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Considering Place in an Integrated Approach to Tall Building Design

高层建筑设计综合方法中的场所考量



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As an architect and urban designer, **Brian Lee** brings a hands-on design approach to his work – maintaining a full integration of the natural and built environment, and providing meaning to those who use the spaces. Mr. Lee has designed projects across the globe.

作为一名建筑和城市设计师，Brian Lee 先生在工作中亲力亲为，在设计中将自然环境和建筑有机的结合在一起，并为其间生活和工作中的人们带来了不同凡响的意义。Brian Lee 先生设计的标志性建筑项目遍布世界各地，包括东亚和东南亚、欧洲和中东等地区。

William F. Baker is a Structural Engineering Partner and is regarded for his work on supertall buildings such as the Burj Khalifa, Zifeng Tower, and Trump International Hotel and Tower in Chicago. Bill is a Fellow of the American Society of Civil Engineers and the Institution of Structural Engineers, a member of the National Academy of Engineering, and a CTBUH Trustee.

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Luke Leung is the Director of the Sustainable Engineering Studio. He is committed to raising the bar in engineering, especially high-rise structures. His work ranges from the LG Art Hall, one of the first displacement performing arts centers in the world, to the Burj Khalifa, the world's tallest man-made structure with a first-of-its-kind stack effect control system.

Luke Leung 先生是SOM设计事务所可持续工程设计总监。他致力于提高各类建筑，尤其是超高层建筑结构设计标准。他所参与的设计项目包括世界上第一个使用置换通风技术的表演艺术中心—LG艺术厅、第一个采用烟囱效应控制系统的世界最高人造结构—迪拜哈利法塔，其它主要项目还包括北京金融街、美国驻加拿大渥太华大使馆、以及南京紫峰大厦。

Abstract

The rapid development of modern Chinese cities has provided designers and developers with unique opportunities to create architecture that either responds to its existing context or, as in the case of emerging cities, creates entirely new urban identities. When coupled with advancements in technology, construction technique and analytical design tools, these opportunities have yielded some of the world's most sophisticated and progressive architecture. This paper will explore the design of supertall buildings throughout China and examine the context of these structures within each tier of Chinese city. It will also examine a holistic approach to achieving high performance design in 21st century architecture. The authors will explore the key design challenges associated with these unique structures and discuss their efforts to create architecture that is iconographic, contextually responsive, and energy efficient.

Keywords: Tall Buildings, China, Context, Place, SOM

摘要

现代中国城市的快速发展为众多设计师与开发商提供了独特的机遇，使他们有机会创造与现有环境相呼应的建筑，或在不断发展的新兴城市中创建全新的都市特征。结合在科技、施工技术与设计分析工具等领域的进一步发展，创建了当今世界最为尖端和进步的建筑物。本文将通过探讨中国超高层建筑的设计，分析在各个级别的中国城市中这些结构的背景环境，详细研究为实现21世纪建筑高性能设计而采用的设计体系。并对与这些独特结构相关的重要设计挑战进行研究的同时，探讨他们在创造具有象征性、与环境相呼应、并且节能的建筑方面所做出的不懈努力。

关键词：高层建筑，中国，环境，地点，SOM事务所

Developing Urban Identity

Twenty-first century China uniquely understands that high-performing, high-quality design can support the strength and development of great nations. In the past twenty years, the country has experienced unprecedented migration to its developing cities. One need only consider Pudong, Shanghai and its rapid transformation. Then, imagine that model replicated over almost two hundred Chinese cities of a million or more population striving to create viable urban centers, to realize it will not be ending anytime soon.

With an estimated influx of 400 million people before the year 2050, Chinese cities are in need of design that exceeds our present aspirations. This type of formidable cultural shift presents both a challenge and an opportunity for design practitioners. How can we create architecture of lasting value for these progressive communities, while allowing for precipitous population growth in an era of limited resources? How can we both advance the science of building effectively and create places that address the human condition? Can tall building design be

开发城市的个性特征

二十一世纪的中国深刻的体会到高性能、高品质的设计对国家发展的重要意义。在过去的二十年中，中国经历了前所未有的城市迅猛发展。从上海浦东极其快速的开发建设即可略见一斑。而此模式也将在中国二百多个、拥有一百万或更多人口的城市中同时、快速的实施。中国正在努力创造可持续发展的城市中心，且这一进程在今后相当长的时期内仍会继续进行下去。

预计到2050年，中国城市的新增人口约4亿，中国对城市设计的需求将超出我们目前的想象。这种令人惊叹的文化转变对设计师而言意味着机遇与挑战。我们如何能够为这些不断发展的社区创造出具有持久价值的建筑，同时又能兼顾到在这样一个资源有限的时代中急剧增长的人口数量？我们如何才能既有效地推进建筑科学的进步，又创造出满足人们使用需求的建筑空间？高层建筑的设计能否在其背景环境中独具特色？通过明确具有清晰表达方式以及具有文化或区域背景独特性的设计理念，设计师可以利用先进的技术创造出令人印象深刻的城市天际线，并在整个中国塑造出生机勃勃的城市景观。然而，城市及建筑设计工作并非独立的创造过程，政府、业主方、金融机构、规划师、建筑

unique to the specifics of its context? By defining a design philosophy that is both clearly articulated and culturally or contextually specific, practitioners can utilize pioneering technologies to design impressive city skylines and shape healthy urban landscapes throughout China. Yet, our design work does not exist independently. The questions of the city are best answered by the collective shared knowledge of governments, owners, financial entities, planners, architects, engineers, and planners, working together collaboratively to create new models and systems.

Commonalities and Differentiators

Tall buildings rely on certain integrated commonalities: structural appropriateness, high performance building systems, expression of programs and use, and innovation in materials and craftsmanship to drive building form. Each building tends to have its particular character derived from the resolution of those issues.

The authors have found that the best buildings have a spirit that grounds their identity to the place in which they are built. This contextualism, or focus on the place, gives the design a basis for differentiation. Many cities disappoint with a dull sameness and a ubiquitous quality of the modern built environment. Buildings designed and constructed as universal commodities to be distributed throughout the world deny the ability of a city and a people to express their character and civic essence. Generally, local markets bring local concerns, needs, and aspirations. Often though, a lack of vision or fear of risks will point to what has been done before.

China has been a leader not only in the sheer number of tall buildings planned and constructed but also for its desire and openness to new concepts and designs. The refreshing willingness to create a unique tall building has enabled architects and developers to search for ways to differentiate their projects. It is suggested, however, that novelty should be avoided as much as banality. Designers should strive to avoid willfulness while being guided by structural integrity, high performing systems, innovative use of materials and high-quality craftsmanship. This practice yields distinctive work that is not tied to a formula or style. It is the exception to the norm and a new interpretation of rational methods which gives a design merit.

As designers at Skidmore, Owings & Merrill LLP (SOM), the authors have found that place is one of the most important influences on the commonalities of an SOM design. In this instance, place is defined as climate, landscape and urban context, social values, cultural characteristics, economic forces, and the gestalt of the time. In the best architectural solutions, a building's form is inspired by its place, but it is not a cartoon representation of the local vernacular. Ultimately, city-specific consideration of these issues yields iconographic urban forms that are contextually responsive, technically high performing and environmentally responsible. By synthesizing these elements, the tall building derives a connection to the city in which it is built, while at the same time driving the evolution of the city's identity. While the new building takes its cues from its existing and anticipated context, it also changes it, thereby informing the next generation of buildings in a continual evolution. Form follows place follows form, etc.

Place

Whether influenced by their geographic location or local culture, buildings are anchored by their context. Inextricably linked to their locale, they weave the fabric of the urban landscape and dictate the

师、工程师和策划师们需要运用各自的知识和技能，精诚合作共同创造出各种新的模式和系统，来解决城市所面临的各种问题和挑战。

共性与个性

高层建筑所具有的共性包括：结构适宜性、高性能建筑系统、形式与功能的结合、材料与工艺的创新。通过对上述因素的研究，提供各种不同的设计方案，从而使每一个建筑物都呈现出其独特的个性。

设计师们发现，最优秀的建筑都具有一种使其个性同周围其它建筑群相互融合的共同点。这种文脉主义，亦或说对环境的关注，为设计的各性提供了依据。许多城市的现代建筑千篇一律以及随处可见的建筑质量低劣令人非常失望。没有任何特色的建筑作为商品广泛分布在世界各地，使得一个城市及其居民无法表达其特色和城市精华。一般来说，当地市场反应的是当地的关注、需求和愿望。然而，缺乏前瞻性和对风险的担忧，使人们更倾向于选择重复以往曾经完成的项目。

中国在规划和建设大量超高层建筑方面，以及对新理念 and 设计的渴望与开放度方面，都处于世界领先地位。创建独特高层建筑的愿望不断地推动建筑师和开发商致力于研究出多种方法来使其项目呈现出独具一格的特色。尽管如此，我们建议应该尽量避免建造稀奇古怪的、或平庸的建筑。在以结构整体性、高性能系统、创造性使用各种材料和高品质工艺等为指导原则的同时，设计师们应当尽力避免随意性发挥。这样所创造的作品才会具有独特性，不会拘束于某一模式或风格，这种设计实践摆脱了平庸，对理性的设计进行新的诠释，也为设计注入了新的价值。

SOM的设计师认为项目所在地域特征是建筑设计的最重要因素。地域特征包括：气候、景观与城市背景、社会价值、文化特征、经济实力，以及时间形态等。最优秀的建筑设计方案的灵感往往源自其所在的地域，但并不只是对当地地方风格的简单复制。只有从城市角度考虑这些问题才可能设计出与环境相呼应、在技术上具有高性能、以及具有环保特质的标志性城市形态。将这些元素综合考量的高层建筑不仅能融入到与其所在城市，同时有助于城市个性的延续和发展。新建筑是以现有和未来的环境为基础而创建的，同时它也对环境的改变做出了积极的贡献，从而为未来建筑的不断发展变化提供充足的信息，使建筑的形式与地域的特点相辅相承，相得益彰。

场所

不论是受到其地理位置的影响还是受到当地文化的影响，建筑都同其周围环境有着紧密的联系，并组成了城市景观的肌理，奠定了人们的生活品质。最理想的状态是建筑不但能够清晰地反映出其所处的时代与地域，还为社会和区域未来的发展建立了良好的根基。

最近，SOM事务所为地处香港核心位置的德成大厦提供了设计服务（参见附图1）。项目场地较小，位于一条最繁忙的道路和两条具有历史意义的繁忙的步行道的交叉路口，SOM设计方案通过采用树干式的结构造型和悬挑楼层使得办公区域高出于周边的大厦。场地覆盖率只允许布置675平方米的标准楼层面积，但平面中核心筒的布局清晰，服务区域和公共区域将两个10米宽的无柱空间在视觉上连接在一起，使人们可以同时获得良好的景观和自然采光。尽管之前已有类似的结构形式，然而高密度的城市环境进一步推动了使建筑与结构设计的有机融合，为大楼提供了开敞的步行环境并为塔楼内使用者提供了优美的景观和良好的自然采光。



Figure 1. Aerial rendering of Takshing House (Source: SOM)
图1. 德成大厦鸟瞰图 (来源: SOM)



Figure 2. Exterior views, Poly Corporation Headquarters, Beijing (Source: SOM / Tim Griffith)
图2. 北京保利公司总部外景 (来源: SOM / Tim Griffith)



quality of life for their inhabitants. In the best instances, architecture not only reflects a clear expression of its time and place, it also provides a precipice upon which to leap into the future.

Recently, SOM proposed the Takshing House (see Figure 1) on a very small site in Central Hong Kong. At the intersection of one of the busiest roadways and two highly trafficked historic pedestrian walkways, the infill site was developed by raising the office program above the surrounding towers via a structural tree trunk and cantilevered floors. Site coverage allows only a 675-square meter typical floor plate, but the plan is composed of a clearly organized core with services and common spaces connecting two 10 meters wide column free spaces of views and natural light. This type of structural form is not new, but the dense urban context encouraged a boldly integrated architecture and engineering solution to open the pedestrian environment and provide views and light to the tower.

In Beijing, the Poly Corporation Headquarters (see Figure 2) was developed to relate to three contextual components: the former Poly headquarters and theater across the intersection, the center city fabric of walled compounds, and the harsh western and southern exposures. Maximizing natural light for the office, the building atrium frames a museum object, hanging from cables that stabilize the 90-meter-high cable-net curtain wall. This gesture of civic responsibility, in this case, an openness and transparency to the city punctuated by a lantern of art and culture, is contrasted with the powerful stance expressed by the heavily textured stone screen wall. The building communicates transparency, service to society, and environmental responsibility. It defines the client and their mission in the capital city.

Sometimes a landscape is so compelling that the building forms find a poetic connection to their place. The Liansheng Financial Tower (see Figure 3) is situated in the new southern CBD of Taiyuan, China. For this supertall tower, two slender tower forms with nominally 2,000 square meters floor plates were developed to accommodate the program, while retaining as much perimeter for views and natural light. The structural system essentially takes two normally proportioned, efficient towers and allows them to reach great height through mutual support. By linking the two towers with three bridging elements of common amenity programs, each tower braces the other. This structurally informed composition has an immediate analogy to the surrounding two mountain ranges and Fen River Valley between.

北京保利集团总部的设计(参看附图2)面临了三各主要环境因素: 十字路口对面原有的保利集团总部和保利剧院、城市中心带有的围墙的相邻地块、场地西侧和南侧强烈的日晒。设计师在建筑正立面设置了90米高的悬索式玻璃幕墙, 中庭的一侧悬挂一个灯笼状的博物馆空间, 从而使中庭和与中庭相连的办公部分能够获得最大限度的自然采光。在此项目设计中, 通过利用艺术和文化的“灯笼”突出面向城市十字路口正立面的开敞性和通透性, 同时与带有大量纹路的石材外幕墙所表现出的力量感和厚重感形成了鲜明对比。该建筑的设计在表达通透性、服务于社会、以及对环境尊重的同时也体现出业主在首都城市中的地位及使命。

在某些地区, 环境景观具有强烈的特色, 有助于建筑外形同环境景观形成富有诗意的融合。联盛金融大厦(参看附图3)位于中国太原市南部新的中央商务区。该超高层大厦的设计方案为两幢细长的塔楼, 2,000平方米的标准层面积以满足功能的需要, 同时办公空间的设计尽可能对外开敞, 有助于人们欣赏周围优美的景致并获得良好的自然采光。双塔楼的结构系统由具有公共配套设施功能的三个连桥连接在一起, 两个塔楼彼此支撑。这一设计造型与周边的两座山脉及汾河河谷遥相呼应。

功能与创新

特定的建筑设计要求来源于当地市场需求和传统文化, 并可通过



Figure 3. Rendering of Liansheng Financial Tower with ventilation diagram (Source: SOM)

图3. 联盛金融大厦效果图带通风示意图 (来源: SOM)



Figure 4. Rendering of Ssiger International Plaza Phase II (Source: SOM)
图4. 香格国际广场二期项目效果图 (来源: SOM)

Programmatic Expression and Invention

The specific programs of a building, usually defined by the local markets and customs, can be expressed in the massing and structure. The form of a single tower may evolve into an aggregation of elements and spatial linkages with an inventive manipulation of the program.

The Ssiger International Plaza Phase II in Cixi, China (see Figure 4) attempts to utilize a site that is too small for the allowable floor area ratio while meeting the daylight and view requirements for three conventional south facing residential and hotel towers. Stacking the hotel on top of the three rotated towers permits this mixed-use structure to maximize light and views, while creating an instantly memorable, but not willful, form. Intermediate connections, similar to the Liansheng Tower, create special units and link common amenities for the residential program. These connections provide additional structural bracing to the slender tower legs. The exterior is clad in operable vertical sunshades which reduce solar gain and present a cohesive form that subtly changes as the sun moves around the site.

A similar strategy was pursued for the Zendai Bund Financial Center in Shanghai (see Figure 5). The adjacent Yu Garden's traditional texture of low-rise buildings and intricate pedestrian paths contrast with the grand sweep of the Huangpu River and picturesque Pudong high-rise district. Between these two worlds, the complex's three office towers lift a residential and hotel block high into the sky to create a symbolic gateway to the old city from the piers and river. The forms are then eroded, terraced, and stacked to recreate the texture of the buildings and landscape which it borders. This raised, aggregated building form, structured to allow horizontal expansion of the residential on top of the office, yields a variety of spaces and a complexity which recalls the scale of the Bund and the adjacent neighborhoods.

The Tectonics of Structure, High Performance, and Craftsmanship

If contextual form is the goal, then how does one achieve it? Ultimately, the endgame is the sum of its many parts: an inherent understanding of the art of design, as it relates to the science of architecture. In his book, "Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture," Kenneth Frampton argues, "modern architecture is invariably as much about structure and construction, as it is about space and form." If, then, a designer adheres to form-making that is guided by certain intrinsic principles, the resulting form will emerge organically. Rather than being a product of willful form-making, the structure boldly resolves itself with an identity that is generated by efficiency and rationality.



Figure 5. Aerial rendering of Zendai Bund Financial Center (Source: SOM)
图5. 外滩国际金融服务中心项目鸟瞰图 (来源: SOM)

建筑体量与结构相结合的设计手法予以表达。单幢塔楼形式可以衍生成一种多种元素与空间联系的创新模式方案。

中国慈溪香格国际广场二期(参看附图4)的设计尝试在一块允许建筑覆盖率极小的地块上,同时满足采光与观景要求的情况下,对三幢南向住宅楼及酒店塔楼进行设计。将酒店叠放于三幢角度旋转的塔楼之上,从而使各种不同功能建筑空间获得最大限度的采光和景观,同时创造了独特但并不做作的建筑造型。与联盛大厦类似,其中间连接部分为住宅功能区创造了一些特殊的单元,并与公共配套服务设施相连接。这些连接部分为纤细的塔楼底部提供了额外的结构支撑。外墙设有可调节的垂直遮阳板,在减少太阳辐射的同时,在立面上展现出因日影变换而产生的建筑形态的微妙变化。

上海证大外滩金融中心(附图5)也采用了类似的设计手法。邻近的豫园具有传统肌理的低层建筑和交错的人行道路,同黄浦江以及独特的浦东高层建筑区形成了对比。在这两个区域之间,由三座办公塔楼支撑着住宅与酒店体块所组成的综合建筑直入云霄,在码头与黄浦江方向建立起了进入老城区的标志性门户。然后对各种形式进行了削弱、退台和层叠,以重新创造出其毗邻区域的建筑及景观肌理。这种提升与拼合的建筑形式,其结构可以使在办公楼顶部的住宅区得以水平延展,营造了各种各样的空间和综合的建筑体,回应了外滩及其相邻的地区。

结构构造、高性能、与工艺

如果是以富有意境的形状为目标,那么如何实现这一目标?从根本上说,最终将是多种因素的综合:设计艺术的内在理解同建筑科学相结合。在肯尼斯·弗兰普顿的著作《建筑文化研究:十九世纪与二十世纪建筑的建造法》中,作者认为:“现代建筑在结构与施工方面始终保持不变,只在空间与形状方面发生变化。”那么,如果设计师采取某些内在的原则来确定造型,最终的形状将会自然呈现。结构物不是随意造型的产物,而是由高效性与合理性所产生的特性来大胆地解决其自身结构问题的结果。

结构简单性和适宜性

最创新、最清晰的建筑设计开始于明确的结构理念。不论结构系统最终是否会外露,使用率和材料经济性等方面都有可能影响到大厦的建造性,以及大厦建筑形式的表现和功能。这一问题最终会演变成如何优化结构设计从而对建筑空间的整体感起到支持作用。

位于广州市琶洲区的保利房产总部大厦所使用的钢交叉支撑结构(参看图6)就是一个较为突出的例子。珠江三角洲地区始终都



Figure 6. Perspective Views of Poly Real Estate Headquarters, Guangzhou (Source: SOM / Tim Griffith; SOM / Fu Xing)

图6. 保利地产总部效果图, 广州 (来源: SOM / Tim Griffith; SOM / Fu Xing)

Structural Simplicity and Appropriateness

The boldest, most articulate designs begin with a clear structural idea. Regardless of whether the structural system is ultimately exposed, the caliber of its efficiency and material economy potently affects the tower's constructability, as well as the expression of its architectural form and function. This evolves into a larger discussion of how structure can be appropriately developed to support a sense of place.

One such example involves the steel cross bracing used on Poly Real Estate Headquarters, located in Guangzhou (see Figure 6). Because the Pearl River delta has always been a dynamic nexus of trade in China, water views have a symbolic value in the project and were paramount to the architectural concept. Relying on its innovative structural double lattice spine and braced ends, the towers' offset cores are light and transparent, permitting a high degree of openness to northern views. On the north, the towers' forms are defined by floor-to-ceiling glass, while on the south they expose their structural framework. In addition to its structural function, the lattice spine also provides a dense screen for shading the structural façade, reducing solar gain by 50 percent. The offset core also maximizes the amount of open space in the interior, supporting the large open office floor plates. At the base, the robust structure allows for open, porch-like terraces and lobbies that serve as climatic transition spaces to the interiors and are appropriately suited to the region.

The Tianjin Global Finance Center (see Figure 7) was developed as a simple, oval, tapering figure. To cover the double curvature of the exterior, a series of folded pleats vary over the height of the tower and create a gently faceted form. Viewed throughout the city, this recognizable tower creates an interplay of the light and has become a strong marker for the new Finance Street development on the Hai River. In between each cantilevered facet is a perimeter column and frame that links to an innovative steel plate wall core. This efficient structure serves the quiet elegance of this central city supertall. Its serrated oval shape has superior behavior in the wind, reducing wind forces and motions.

The 530-meter tall New World CTF mixed-use tower in the TEDA district of Tianjin utilizes an innovative mega column structure that is diagonalized on the lower tower to brace against seismic and wind loads (see Figure 8). Expressed as a lyrical edge to the convex and concaved surfaces which correspond to the uses inside, the mega



Figure 7. Tianjin Global Finance Center, Tianjin (Source: SOM | © Tim Griffith)

图7. 天津环球金融中心 (来源: SOM / Tim Griffith)

是中国最具活力的贸易枢纽, 水景在当地文化中象征经济的繁荣昌盛, 因而对建筑设计也产生了至关重要的影响。依靠创新性的结构双框架支撑体系将核心筒与办公空间连接在一起。偏移核心筒还为办公室内部提供了最大的开敞空间, 从而确保了较大的开放式办公平面, 并使得办公空间最大限度的获得了朝江面的北侧自然景观。结构双框架支撑体系在结构支撑的同时为办公空间的南侧提供了有效的遮阳, 从而降低了约50%的太阳辐射。在塔楼底部采用了开放门廊式的平台和门厅, 用作为室内空间的过渡区域, 非常适宜广州的气候。

天津环球金融中心 (参看附图7) 为简单的椭圆形平面, 向上逐层收分。塔楼两侧弧形外墙的立面采用了竖向折线式玻璃幕墙, 从而强调了建筑顺畅挺拔的立面效果, 成为了海河新金融街开发区的标志性建筑。在每个出挑的折面之间有一个周边柱和框架, 与具有创新性的钢板核心筒墙相连接。这种高效的结构彰显出了这个城市中心区超高层建筑典雅的外形。其边缘呈锯齿状的椭圆形造型, 可以增强塔楼的抗风性。

位于天津经济技术开发区, 530米高的天津周大福中心多功能塔楼采用一种创新的巨型柱结构形式。这种结构在塔楼较低的部分成对角布置, 可以有效对抗地震荷载与风荷载 (参看附图8)。凹凸有致的立面与建筑内部功能对应, 通过巨型柱的应用使得办公部分的外围框架的间距可达到9米。这种弧形巨型柱承受了来自上部住宅与酒店部分外围框架4.5米间距的荷载, 并将这些负荷力分散到各个角落, 从而提高空间使用率。并结合风洞开口和多孔冠顶, 以降低风力旋涡和负荷。与其他采用标准结构系统的同等高度建筑相比, 该项目塔楼的结构设计显著降低了钢材和混凝土材料的用量。该超高层塔楼的设计在充分考虑了风力、重力作用以及内部使用功能的需求的同时, 突出了具有雕塑感及流线感的造型。

可持续性发展和高性能建筑系统

在今天, 世界各地的法规及各个行业的市场需求都要求高性能的建筑与城市设计。作为21世纪设计的推动力量, 可持续性发展需要建筑师、城市规划师、以及环境和结构工程师之间高度的配合, 以探讨建筑与场地的整体性。考虑到中国有多个极端气候的区域, 获取洁净能源和水源的途径有限, 以及未来所面临的各种严峻挑战, 这种分析对于中国的建筑尤为重要。

SOM已经制定了多种不同的策略, 以应对各种气候情况。对于侨鑫集团珠江新城项目 (参看附图9), 办公大楼外部包裹了一系列水平异形遮阳板, 可以从内部获得自由畅通的视野。在凹角处, 玻璃幕墙内拉, 可以营造出一系列的可用平台, 同时对玻璃幕墙产生了遮阳效果。宽大的遮阳板从幕墙中间位置突出, 向外

column allows 9 meters spacing of the perimeter frame at the office. This curving mega column picks up loads from the 4.5-meter spacing of the residential and hotel perimeter frame above and distributes those forces to the corners for greater efficiencies. Together with wind tunnel tested slots and a porous crown to reduce wind vortices and loads, the structural engineering of this tower significantly reduces the steel and concrete material quantities compared to a typical structure of this height. Here, the supertall tower is envisioned as a sculptural, fluid form that has been shaped by the wind, gravity, and internal programs.

Sustainability and High Performance Building Systems

Global trends in legislation and market forces in all sectors are requiring greater performance in building and city design. As a driving force behind 21st century design, sustainable initiatives involve highly integrated coordination between architects, urban planners, and environmental and structural engineers to examine the total building and site performance. This analysis is particularly important for buildings in China which, given the country's multiple and extreme climate zones and limited access to clean energy and water, face significant challenges for the future.

SOM has pursued a number of different strategies for dealing with various climates. For the Kingold Group Zhujiang New Town project (see Figure 9), the office tower is wrapped with a series of horizontal, shaped sunshades that grant unobstructed views from the interiors. At the re-entrant corners, the glass is pulled inward to create a series of usable terraces that also shade the glazing. The broad sunshades transition from a projecting prow at the mid-facade to flat spandrels at the corners, resulting in a powerful flowing surface, particularly when viewed from below. In a city of hundreds of new all-glass towers, this visually solid, dense, and substantial mass is a refreshing antidote to the prevailing architectural expressions, giving the tower a unique identity in the city.

High wind forces were both resisted and exploited in the Qingdao Shen Lan Plaza. Situated on the coast of the Yellow Sea, the site affords spectacular views in an area of high winds. A stacked mixed-use office, residential, and hotel program requires a tapering external form to accommodate the different floor plate sizes. The curved brace on the sides of the slender 325-meter-tall structure allow the tower to have both a water and city orientation, which is expressed in a sweeping, sail-like profile. At the top of the tower, a monumental portal frames the special functions located at the top, while additionally catching the prevailing winds. As wind speeds increase in this engineered wind scoop, the pressure differential is coupled with stack effect to drive exhaust ventilation fans for the office, residential, and hotel units (see Figure 10). The dramatic form is grounded in the site, sea, and wind.

The Jinao Tower in Nanjing, China has an efficient perimeter braced frame for speed of construction and reduction in material. An externally ventilated double wall is integrated within the structure by setting the facets to correspond with the brace lines. The unusually low slope of the diagonals helps to satisfy specific Chinese code requirements concerning interstory drift. In addition, the diagonals were installed after completion of the concrete frame helped to minimize the gravity loads carried by the diagonals. Wind analysis and testing showed that the tower's exterior would almost always experience both positive and negative wind pressure. By allowing air to enter into the double wall cavity, that air would be drawn through by the pressure differential on opposite sides of the tower and naturally reduce the ambient temperature on the interior wall (see Figure 11). In

过渡到各个角落的平坦拱肩处，从而形成了强烈的流动表面，特别是从下向上看时。在一座拥有数百幢新建的全玻璃幕墙大厦的城市中，这种外表坚固、紧密和厚实的建筑体量令人耳目一新，使大厦在城市天际线中脱颖而出。

在青岛市深兰广场的塔楼设计中，设计师对强风力的影响进行了充分的研究。该项目位于黄海之滨，地处强风区，拥有壮阔海景和开敞的城市景观。325米高的综合塔楼包括办公、服务式公寓与酒店等功能，为满足不同功能空间的进深要求，需通过采用收分的外部造型。所以在塔楼面向城市的一侧设置了弧线形向上延伸的外墙，如同一叶向海面张开的风帆。塔楼的顶部有一个巨大的玻璃空中酒吧，酒吧上方是通透的风斗型塔顶。随着风速的增加，通过室内外气压差的烟囱效应来驱动办公、服务式公寓和酒店客房单元的排风（参看附图10）。该塔楼独特的造型设计充分展现了场地、海洋和风等环境特色。

中国南京金奥大厦采用高效的周边支撑框架，有助于加快施工进度并减少材料用量。立面采用小坡度分节立面与斜向拉撑系统组合，在结构中纳入外部通风的双幕墙系统。不同寻常的小坡度的对角斜面有利于满足中国规范中有关层间位移的具体要求。此外，在完成了混凝土框架之后，才安装了对角斜面部分，这种做法可以最大限度地降低对角斜线所承载的重力负荷。风力分析与测试表明，在塔楼的外墙上会有持续的正风压和负风压作用。空气进入到双幕墙空腔中后通过塔楼相反一侧的压差吸入空气，从而自然地降低了内墙的环境温度（参看附图11）。南京市夏季炎热，因而在外墙设计中需要很大程度的降低太阳日晒与冷却负荷，同时要提高进入到室内空间的日光量。将结构工程与环境设计相结合，使该建筑具有高性能，展现了其独具特色的外观形体，成为南京市的标志性建筑之一。

当地的工艺、合理的材料使用、以及经过验证的有效措施都是推动建筑形式发展的动力。国贸中心三期A阶段大厦是北京中央商务区的地标建筑，目前是首都北京最高的建筑。业主想在这令全国人民自豪与骄傲的城市创建一个精致的、庄重的标志性建筑。该建筑缓缓收分的造型采用了肌理精密、呈波浪形的玻璃墙体（参看附图12），在遮蔽直射阳光，并为室内空间提供间接日照反射的同时，随着日影移动熠熠生辉。该塔楼并没有采用一种与前几期开发建筑截然不同的造型，而是通过有效的规划，并采用



Figure 8. Rendering of New World CTF with diagram of structural system (Source: SOM)
图8. 中国天津周大福滨海中心发展项目效果图带结构系统图（来源：SOM）



Figure 9. Rendering of Kingold Group Zhujiang New Town (Source: SOM)
图9. 侨鑫集团珠江新城P1-1项目效果图 (来源: SOM)

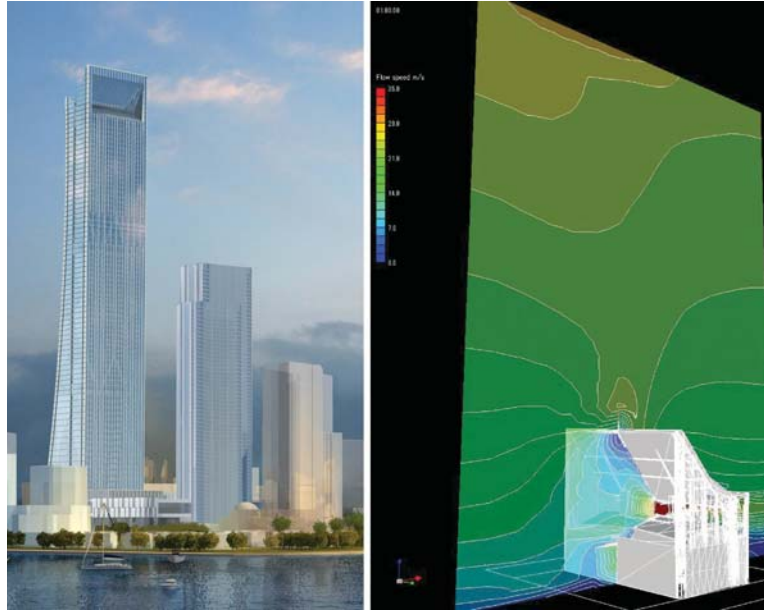


Figure 10. Rendering of Qingdao Shi Nan District Audit Bureau and its wind harvesting device (Source: SOM)
图10. 青岛市南区审计局项目效果图及其风收集装置 (来源: SOM)

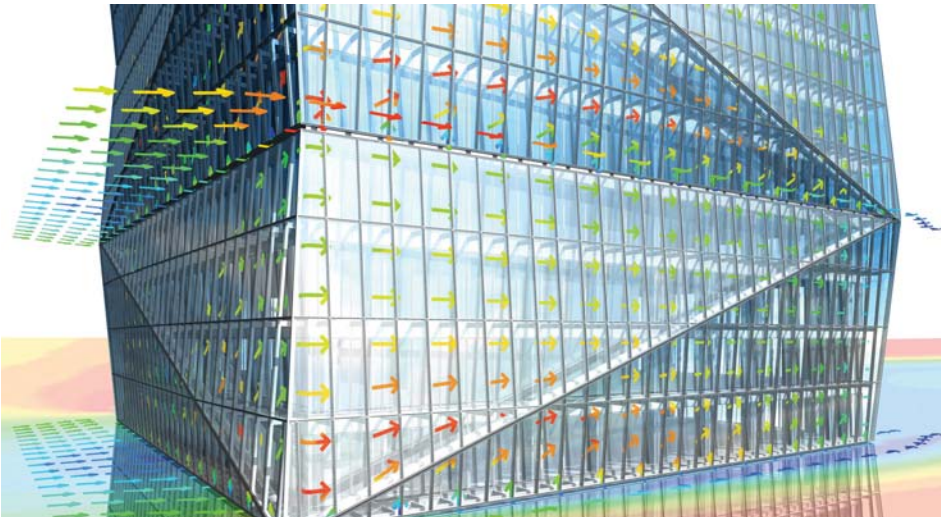


Figure 11. Wind Ventilation on Jiniao Tower's Double Wall (Source: SOM)
图11. 金奥大厦的双层墙通风系统 (来源: SOM)

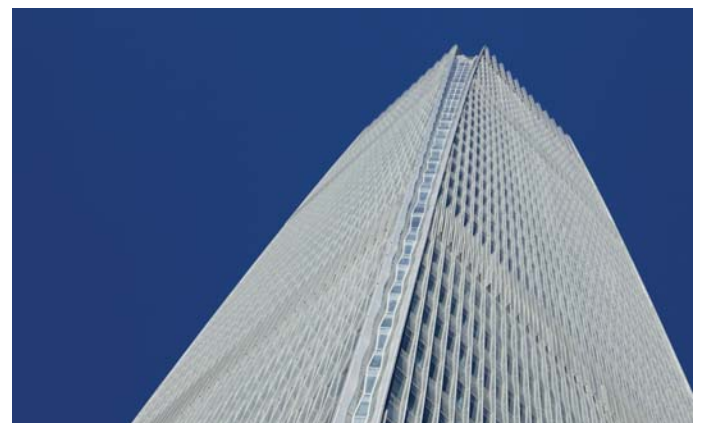


Figure 12. Undulating glass wall of CWTC IIIa, Beijing (Source: SOM / Tim Griffith)
图12. 北京国贸中心三期A项目的波浪形玻璃墙 (来源: SOM / Tim Griffith)

this city which experiences hot summers, significant reductions in solar and cooling loads were predicted for the wall, which also increases daylight transmission to interior spaces. The bold form, based on an integrated structural and environmental design, has a singular high-performing identity for Nanjing.

Local craftsmanship, intelligent use of materials, and proven quality measures should drive building form. The CWTC IIIa tower marks the center of Beijing's CBD and is currently the tallest building in the city. In a place of national confidence and civic pride, the clients wanted a refined, dignified beacon for the development and district. This gently tapered form uses a sophisticated textured, undulating glass wall (see Figure 12) to capture the atmospheric quality of Beijing's light, while also shading direct solar gain and reflecting indirect light into the interiors. In lieu of creating a new novel form, the place dictated an elegantly proportioned tower, efficiently planned, and clad in a high-performance, timeless facade. For a second phase tower, SOM is working on a scheme which forms a dialogue with the existing tower, provides shading of the exterior wall, and is specifically configured to reduce the maintenance associated with the region's dusty air quality.

高性能的、简洁的外墙形式，使其与所在场地其它建筑经典、均衡的个性融为一体。对于第二阶段的塔楼，SOM正在研究一种设计方案，使其与现有塔楼相呼应，外墙能够提供自身遮阳，同时塔楼布局上的考虑尽量减少由于该地区多尘的空气质量而造成的维护工作。