabric. The intent of the design is to reinforce the Jiangnan culture, integrating it with the functional stacking of spaces in order to create a vertical public realm.

The tower's vertical geometry is set out by combining three delicate radial curvatures tangent to each other, giving shape for the sensuous tower form. The four corners of the tower are treated by two strips of metal cladding panels at the edge of each corner, giving definition to its geometric form. The geometry is defined and determined by the diversified program functions of the tower. The project will enhance the general image of the Suzhou CBD to become a major destination for both local and international visitors.

The form of the tower relates to the Jiangnan culture, inspired by the pagoda and the springs of water flowing down to Jinji Lake. This gives the Suzhou Tower a feminine, elegant and sensuous form. The concept also signifies the strength and cultural values of Zhongnan's brand identity.

Building Massing

The 137-level tower, being the dominant mass in the region, is juxtaposed with the eight-level podium attached to the south side of the tower. The podium is the modern interpretation of the "flying lantern" (see Figure 2.2), with a recessed mass linking the podium and the tower

基地

基地主入口位于苏惠路及星阳街上; 裙楼悬挑于通往广场的主入口上方，主要提供与商业、酒店宴会厅及办公的出入口。办公下客区位于塔楼的南面。塔楼北侧入口与世纪广场南面的道路相毗邻，为七星级酒店的出入口。公寓下客区坐落于塔楼的西面。货运出入口位于东面的星洲街上 (参见图2.1) 。

设计概念及塔楼几何外型

设计旨在将苏州中南中心建成苏州中心位置最具标志性的目的地。我们的设计手法强化了江南文化，与空间的垂直功能相整合，营造出垂直的公共空间。

三个曲率半径相切，构成了塔楼的垂直几何外形。塔楼四个角的各个边缘均采用两条金属外挂板处理，定义了其几何体型。此外，还利用不同的业态功能区别界定了该体型。该项目将改善苏州中央商务区的形象，使其成为当地及国际访客的主要目的地。

塔楼的外型与江南文化相关联，从佛塔及从天空顺流至金鸡湖的泉水获得灵感，为苏州塔楼提供了具有女性气质、优雅且富于美感的外型。该概念还体现了中南品牌标识的实力及文化价值。

Figure 2.1. Site plan (Source: Gensler)
图2.1. 场地平面图 (来源: Gensler)

together. The podium canopy and tower core act as beacons of light, shining on the tower. The architectural vocabulary of the tower canopy serves as a circulation linkage between the tower and podium.

The approach of lifting the podium off the ground creates an open public plaza at ground level connected by escalator to Level 2 through an atrium space. The atrium space then spans four levels vertically, all connected by escalators. This sequence creates inviting and sculpted space for retail and entertainment.

The design challenge of resolving these two extremely contrasting masses requires articulation by breaking up the podium massing and expressing the podium lantern separately.

Diversifed Vertical Community – Program Functions

The vertical functional stacking of the mixed-used development connects public spaces such as retail, entertainment and hotel ballrooms at the podium to the tower base by traversing skywards into more private spaces. The latter consists of apartments

建筑体量

主结构为137层高的塔楼，与8层高的裙楼 (与塔楼南侧相连) 比肩齐飞。裙楼是孔明灯的现代诠释 (参见图2.2)，凹槽将裙楼与塔楼连接起来。夜晚裙楼雨篷及塔楼如灯塔般闪闪发光。塔楼雨篷的建筑设计语言使塔楼和裙楼连接在一起。

裙楼的架高设计在地面层营造出开敞公共广场，通过自动扶梯通往二楼，而中庭空间通过内部的自动扶梯将四个楼层垂直连接，为商业和娱乐功能营造出引人入胜的室内空间。

对于这两个反差极大的体量，其设计挑战在于需打破与裙楼体量的衔接，单独体现裙楼灯笼外型，而无需与塔楼相呼应。

多样化的垂直社区—功能规划

多功能项目的垂直功能叠加从裙楼和塔楼底层的商业、娱乐和酒店宴会厅等公共空间一直向上延伸到更加私密的空间，包括沿塔楼至楼顶竖向叠加的公寓和酒店功能。塔楼一共分为9个区 (参见图2.3)，裙楼和塔楼1区包括位于2层和3层的商业空间，4层和5层的餐厅，6层的KTV娱乐和温泉水疗设施，以及7层的主次宴会厅。国际甲级办公布置在2区，公寓式办公布置在3区，豪华公寓布置在4到7区，7星级酒店布置在顶部的8区和9区。各区由避难和设备层分隔。本项目的酒店将成为世界上最高的酒店。

通往酒店上部观光层的体验旅程始于2层，将成为塔楼顶部游客的亮点，可观赏到风景如画的金鸡湖景色。

地下室共5层。B1层布置商业和餐饮功能; 包括卸货和装货区的交通运输中心位于B2层，而B3，B4和B5层的功能设置为停车库和位于西北角的人防。主要的设备机房位于B5和B2。

作为商业总体开发策略，地下商业空间的北部和东南部通过地铁通道与相邻的商场连接，打造了跨越两个基地的商业环路。商业人流可通过基地北侧的下沉式广场竖向流通，并可通过南侧的下沉广场到达1层广场，形成通往地下商业的主入口节点。1层广场打造了同地下及地上商业空间相连的商业联系，吸引人流，同时营造了场所感 (参见图2.4, 图2.5)。裙楼的商业空间通过连廊与相邻的商场相连，是商业总体开发策略的一部分。

Figure 2.2. The flying lantern inspired the building podium (Source: Gensler)
图2.2. 孔明灯为裙楼设计提供了灵感 (来源: Gensler)

and hotels that are stacked vertically along the tower towards the top. The tower is composed of nine zones in total (see Figure 2.3). Zone 1's podium and tower consists of retail spaces, of which levels 2 and 3 are restaurants, levels 4 and 5 are entertainment and spa facilities, and level 6 hosts hotel facilities including junior and main ballrooms. International Grade-A offices are provided in zone 2 of the tower. Office services are on zone 3, while luxury apartments are located on zones 4 to 7. A seven-star hotel occupies zones 8 and 9. Each zone is differentiated by a refuge and mechanical floor. The hotel will be the highest hotel in the world when it opens.

The experience of the journey to Observation level at the uppermost zone atop the hotel begins at Level 2, which will be a highlight for visitors to the tower top, affording a magnificent view of Jinji Lake.

The basement consists of five levels. B1 serves as retail space, containing food and beverage services, and a transport center. Loading and unloading is located at B2. B3, B4 and B5, comprise parking and a civil defense zone at the northwest corner. The main mechanical plant rooms are located at B2 and B5.

The retail master plan strategy connects underground retail space to the north and south-east to the adjacent mall via metro connections, creating a retail loop spanning across two sites. Pedestrians are vertically connected through the sunken plaza on the north side and up to the Level 1 plaza on the south side. These connections form major entrance nodes to the basement retail. The Level 1 plaza connects retail spaces below and above ground, encouraging pedestrian movement and creating a sense of place (see Figures 2.4 and 2.5). The retail spaces in the podium are connected by a link bridge to the adjacent retail mall.

The square floor plates are designed with reveals at the four tower corners. They are consistent and maximize the efficiencies of the floor plates. The central core arrangement complements the floor plate's design, allowing for flexible space planning. This also contributes to achieving good lease spans for the floor plates of different functions.

塔楼平面为正方形，四个角部内收，方正的平面可以最大化楼层的利用率。中央核心筒的布局与平面设计形成互补，打造了灵活的空间布局，同时也为不同功能的楼层打造了良好的出租空间跨距。

多样化的垂直社区由竖向叠加的基于功能要求和精心的几何设计从而达到最大化的出租跨距和使用率所组成，满足各个功能布局的商业模式要求。塔楼低层办公的跨距较大，相应楼板面积也较大，适宜办公，与此相反，高层出租跨距较小，适合公寓和更高楼层的酒店功能。达到出租跨距要求和超高层塔楼利用率的挑战在于核心筒规划。须理解核心筒布局的内在部分和组成，包括各种多功能业态的垂直交通，生命安全与疏散，结构和机电，以便解决所有的技术难题。

垂直交通

核心筒为塔楼的主动脉，根据不同的功能进行布局，而垂直交通在充满挑战性的塔楼设计中起着关键作用。垂直交通平均每天须运送多达20000多的人。设计团队对电梯的能力和数量进行了精心研究，以便最大化建筑核心筒的利用率。客梯主要为1600千克载重，但公寓客梯载重为1350千克，为更高速的电梯提供了更大的竖井空间，同时达到节能效果。服务式办公、公寓和酒店采用高速穿梭电梯，节省了核心筒空间、施工造价和能源，同时在空中大堂增设了配套设施和开放空间，可供欣赏城市景观和湖景，促进人们互动，提高了社会和经济价值。

外立面

在根据业态对功能进行性能评估的同时，塔楼外立面设计提升了建筑概念，突出了建筑形式的简洁明快的风格。塔楼外立面设计为模块化幕墙，各单元完全在工厂预加工。标准单元为1500mm宽，高度为楼层高，由氟碳喷涂铝合金龙骨和可视玻璃构成，层间区域由铝框和阴影盒组件构成。为强调大楼的竖向造型，各幕墙单元都设计了室外垂直铝合金装饰肋。建筑主体的可视和层间玻璃采用透明反射高性能Low-e中空玻璃。角落处采用的玻璃类似，但颜色较深，边缘处同样采用

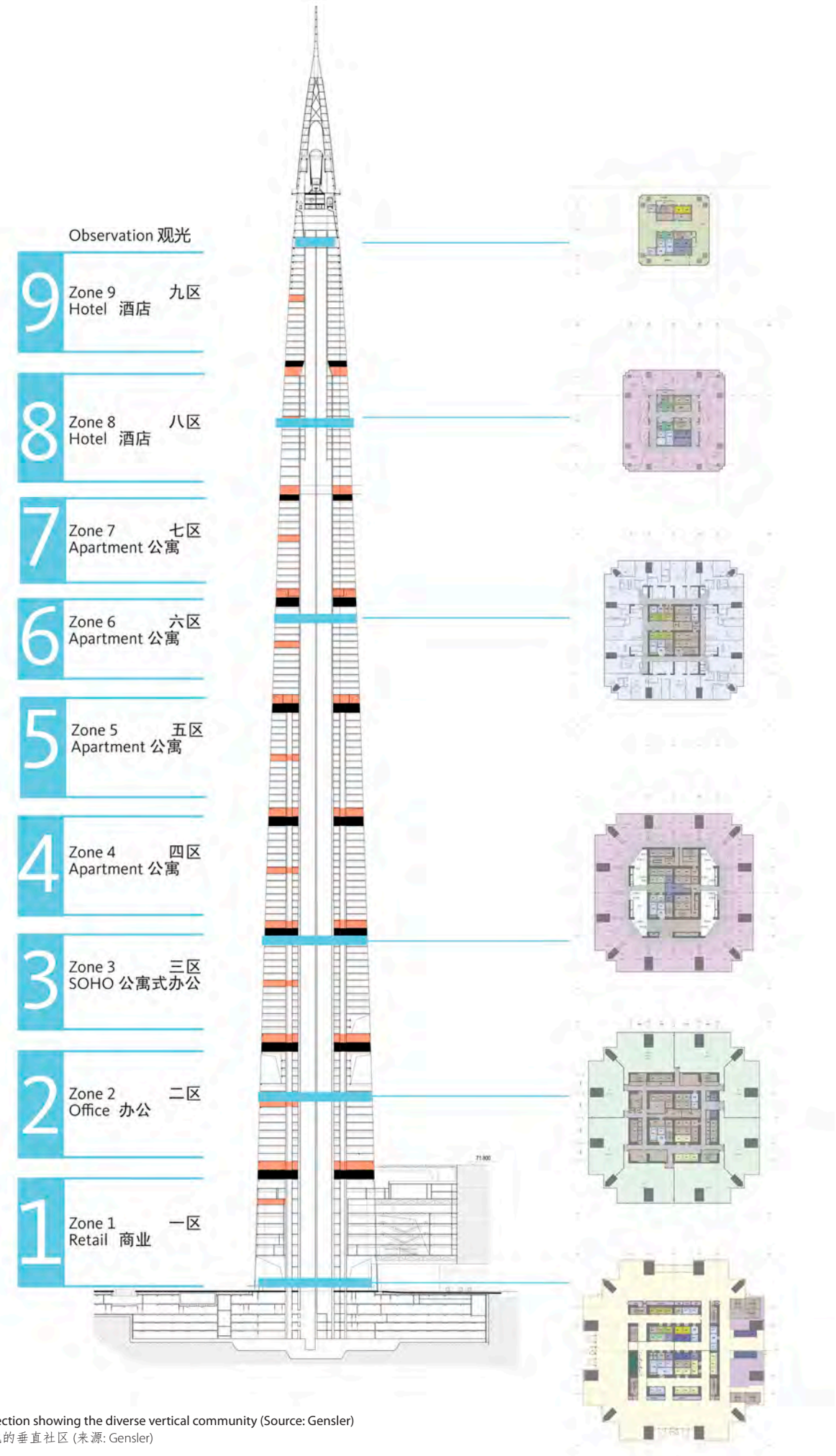

Figure 2.3. Section showing the diverse vertical community (Source: Gensler)
图2.3. 多样化的垂直社区 (来源: Gensler)

This diverse vertical community is created by deliberate geometrical stacking to maximize the lease spans and efficiencies necessary to satisfy the business model for each functional layout. The formation of the tower, with deeper lease spans on the lower floors for office functions, in contrast to the upper floors with narrower lease spans for apartment and hotel functions. The challenge of achieving the necessary lease spans and efficiencies of the supertall tower was resolved in the core planning. Components accommodated in the core include vertical transport along the different mixed-used functions, fire and life safety for evacuation, structure and MEP components.

Vertical Transportation

The core, being the spine of the tower, is configured according to the different functions. Vertical transportation plays a key role in the challenging tower design. Over 20,000 people will be transported vertically on a daily basis. The capacity and number of elevators were carefully studied in order to maximize the building core efficiencies. The passenger elevators used are primarily 1,600 kilograms in capacity, with the exception of the 1,350-kilogram elevators used for apartments. This provides greater shaft space necessary for higher-speed elevators and achieves energy savings. High-speed shuttle elevators are used for service offices, apartments and the hotel. This reduces core space, construction costs and energy usage while adding amenities and open spaces at the sky lobbies, while promoting personal interactions and supporting social and economic values.

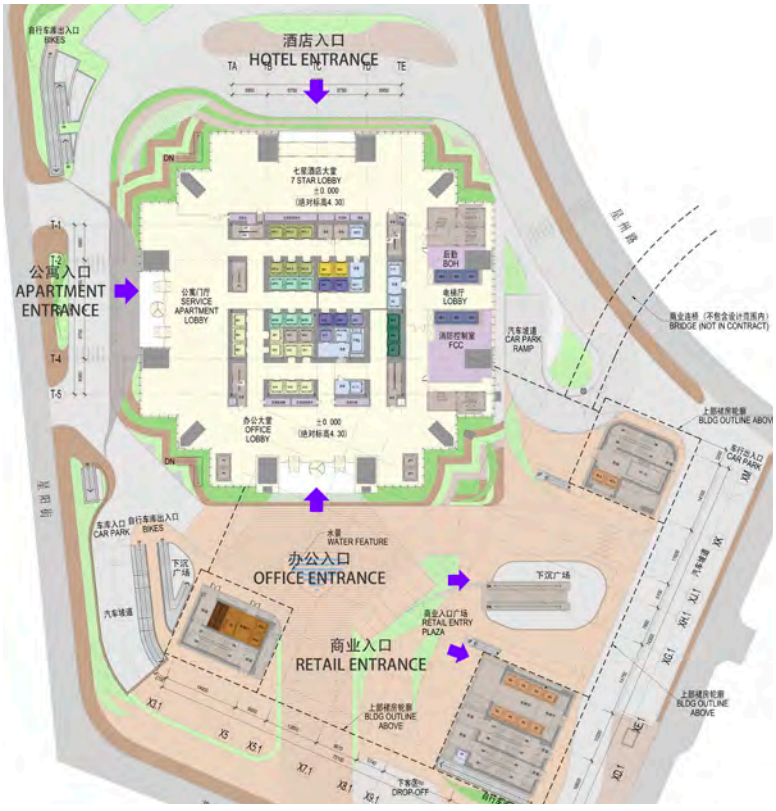

Figure 2.4. Site access diagram (Source: Gensler)
图2.4. 场地出入口图 (来源: Gensler)

竖向金属铝板，进一步突出建筑造型和几何形状。

塔楼外立面上采用相同的模数和视觉化设计从建筑底层一直延伸至建筑最顶部，仅在机电层的百叶系统中断。首层入口大厅处改用约16米高的全玻璃组件，建筑入口处，比整体的建筑表面略微内凹，并采用单独的系统-拉锁点式玻璃结构，在上方设置悬臂式雨篷。

裙楼建筑为9层结构，首层架空约16米，采用三个石材面层的核心筒，并通过凹入式的玻璃外立面同主楼相连(参见图2.6)。建筑体量主要采用半透明彩釉玻璃外立面系统打造立体"孔明灯"的形象。

超高层塔楼外立面设计最重要最具挑战的一个方面就是对幕墙系统的位移及设计荷载的充分理解。建筑外表面的设计受到风洞试验的限制，而实验结果则是铝合金、玻璃结构设计及外幕墙锚固系统的基本设计标准。

此外，室外围护结构设计必须考虑热胀冷缩引起的位移和结构构件的变形，比如楼板挠度差异、钢筋混凝土周边立柱缩小、楼层间建筑侧向挠度-风压及地震施加在结构上的影响。对以上所有标准的全面、深入的综合分析是构成超高层塔楼外立面设计依据的一部分。

Figure 2.5. Plaza – Public Realm (Source: Gensler)
图2.5. 广场 – 公共领域 (来源: Gensler)

Façade

The tower façade is designed to enhance the architecture, emphasizing purity and simplicity. The façade is proposed as consisting of modular curtain walls in prefabricated units. The typical unit is 1500 mm wide by a full story height, and comprises a painted aluminum frame along with vision glass. A shadow box is inserted in the spandrel area. To emphasize the verticality of the building, each unit features an external vertical aluminum fin. The primary building's body vision and spandrel glass is selected to be clear, reflective, high performance and is a low-e insulating glass units. Similar, but slightly darker, glass is used at the corners framed by the vertical metal panel edges, thereby further enhancing the form and geometry of the building.

The tower façade's visual design continues through the entire height of the building to the ground. It is broken only by a louver system at the mechanical floors, and terminates at the entrance's lobby. It is an approximately 16-meter-tall, fully glazed assembly. Separate systems, slightly recessed from the face of the building, are proposed at the building entrances, utilizing tension-cable-point-supported structural glass with cantilevered canopies above.

The podium building is a nine-story structure lifted from the ground approximately 16 meters by three stone-clad cores. It is attached to the tower through a recessed, glazed façade (see Figure 2.6). Predominant massing is accomplished by a cubical interpretation of the Chinese "flying lantern," using a translucent and fritted-glass façade system.

One of the most important and challenging aspects of designing the façade for the supertall towers was the need to acquire a full understanding of the movements and design loads that the curtain-wall system has to accommodate. The building cladding was subjected to wind-tunnel test pressures, and the results of the test formed the base criteria for the structural design of the aluminum, glass and façade anchoring systems.

In addition, the exterior enclosure design must take under consideration thermal movement expansion and contraction, plus all the building's structural movements, such as slab defection differentials, reinforced-concrete perimeter-column shortening, and interstory building lateral deflections, such as the racking and cantilever effect caused by wind pressure and earthquakes. Rigorous, in-depth and comprehensive analysis of all the above criteria drove the façade design for the megatall tower.

Sustainable Design

The sustainable objectives for the project are to achieve the China Green Building Evaluation standards (GB/T 50378-2006), 3-star and USGBC LEED Gold. The architect takes the lead

可持续设计

项目的绿色设计目标旨在达到中国绿色建筑评定标准 (GB/T 50378-2006) 3星级标准及美国绿色建筑委员会LEED金级认证。Gensler带领绿色建筑顾问、工程顾问及设计院倡导绿色建筑设计。整个绿色设计应考虑以下这些方面——室内外环境连接界面、能源节约、能源使用、节水与用水、节约用料及室内环境质量保证。以下为绿色设计的一些主要方面。

绿化屋顶及屋顶光伏系统

预计项目会提供至少50%的绿色裙楼屋面设计。景观化的裙楼屋顶花园含线性绿色带，同时还有硬铺装材料、景观家具及照明，共同营造一个富有活力和魅力的空间氛围。裙楼绿色屋面可以有效的减少城市热岛效应，通过裙楼屋顶的构造减少能量损失，并提升建筑的使用寿命。绿色屋面同样可以减少雨水流量，反过来减轻城市内涝。

裙楼屋面花园上方覆盖了大约1500平方米的光伏发电板模块，形成了露天及半露天的裙楼露台。裙楼屋顶景观融合了设计理念及功能需求，并为塔楼高区以及相邻的建筑提供了良好的视觉景观。预计本项目最少将提供190kw的太阳能发电功率，其年发电量预计超过250000千瓦时。

地下空间及可选交通的合理开发

由于基地已经被建筑所撑满，首层室外空间极为有限，因而95%的停车空间设置在w地下。卸货区、后勤服务及设备机房同

in advocating the sustainable building design, together with green building consultants, engineering consultants and design institutes. The sustainable design considerd multiple aspects: interface with outdoor environment, energy conservation, water use, material choices, and indoor environmental quality.

Green Roof and Photovoltaic System at Roof

The design of the podium is expected be at least 50% green roof. The podium's landscaped roof garden will consist of linear strips of plantings and integrated paving. Landscape, furniture and lighting will create a lively and captivating atmosphere. The podium green roof can effectively reduce the urban heat island effect, reduce energy loss of the podium, and increase the service life of the building. The green roof also reduces stormwater runoff.

Photovoltaic modules are graphically composed above the podium's roof garden, thereby covering 1500 m^2 of podium roof area. This creates an outdoor and semi-outdoor podium terrace. The podium roofscape merges both design and function, providing visually captivating views down from the tower and neighboring buildings. The project is expected to consume a minimum of 190 kW of solar power, while generating an expected 250,000+ kWh of power per year.

样设计在地下层，以节约土地资源，最大化环境安全，最小化交通堵塞及环境污染。地下室还设计了一些自行车停车位，并提供相应的淋浴设施。此外，还为特殊新能源汽车设计了优先停车位。汽车坡道边缘设有一条绿色缓冲带，以美化环境及视觉效果。

地下空间照明

地下室设计了两个下沉广场，将自然采光引入地下商业楼层，形成商业空间组织的独特节点。主要下沉广场为半露天，与1层的公共广场空间的中庭空间垂直相连，这样一来，地上及地下空间都更加充满活力，吸引着四面八方的人流。

Figure 2.6. Tower base and podium connection (Source: Gensler)
图2.6. 塔楼底部与裙房连接 (来源: Gensler)

Figure 2.7. Tower entrance (Source: Gensler)
图2.7. 塔楼入口 (来源: Gensler)

Rational Development of Underground Space and Alternative Transport

The tower footprint is minimal, therefore, over 95% of the parking spaces are provided below ground. Loading and unloading of house services is located on the rear of the site. Mechanical plants are also placed below ground to save land resources while maximizing the safety of the environment. Minimizing congestion and pollution is also accomplished by mechanical plant placement. A number of bicycle parking spaces are included, as are corresponding shower facilities. Priority parking spaces for special new-energy vehicles have also been designated. A landscape buffer is designed at the edge of the car ramps for environmental and visual effect.

Lighting for Underground Space

Two sunken plazas have been designed to bring natural daylight to the basement retail level, while creating distinct nodes for the retail spatial organization. The main sunken plaza is semi-open air and is vertically connected with the atrium space at level 1 of the public plaza space. Both spaces above and below ground are now activated, drawing people to the site horizontally and vertically.

Façade

Energy design targets are set by the green building consultant for the façade design. Targets included annual energy cost savings of 16%, annual HVAC system energy savings of 20% and cumulative annual heating and cooling load reduction through the envelope by 3%.

Conclusion

The goal and desire of the designers and architects of the Suzhou Zhongnan Center have taken the design challenges as opportunities. Creating this megatall tower requires balancing aesthetics and performance-based measurements while incorporating diverse program functions. To be economically competitive and to become a role model for different city contexts is also a primary objective. The project is envisaged as a continuation of the living history of Suzhou, beyond this era into the future.

外立面

绿色建筑顾问为外立面设计确立了能源设计目标，包括16%的年节能目标，20%的空调系统节能目标及通过外护结构将年度总供暖、制冷负荷减少3%。

结论

设计师及建筑师的目标是以挑战性的设计作为机遇来打造此超高层塔楼，通过平衡不同业态使用功能,结合建筑美学，结构美学等，和投资回报的综合优化，使塔楼具有经济竞争力，成为不同文脉城市同类项目的楷模。本项目将成为苏州生活的历史超越这个时代到未来。

References (参考书目):

Energy Analysis for Typical Office Floor Envelope Design (Source: EMSI)

Green Design Schematic Design Report (Source: EMSI)