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How High Could Beijing Reach?

北京的建筑可以建多高?

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Abstract | 摘要

Can we still save our city? How high can buildings in Beijing arise? Beijing has so many ancient buildings; can they coexist harmoniously with skyscrapers? This essay will present the results of our research through the following four aspects: The Tradition of Chinese Architecture, Urban Planning Analysis, Seismic Resistance Technique, and The Modes of Tall Building Design.

Keywords: Architectural History, Beijing, High-rise buildings, Sustainability, Vertical Urbanism

今天，人们通常用城市中那些最高建筑的高度称之为城市的高度。在北京成为都市的三千一百年间，建筑高度并不是这座城市追求的目标，这需要追溯很多文化传统、地理特征、历史因素和技术局限。但是时至今日，现代化、城市化进程已经使我们不得不去面对日益突出的人口问题、交通问题、环境问题和资源问题，本文将从“中国建筑传统”“规划理念分析”“地质抗震条件”“北京高层模式”四个方面来分享我们的研究成果。

关键词：建筑历史、北京、高层建筑、可持续性、垂直城市化

Introduction

A city's height is often defined by its tallest buildings. While Beijing has been established for over three thousand years, the height of its architecture was never the emphasis of any previous urban planning regime because of its unique history, culture, and tradition, as well as geographical features and technological limitations. However, through the process of modernization and urbanization, we have to face increasingly serious issues about population, traffic, environment, and resources, thus the city's height may need to be considered more importantly at the moment. This essay will introduce our research through the following four aspects: The Tradition of Chinese Architecture, Urban Planning Analysis, Seismic Resistance Technique, and The Modes of Tall Building Design.

The Tradition of Chinese Architecture: The Mainstream Style of Ancient Chinese Architecture is to Extend Horizontally

The layout of traditional Chinese architecture is preferable to a courtyard model, with buildings extending horizontally. For instance, the Forbidden City in Beijing has 9,900 houses, all of which are connected through courtyards and gallery bridges. Tall and multi-story buildings are hardly seen. This even applies to the most magnificent and tallest building of

引言

今天，人们通常用城市中那些最高建筑的高度称之为城市的高度。在北京成为都市的三千一百年间，建筑高度并不是这座城市追求的目标，这需要追溯很多文化传统、地理特征、历史因素和技术局限。但是时至今日，现代化、城市化进程已经使我们不得不去面对日益突出的人口问题、交通问题、环境问题和资源问题，本文将从中国建筑传统、规划理念分析、地质抗震条件、北京高层模式四个方面来分享我们的研究成果。

中国建筑传统：中国古代建筑观决定了中国建筑更加喜爱水平展开

中国古代建筑讲究的是院落式布局，建筑沿水平方向延展，比如北京的紫禁城共有9999间房子气势最为恢宏的太和殿也不过只有一层，35米高（图1）。

又比如北京的民居四合院，建筑也是讲究沿着中心院落展开，主体建筑不过一、两层，即使算上坡屋面和高高的屋脊，也不过12米高。

城里最高的建筑除去气势恢宏的城门与城墙，一般出现在寺庙中，藏经楼可以修到三层，而佛塔则可以建至七层、九层，高度达到80米，这种方式很像近代欧洲城市建造的教堂（图2）。

all: the Taihe Palace has only one floor with a height of just 35 meters (Figure 1).

Moreover, the quadrangle courtyards, as the most representative architecture of Beijing, pay full attention to the core courtyard concept with only one floor and a height of no more than 12 meters when the roofing and tall bridge are all counted.

Apart from the magnificent gates and walls, the tallest building in ancient Chinese cities generally appears in the temple complex. A scripture repository could be built to three stories, and the pagoda would be built between seven and nine stories, for a height of 80 meters, which is similar to the churches built in Medieval European cities (Figure 2).

Moreover, in order to greatly increase the perception of building height, ancient architects would generally follow an approach that placed buildings on the highest plateau or even directly built into the mountains.

The concept of "The Unity of Heaven and Man" has influenced Chinese architecture for thousands of years, and a soothing and peaceful lifestyle had been dominant until the funding of new China.

In the early years of new China, a group of overseas scholars combined the architectural ideals of ancient China with the architectural theories of Western modernism, using this new mode and advanced materials for the sake of improving citizens' modern life. The buildings were designed to use concrete structures, which could be built much higher than Forbidden City.

However, from the perspective of preservation, instead of blindly increasing the height of the buildings, they kept an appropriate distance between new buildings and important ancient ones, and added classical slope roofs in order to show some respect. At this period, the height limit of Beijing was represented by the Palace of Nationalities, which is 67 meters tall, and the Great Hall of People, which is 46.5 meters in height, while residential structures normally varied from five to six floors, or 18–24 meters (Figure 3).

However, nowadays in the 21st century, Beijing has developed rapidly, with the Third Ring Road as the boundary of a 120-square-kilometer central city inhabited by about 8 million people and 2 million vehicles. Moreover, hazy weather for more than 100 days per year in coordination with high land and housing prices have forced the majority of people to give up a traditional way of life.

Figure 1. The Forbidden City, Beijing, China (Source: BIAD)
图1. 中国北京紫禁城（来源：BIAD）

Figure 2. Yingxian Pagoda, Shanxi Province, China (Source: http://www.nipic.com/show/1/62/4076857k4b215506.html)
图2. 中国山西省朔州市应县木塔（来源：http://www.nipic.com/show/1/62/4076857k4b215506.html）

Figure 3. The Cultural Palace, West City District, Beijing (Source: http://www.microfotos.com/?p=home_activity&activityid=1066)
图3. 民族文化宫，北京西城区（来源：http://www.nipic.com/show/1/62/4076857k4b215506.html）

古人还有一个十分聪明的做法，就是把建筑修在高高堆砌的土台之上，甚至直接建于山巅，由此大大增加了建筑的观感高度。

这种天人合一的建造思想影响了中国建筑几千年，舒缓的生活方式以及天人合一的建筑理念一直延续到新中国成立，也没有发生实质性改变。

建国初期的50年代，一批海外归来的建筑学者把中国古代的建筑思想和建筑形式与西方现代主义的建筑理论相结合，满足了现代的生活使用需要。这个时期最高的建筑包括67米高的民族宫，46.5米高的人民大会堂和历史博物馆，而普通的居民住宅楼也不过五六层，高度18–24米（图3）。

然而，时间推进到二十一世纪，现在的北京早已不是历史上的北平，以三环路为边界的120平方公里中心城区居住着约800万人口，200万辆机动车，每年阴霾天气超过了100天，高额的地价、房价已经使绝大多是人被迫放弃了传统的生活方式。

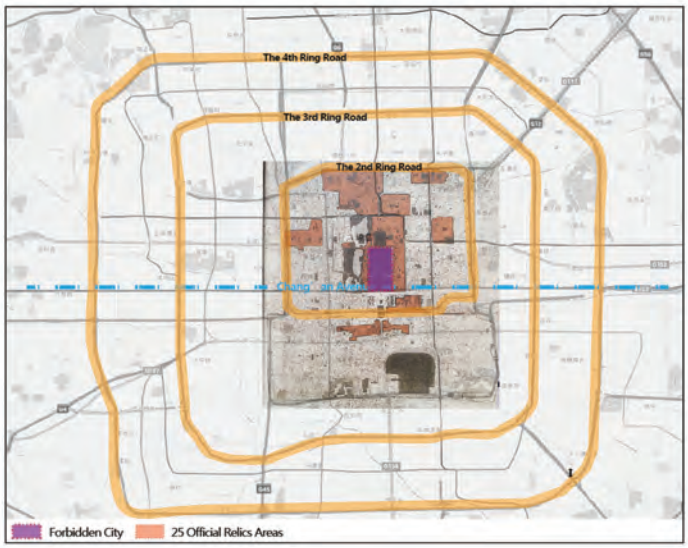

Figure 4. Beijing's 25 Official Cultural Relics Areas (Source: Long Ma and Wang, 2003)
图4. 北京二十五片官方文物区（来源：马泷 and Wang, 2003）

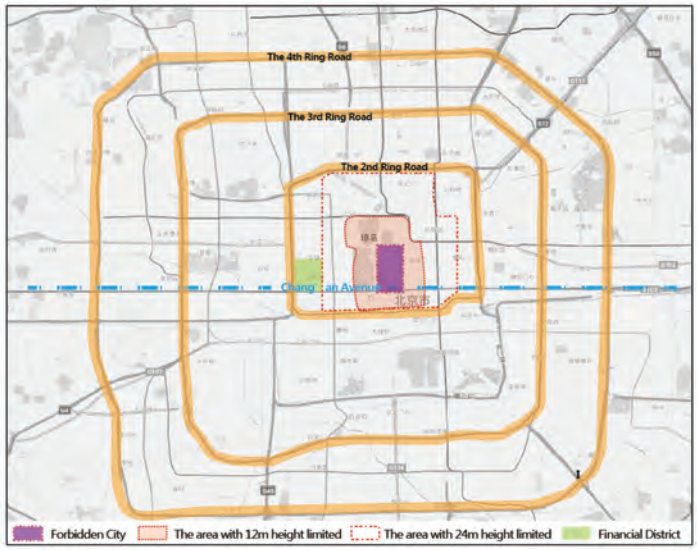

Figure 5. Diagram of urban height limitations around the Forbidden City (Source: Long Ma)
图5. 紫禁城周围城市限高分析图（来源：马泷）

The Analysis on Planning Concepts: The Theory of Modern City Planning Determines that Buildings in Beijing Should Not Be Too High

The city of Beijing has a long history. Dating back to the Zhou dynasty, this area was known as "Ji," and witnessed the gathering of population and the establishment of markets. Furthermore, Beijing served as the capital city in the Yuan, Ming, and Qing Dynasties for one thousand years. It is precisely because of the complete patterns and organizations of the old city and its numerous historic relics that it is a very demanding task to shape the city's future outlook.

In February 1950, a new planning development program was proposed by Sicheng Liang and Zhanxiang Chen (Wang, 2003). It was presented to preserve the old district and establish a new urban area. However, due to the poor economy and development of China at that time, it was very hard to maintain old Beijing as a historical site.

From 1949 to 1979, the urban development of Beijing withstood the baptism of political movements, and from 1979 to 2009, urbanism excessively accelerated without careful consideration. Thus, many ancient buildings and lanes disappeared, and only a few relics survived in the form of parks, temples, and heritage sites (Wang, 2012; Figure 4).

Even so, Beijing city planning has always taken care of historical relics. For instance, the city employs strict regulations for the financial street district located several kilometers away from the Forbidden City. Buildings cannot rise beyond the following height limits: Areas next to the Forbidden City must observe a height limit of 12 meters; areas near the Forbidden City, 18 meters; areas further away, 24 meters; which strictly ensured that no modern buildings would be seen when standing in the imperial palace (Figure 5). While it is important to preserve the existing ancient buildings, preserving the ancient skyline and its views seems to be prohibitive (Figure 6).

Therefore, it is necessary to seek high-rise space in order to meet the population density; to set up vertical transportation system in order to ease traffic congestion; and to return more city area to parks and greeneries in order to improve the living environment. People's old conceptions have never been overturned so much by the limited resources of city and land as is happening now. In short, it is time to reevaluate the balance between building height and urban dimensions in Beijing.

规划理念分析：现代城市规划思想决定了北京的建筑不宜建得过高

古老的北京城形制完整，气势宏伟，文物古迹众多。悠久的历史文化积淀，使它拥有无以伦比的灿烂城市文化，也给建国后的城市规划方向提出了巨大的挑战。

1950年2月， 由梁思成和陈占祥联合提出的北京规划发展方案，提出保留老北京另建新北京的构想，但是那时的北京一穷二白，根本没有能力把整个北京城当作历史古迹保留下来。

从1949–1979年，北京建筑经受了历次政治运动的洗礼，从1979–2009年，北京建筑又在势不可挡的经济发展中来不及深思，于是很多古建筑消失了，历史悠久的胡同没有了，原有成片的历史古迹逐渐收

Figure 6. Beijing Financial District showing height limitations (Source: http://news.163.com/15/0701/11/ATEE30H800014Q4P.html)
图6. 金融街，市中心重要办公建筑群，限高60米。（来源：http://news.163.com/15/0701/11/ATEE30H800014Q4P.html）

The Study on Seismic Resistance Conditions: The Strict Anti-seismic Grade Affects the Height of the CSity

Another factor that limits the height of buildings in Beijing is the strict anti-seismic grade concerning the special political function of the city, the protection of all the important architecture and accompanying facilities, and the history of serious geological disasters in surrounding areas. Specifically, a 7.8 magnitude earthquake happened in Tangshan in 1976, less than 200 kilometers away from Beijing. Thus, seismic resistance is one of the most important factors needed to be considered by Beijing architects.

In the 1990s, the majority of buildings in Beijing were less than 100 meters; the Jingcheng Tower – 183 meters tall and built in 1991 – and the Jingguang tower – 208 meters tall and built in 1994 – were the tallest in Beijing for a long time. Following the Beijing Olympics in 2008, China World Tower (330 meters) and CCTV Headquarters (234 meters) precipitated a breakthrough in Beijing's height (Figure 7).

Beijing is an 8 intensity area on the anti-seismic grade, which is double compared to Shanghai and Guangzhou; therefore, it brings the rise of component seismic behavior, physical dimensions, and construction costs. As building height rises, it is necessary to take enhanced stiffness into consideration as early as possible, perhaps by adding a story with outriggers or adopting a steel structure system, so that the structure cost would be increased prominently.

For instance, to build the same 300-meter skyscraper in Beijing, the costs of construction and material will be 30% higher than if built in Shanghai or Guangzhou, and this is why in some cities high-rise buildings are like vertical forests, but in Beijing, for quite a long time, high-rise buildings are extraordinarily rare.

However, the price of land in Beijing is much higher than the cost of construction in recent years. It gives rise to more attention on the strategy of urban planning, the research of urban design, the solution of traffic congestion, and the consideration of homeland security. For instance, the cost of construction to build a supertall high-rise office building has declined from approximately 20,000rmb per square meter to about 12,000rmb per square meter; the cost to build an office with 150 meters' height has decreased to less than 10,000rmb per square meters.

Therefore, the objective condition of the seismic grade is no longer the most important factor that restricts building height. Beijing today gives rise to more attention on strategy.

缩，以公园、庙宇、文物保护单位的形式吃力的保留着（Wang, 2012; 图4）。

即使这样，我们的城市规划一直小心翼翼的试图保护历史文物。比如北京曾经推出过严格的限高法规，紫禁城紧邻地区限高12米，相邻地区限高18米，再向外地区限高24米，向西5公里之外的金融街地区也不过限高60米，使这片市中心的重要办公建筑群都呈现出低矮、墩实的感觉（图5）。据说此项法规目的是保证在故宫里的人看不见外围的现代建筑。当然，一个城市的发展怎能亦步亦趋的跟随着历史，保护现存的古建筑是千真万确的，但保留古代的视野和天空，似乎显得固步自封（图6）。

我们只有设计出更好、更高的建筑，向天空寻找资源，以承载高密度的人口压力，我们必须构筑地上和地下立体交通网络，以确保市民出行的基本畅通，我们还需要返还更多的公园绿地，改善日益恶化的自然环境，总之，是该重新思考北京建筑高度与城市关系的时候了。

地质抗震条件：严格的抗震等级影响了城市高度的形成

由于抗震等级制约，北京大部分的公共建筑都在100米以下，九十年代初完成的京广大厦高度为208米，京城大厦高度为183米，它们长期占据着北京建筑高度第一、第二的位置，这一格局直到2008年北京举办奥运会的时候，才由330米高的国贸三期以及234米高的CCTV大楼打破（图7）。

北京的抗震等级为八度，相比于上海、广州、天津，地震力增加了一倍。用一个形象的比喻，同样设计一幢300米的超高层大楼，在北京付出的土建成本和建造难度要比上海、广州高出30%，这也是为什么有些城市的高层建筑层出不穷，而北京在相当长的一段时间，高层建筑显得凤毛麟角。

在北京建造一栋中高档超高层写字楼的建安成本从20000元/平方米，下降到12000元/平方米，一栋150米高的写字楼，建安成本已经下降到10000元/平方米以下。

因此，抗震等级的客观条件，已经不再是制约我们建设更高建筑的最重要考量。今天的北京，更加注重城市规划的策略，城市设计的研究，交通拥堵的对策，反恐安全的保证.....

北京高层模式:分析北京现有超高层建筑格局及发展脉络

回顾一些国际发达大城市，以纽约为代表的新兴工业化城市一百多年来一直引领着世界城市的高度。 911事件以后，美国政府曾经认真反思过高层建筑可能给人们带来的灾难，但没有多久，他们就在世贸中心的原址边上建设起高度达到天线550米的新世贸中心。

巴黎是欧洲的历史名城。一百多年前，这里建成了代表工业时代早期成就的埃菲尔铁塔，但是遭到大批文化名流和市民反对。到了上世纪五十年代，市政府终于决定在巴黎郊区的德方斯建造一个新的CBD区，那里高楼林立，而老城区则保留着相对舒缓的格局。

东京是少数几个与北京抗震等级相同的大都市。二战以后日本东京几乎被战火夷为平地，新东京的建设没有太多古典建筑的

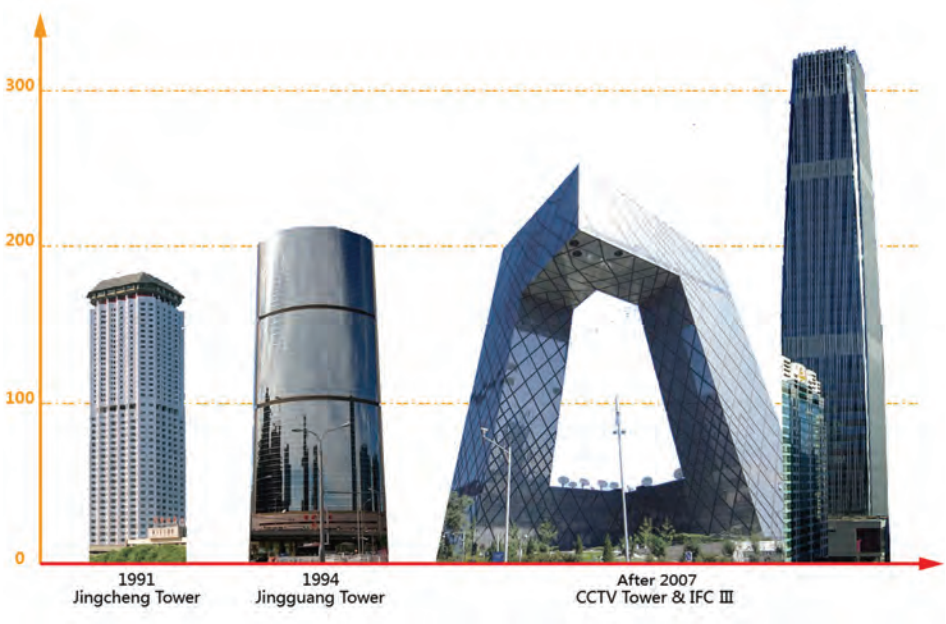

Figure 7. Diagram of Beijing's tallest buildings through the years (Source: Long Ma)
图7. 不同年代北京最高建筑示意（来源：马泷）

The Modes of Tall Building Design: The Analysis on the Patterns and Development of Supertall Buildings in Beijing

Firstly, consider the development of high-rises in some leading international cities, such as New York, Paris and Tokyo. New York serves as a first example as it has been a world-wide industrial pioneer for more than a century, and it is renowned for its skyscrapers and skylines. The September 11, 2001 terrorist attack halted growth and forced the US government to rethink how high-rise buildings can affect people's life in a negative way. This period of uncertainty was followed by an even more ambitious plan to build a new 541-meter-tall World Trade Center.

The historical metropolis of Paris comes into our sight with its abundant artistic and cultural heritage and the very classic and lively architecture found in the city. Over a century ago, the epic Eiffel Tower was made to represent the achievements of the early industrial age, but was strongly opposed by many cultural celebrities and ordinary citizens. By the 1950s, the municipal government finally decided to build a new CBD named "La Défense" in the suburbs of Paris. As a result, many tall buildings found their rightful place in the city while the old town remained true to its original communities.

Tokyo is one of a few metropolises that have the same anti-seismic grade as Beijing. As a result of World War II, Tokyo was virtually razed to the ground; only small areas of Kyoto and Nara retained the ancient character of Japan. The new Tokyo is a city with scarce ancient buildings that is frequently visited by earthquakes, so a strict limitation of anti-seismic grade is indispensable. In order to solve all the above problems alongside an overcrowding problem, architects in Japan normally design buildings between 100 and 300 meters high.

Returning to Beijing, the city could be divided into nine regional urban patterns, with the Forbidden City as the central region where the field of vision can be seen as the center of a circle. In this manner the development context of an urban high-rise building can be clearly seen (Figure 8).

The North Olympic Business District was projected along the city's North axis (Figure 8A). Due to the success of the Beijing Olympic Games, this district attracted a large population and supporting facilities, which makes it a perfect spot for a future regional center with 200 meter building heights at present.

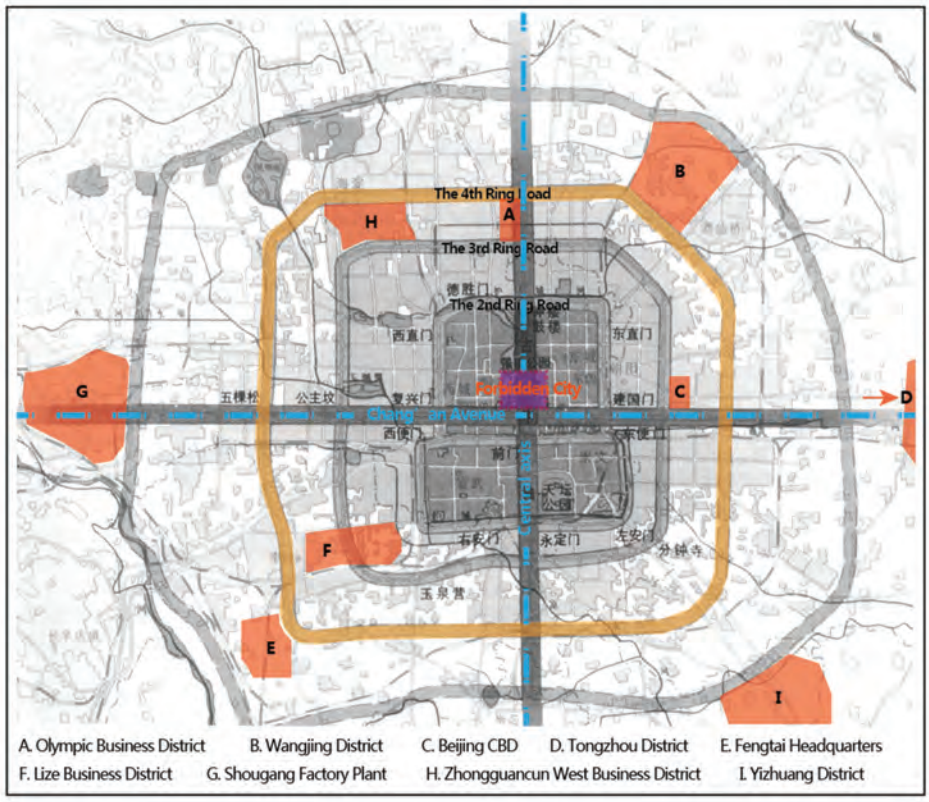

Figure 8. Beijing Region analysis (Source: Long Ma)
图8. 北京区域分析图（来源：马泷）

制约，但却有着抗震等级的严格限制，为解决超大城市的拥挤问题，那里建筑的高度一般建造在150米以下……

回到北京，这里既有着丰富的历史建筑需要细心保护，又有众多的国家机关需要妥善安置，同时还面临着人口稠密、交通拥堵、环境恶化、地质复杂、以及众多社会问题的挑战。我们必须通过规划政策的调整，增加新建建筑高度，建立分级高度控制体系，扩大城市资源总量，以期最终逐步缓解北京的城市问题。

我们将北京的城市格局划分为九个区域，如果以紫禁城所在的中心区域及可见视野作为圆心，可以清晰的看到城市超高层建筑的发展脉络（图8）。

沿中轴线正北方向（图8A），规划有奥林匹克商务区，目前建筑高度180米；

东北方向，规划有望京超高建筑群，目前建筑高度220米（图8B）；

沿长安街正东方向（图8C），规划有中央商务区，目前建筑高度528米（图9）；

东南方向，推远至北京副中心，目前建筑高度300米（图8D）；

沿中轴线正南方向，由于新机场的航路限制不计划建设超高层建筑；

西南方向，规划有比邻的丰台总部区和丽泽商务区，目前建筑高度260米（图8E和F）；

沿长安街正西方向，随着未来首钢改造计划，很可能出现新型城市综合体（图8G）；

西北方向，规划有中关村电子商务区，目前建筑高度200米（图8H）。

由此可以发现，沿四环路的内外两侧，已经分布着大量超高层商务区和潜在新区，也是未来超高层建筑最密集的地方。这些建筑的高度由于相对远离中心区，因此规划条件逐步放开，总体高度将提升至150–300米。

结论

谁来带领这个充斥着无数现代矛盾的古老城市走向未来?

垂直城市设计是解决北京城市可持续发展的灵丹妙药吗?

基于上述四个层面的分析，可以发现北京的超高层时代正在到来，但这不是单纯增加建筑限高的政策，也不是几栋标志性的超高层塔楼可以解决问题，北京的高度需要城市规划、城市设计、区域导则、建筑设计的整体控制与提升。

我们把这些要素总结为三点：

1. 坚守北京绚烂的古代建筑文化古老的建筑留存与基于文化复兴的现代城市和谐共生，在二环路以内的

Along the northeast axis, the Wangjing urban complex is a surefire attraction (Figure 8B). After decades of hatching, it became a popular area for foreign headquarters and residential communities.

Along the Chang'an Avenue and the east axis stands the famous Beijing CBD (Figure 8C). This area enjoys the gathering of the densest and tallest skyscrapers in the capital with heights up to 500 meters (Figure 9).

Along the southeast axis, the Tongzhou district (Figure 8D) is planned to be the sub-center of Beijing, and some skyscrapers here have already become landmarks of the new polity. On account of airline-related limitations, the peak of Tongzhou is around 300 meters.

Along the south axis, a new Beijing airport is planned to be located on the southern extension, therefore the height here would be limited by airlines, and tall buildings are forbidden.

Along the southwest axis, the Fengtai headquarters and the Lize business district are planned. The tallest building here so far is 260 meters (Figure 8E&F).

Along the west axis, the regeneration of the Shougang Factory Plant in the future might generate a brand-new high-rise urban complex in this area (Figure 8G).

To the northwest, the Zhongguancun West Business District is planned; the peak there is around 200 meters (Figure 8H).

From this picture we can determine that there are a lot of potential high-rise urban complexes located beside the 4th ring road of Beijing. These areas will likely be the densest places for high-rise buildings in the future. The height of buildings would be raised up to 150–300 meters.

By 2015, the central government put forward a national strategy coordinating development of Beijing, Tianjin, and Hebei province, called Beijing-Tianjin-Hebei integration. Although the construction of the core area of the capital will be subject to tighter control, the development would bring greater urban population to the surrounding areas of the capital, leading to the formation of a large world-class urban agglomeration, and a determination to further promote the development of Beijing into the sky.

Moreover, it is proposed to establish sub-city centers in order to ease this density. Then, Beijing will host the 29th Winter Olympic Games in 2022, and stadium and facilities have been considered as part of urban planning. Meanwhile, the new Beijing airport is stepping up construction in the south area. This series of ambitious strategies and plans will profoundly affect the outlook of the city of Beijing in the next decade.

Conclusion

What will be the future prospect of Beijing, an ancient charming city that is perplexed with its many modern contradictions? Is vertical urbanism the magic drug to make sustainable development happen in Beijing?

Based on the analysis of these four factors above, we found that the right time for high-rise development in Beijing is coming. It is not just simply increasing building height, nor adding iconic supertall towers that is needed, but rather increased density is necessary to take urban planning, urban design, regional guidelines, and architectural design into overall control and promotion. It would lead to a harmonious coexistence between ancient buildings and a modern city based on the Cultural Renaissance.

Our research can be summarized into the following three conclusions:

Firstly, for the area inside the second ring road, we suggest to dismantle or renovate those buildings built with little attention paid to Beijing's culture and tradition; whereas to preserve buildings with historical value.

中心城区逐步拆除、改造、更新不同时期的简易建筑。建筑高度以紫禁城为中心，逐步提高，并增加城市设计的更全面控制体系，例如限高与限低控制，街墙与主楼控制，退线与贴线控制，容积率与覆盖率控制等，并且限高控制在75米。

2. 在二环至四环路之间适度提高城区的容积率和绿化率，同时减少区域内部的建筑密度，建筑高度限制可以由75米增加到150米，城市容积率由现在的3.5提升至5.0，即建筑高度提高一倍。与此同时，建立 完善的地下轨道系统、地面公交与绿色交通系统，地上高架快速系统的立体交通体系，这将大大缓解中心城区的巨大压力。

3. 在四环路以外的城市节点或区域性中心地带，重要建筑的高度完全可以提升到300米甚至600米，形成新的区域城市中心。特别是大力提升南城开发的战略地位，建造文化、创新、绿色、共享的街区，通过建筑高度的提升，获得新的城市发展机遇，通过城市更新治愈遗留的旧城困扰。

总之，北京不再为天空设限。

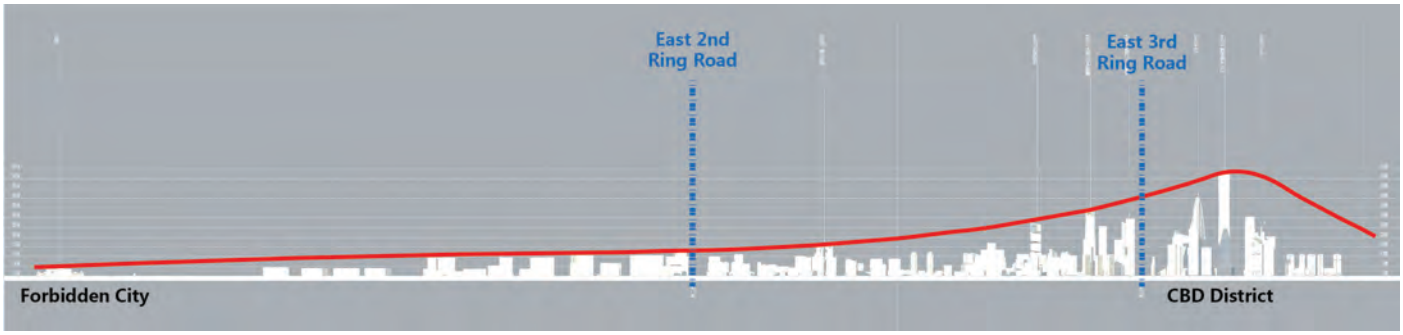

Figure 9. Eastern Chang'an Avenue skyline, Beijing (Source: Long Ma)
图9. 北京天际线：沿长安街正东方向城市天际线（来源：马泷）

Centered from the Forbidden City, the height limitation goes up gradually to 75 meters above ground, with carefully designed urban planning guidance and regulation, such as height limitation, façade design, set back control, FAR, and building coverage ratio.

Secondly, for the area between the second and fourth ring roads, we suggest to raise plot ratios from 3.5 to 5.0 and to increase the height limitation from 75 meters to 150 meters, as well as to further increase the requirement for vegetation coverage. Meanwhile, vertical public transportation, including subways, buses, sky trains and other green vehicles need to be further developed to reduce the traffic pressure for the city center.

Thirdly, for districts outside the fourth ring road, the height limitation can be further pushed to 300 meters and above, to form new regional centers or satellite cities. Previous rural or under-developed areas deserve such opportunity to increase spatial and visual quality via efforts to build modern, sustainable, and creative urban space.

Beijing should no longer set height limitation for its skyline.

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