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An Overview of Modern Supertall Development in China
现代超高层建筑在中国的发展

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Mr. Junjie Zhang graduated from the Department of Architecture at Tsinghua University with a Bachelor's Degree in Architecture as well as a Master's Degree in Business Administration from Ohio State University in the United States. In 1986, he started his career on architectural design in the East China Architectural Design & Research Institute Co., Ltd. (ECADI). Now, he is working as chairman of the board of ECADI with multiple titles such as first-class registered architect, professor-level senior engineer, senior member of the Architectural Society of China, and vice president of the Architect Branch of the Architectural Society of China. He successfully directed the design of multiple types of large public buildings and building complex designs with respect to office buildings, finance buildings, conference and exhibition centers, hotels, educational buildings, and cultural buildings. In 1993, he was awarded the First Young Architects Award of the Architectural Society of China. Afterwards, he won multiple National Excellent Design Awards.

张俊杰，1963年8月2日生于上海。1986年毕业于清华大学建系建筑学专业，建筑学学士。美国俄亥俄州州立大学工商管理硕士学位。1986年进入华东设计院从事建筑设计工作。现任华东建筑设计研究院有限公司董事长，一级注册建筑师，教授级高工，中国建筑学会资深会员，中国建筑学会建筑师分会副理事长。先后主持过办公金融、会展、酒店、文化教育等多类大型公共建筑及综合体建筑设计。1993年获中国建筑学会首届青年建筑师奖，曾多次荣获全国优秀工程设计奖。

Abstract

Modern supertall buildings have become one of the vital icons in economic development and urbanization progress in mainland China as well as one of the major focuses in China's construction industry. This paper will review the context of modern supertall buildings rising in mainland China, comprehend developmental threads and stimuli, and analyze evolving advancements. These will have a guiding significance on the prediction and outlook of China's supertall future emerging trends.

Keywords: China, Supertall Buildings, Rising Background, Developmental Threads and Stimuli, Evolving Advancements, Emerging Trends

摘要

现代超高层建筑已经成为中国大陆地区的经济社会发展和城市化进程的重要标志之一，同时也已经成为中国建筑行业发展的重大课题之一。通过回顾中国大陆地区的现代超高层建筑的兴起背景，梳理发展线索和动力，分析发展历程，对于预测和展望中国超高层建筑今后的发展趋势具有重要的指导意义。

关键词：中国，超高层建筑，兴起背景，发展线索和动力、发展历程，发展趋势

Definition and Rising Context of Modern Supertall Building in China

Supertall buildings in mainland China are defined to hold a construction height of over 100 meters. According to the Code of Fire Protection Design of Tall Civil Buildings published in 1995, the code specification identifies the minimum height of all tall buildings to be 100 meters. Thus, the Chinese construction industry sets 100 meters as the minimum height for all supertall buildings.

The rise of supertall buildings in modern Chinese architecture has a social context, as well as an economic and cultural background. The Chinese ancestors relentlessly tried to to conquer the highest mountains and the biggest rivers in order to challenge the order of nature. The Wood Pagoda in Ying County, Shanxi Province is a high-rise prototype. Since the beginning of the 20th century, modern commercial cities in China progressively emerged, and high-rise and supertall buildings developed as representations of the cities and their business advancements. Ever since then, these buildings have stepped onto the stage of history, sustaining the glorious view of the flourishing forthcoming 100 years.

中国现代超高层建筑的定义和兴起背景

中国大陆地区的超高层建筑是指建筑高度达到或超过100米的建筑物，这个指标来源于1995年颁布的《高层民用建筑设计防火规范》，该规范对高层建筑的上限认定为100米，因此中国建筑行业将100米作为超高层建筑的下限指标。

中国现代超高层建筑的兴起有着社会历史和经济文化的背景。中华民族的先辈们富有征服高山大河，挑战自然规律的不懈追求，山西应县木塔就是当时的高层建筑雏形。从20世纪初开始，中国现代商业城市逐步涌现，高层建筑和超高层建筑作为城市形象和商业发展的象征，迈上历史舞台，开始演绎了持续100年蓬勃发展的壮丽图景。

中国现代超高层建筑的发展线索和发展动力

发展线索

中国现代超高层建筑以“时间”为发展线索，可以分为4个阶段：

- 准备阶段：1900–1949年，
- 萌芽阶段：1950–1979年，
- 发展阶段：1980–1999年，
- 繁荣阶段：2000年–至今。

Developmental Threads and Stimuli of Modern Supertall Buildings in China

Developmental Threads

The modern supertall buildings in China uses "time" as the developmental thread to the whole story, which can be divided into four time periods:

- Preparation Period, 1900 to 1949
- Germination Period, 1950 to 1979
- Development Period, 1980 to 1999
- Prosperity Period, 2000 until now

Criteria of Each Period

Through analysis and research, the three related characteristics are "building height," "GDP (Gross Domestic Product) per capita in major cities," and "the number of completed projects." These can be used to depict the criteria for the four periods mentioned above:

- Preparation Period: building heights are below 100 meters;
- Germination Period: emerging a breakthrough from the first supertall building height over 100 meters;
- Development Period: building height breaking through 200 meters; GDP per capita in major cities reaches 5,000 RMB; the number of completed 200 meters+ supertall buildings is less than 30;
- Prosperity Period: building height breaking through 400 meters; GDP per capita in major cities reaches 25,000 RMB; the number of completed 200 meters+ supertall buildings is over 100.

Developmental Stimuli

Through an in-depth analysis of these four periods, four hidden developmental stimuli can be revealed:

The National Economic Development Impact. In the past 30 years, GDP grew from under 1 trillion RMB in 1980 to 47 trillion RMB in 2011. Real estate developments and investments have also exceeded six trillion RMB. As a result of large investment stimuli, supertall buildings played one of the most important roles in the economic development of cities.

Impacts from the Urban Population Size and Urbanization Level. In the past 30 years, the effect of the urban population concentration is becoming more prominent. The urban population size increased from under 100 million people in the 1980s to exceeding 350 million people in 2010. The urbanization rate reached 50% in 2011. "New completed urban areas covered nearly 40,000 square kilometers at the end of the 2000s. As a result of intensive land uses, high efficiency, supertall buildings are gradually becoming a significant symbol in urban development.

Impacts from the Development of the Central Business District. The construction boom of the Central Business Districts (CBD) in megalopolises began with the River Delta Region in the 1980s and the Shanghai Pudong New District in the 1990s. Currently, the expanding Beijing CBD, the financial district of Yujiabao in the Binhai New Area of Tianjin, the Wangjiadun CBD of Wuhan, and the Hengqin new area CBD of Zhuhai are among the metropolises that have attracted a great number of financial institutions, international multinational corporations, large national companies and private enterprises in China. As a result of its high efficiency in business investment values, supertall buildings have been in favor with entrepreneurs.

Impacts from Building Technology Development. The construction industry in China has made tremendous advancements in structural

阶段标准

通过分析研究，可以运用“建筑高度”、“主要城市人均GDP（国内生产总值）”、“已建成项目数量”3个特征维度，来描述前述4个阶段的划分标准：

- “准备阶段”：建筑高度均在100米以下；
- “萌芽阶段”：出现突破100米高度的首栋超高层建筑；
- “发展阶段”：建筑高度突破200米；主要城市人均GDP达到0.5万元人民币；全国已建成200米以上超高层建筑在30座以下；
- “繁荣阶段”：建筑高度突破400米；主要城市人均GDP达到2.5万元人民币，全国已建成200米以上超高层建筑超过100座以上。

发展动力

通过对4个阶段的深入分析，可以揭示隐伏其中的4项发展动力：

国民经济发展的影响 。近30年来“国内生产总值”（GDP）从1980年不到1万亿，到2011年突破47万亿、“房地产开发投资额”突破6万亿。因其巨大的投资拉动效应，超高层建筑成为城市经济发展的主角之一。

城市人口规模和城市化水平发展的影响 。 近30年来城市人口集聚效应明显，城市人口规模从1980年代不到1亿，到2010年超过3.5亿。“城市化率”到2011年代达到50%。“城市新建成区面积”到2000年代末接近4万平方公里。因其高效的土地集约化利用，超高层建筑逐渐成为城市发展的重要标志。

城市中央商务区发展的影响 。从1980年代的珠三角区域、1990年代上海浦东新区开始，特大型城市兴起了中央商务区的建设热潮。目前，北京中央商务区及东扩规划、天津滨海新区于家堡金融区、武汉王家墩中央商务区、珠海横琴新区中央商务区等区域，吸引了许多金融机构、国际的大型跨国公司、国内的大型央企、民企等进驻。因其高效的商业投资价值，超高层建筑得到了企业家们的青睐。

建筑技术发展的影响 。中国建筑业在结构技术、抗震防灾、电梯设备技术、机电设备技术、施工技术等方面取得了巨大进步。

近三十年来，在结构技术方面，颁布了《高层建筑混凝土结构技术规程》和《高层民用建筑钢结构技术规程》。在抗震防灾方面，颁布了《建筑抗震设计规范》和建设部111号令《超限高层建筑工程抗震设防管理规定》，以及《高层民用建筑设计防火规范》。在电梯等设备技术方面，颁布了《电梯技术条件》，国家标准《电梯制造与安装安全规范 》，国家标准《电梯制造与安装安全规范》 。在机电设备技术方面，颁布了《采暖通风与空气调节设计规范》，《智能建筑设计标准》。在幕墙技术方面，颁布了《玻璃幕墙工程技术规范》、《金属与石材幕墙工程技术规范》、《建筑幕墙》。在施工技术方面，高层现浇钢筋混凝土施工技术着重发展了模板、混凝土、钢筋的施工新技术，并在钢结构和钢—混凝土混合结构方面的安装方法和多种混合施工方法进行了实践。

中国现代超高层建筑的发展历程

准备阶段（1900-1949）：

时代背景和代表作品 。 当时上海是中国最大规模、最繁华的工商业都市，并成为中国建筑业最发达的地区。主要作品有：和平饭店(又名沙逊大厦、1929年、77米)、上海国际饭店(1934年、84米)，中国银行(1937年、76米)等。

技术特征 。 在结构技术方面，主体结构为钢框架结构；在电梯等设备技术方面，1906年首次使用奥迪斯客运电梯（上海汇中饭店） 。上海国际饭店是当时中国和亚洲最高的建筑物，主体结构为钢框架结构和钢筋混凝土楼板，安装了三台并联高速客梯。

technology, earthquake and disaster prevention, elevator equipment technology, mechanical and electrical equipment technology, and construction technology.

In the past 30 years, a great number of code standards have been published. In regards to structural technology, there are the High-Rise Concrete Structure Technology Regulations and the High-Level Civil Buildings Steel Structure Regulations. For earthquake and disaster prevention, there are the Buildings Seismic Design Codes, High-Rise Construction Seismic Fortification Regulations authorized by the Construction Department No.111 Regulation, and the Civic High-Rise Fire-Protection Design Regulations. In regards to elevator and related technology, publications include Specification for Electric Lifts and the National Standard of Safety Specification of Elevator Manufacture and Installation. Mechanical and electrical equipment is covered by the Code for Design of Heating Ventilation and Air Conditioning and the Standard for Design of Intelligent Buildings. For façade technology, there are the Technical Code for Glass Curtain Wall Engineering, Technical Code for Metal and Stone Curtain Wall Engineering, and Architecture Façade.

The Developmental History of Modern Supertall Buildings in China

Preparation Period (1900 to 1949):
Background of the Era and Representational Building. Shanghai was the largest and most prosperous industrial and commercial city in China at one point. Shanghai was also the most developed construction region in China. The main construction projects were the Peace Hotel (also known as Sassoon House, completed in 1929, 77 meters), the Shanghai International Hotel (completed in 1934, 84 meters), and the Bank of China (completed in 1934, 84 meters) among other projects.

Technical Characteristics. In terms of structural technology, steel frames were used for the main structures. In this period, the Shanghai International Hotel, the tallest building in China and Asia, was composed of steel frame structures and reinforced concrete floors as the main structure, with three parallel high-speed passenger elevators. The Otis passenger elevator was used in 1906 for the first time in the Shanghai Huizhong Hotel.

Germination Period (1950 to 1979):
Background of the Era and Representational Building. After the People's Republic of China was founded, the Pearl River Delta Region became a significant source for international trade. New facilities and hotels were built for the foreigners visiting the Canton Fair. The first truly tall building in China was the Guangzhou Baiyun Hotel (1976, 114 meters). Another high-rise building from that era was the Guangzhou Hotel (1968, 88 meters).

Technical Characteristics. In terms of structural technology, the main structure of the Guangzhou Baiyun Hotel is a shear wall construction. A high-speed elevator was installed with a lifting height of 102 meters. At that time, high-rise building technologies were still in the exploratory phase.

Development Period (1980 to 1999):
Background of the Era and Representational Building. During this period, the Pearl River Delta Region had its first breakthrough in supertall building construction, followed by the Shanghai Region of the Yangtze River Delta , which was experiencing strong economic growth.

Figure 1. Shanghai Center
图1. 上海商城

萌芽阶段（1950–1979）：
时代背景和代表作品。 建国后国民经济快速增长，珠三角区域作为对外贸易的重要窗口，新建的涉外酒店成为广交会的重要服务设施。中国首座超高层建筑是广州白云宾馆（1976年、114米），其他高层建筑还有广州宾馆（1968年、88米）等。

技术特征 。 在结构技术方面，广州白云宾馆的主体结构是剪力墙结构；在电梯等设备技术方面，广州白云宾馆安装了提升高度102米的高速电梯。当时的超高层建筑技术还处于探索和萌芽阶段。

发展阶段（1980–1999）：
时代背景和代表作品。这个时期，珠三角区域在超高层建筑领域率先突破，长三角上海地区在一个更高的经济基础起点上，继续接力前进。

前10年中，珠三角区域的代表作品主要有：深圳发展中心大厦（1987年、165米），深圳国贸中心大厦（1989年、160米）等。全国共建成100米到200米之间的12幢超高层建筑。

后10年中，沪、广、深等多地联动，出现一批200米到400米之间的超高层建筑。上海金茂大厦（1999年，421米）是当时中国大陆地区第一、亚洲第二、世界第三的超高层建筑，广州中信广场（1996年，390米）、深圳地王大厦（1996年，384米）紧接其后。全国共建成100米以上超高层建筑124座，包括200米以上27座。

建设理念和建筑技术特征。

在建设理念方面 。 这个时期开发数量较少、布局分散。建设理念聚焦于单栋单功能建筑布局，也有个别项目如上海金茂大厦、上海商城（1990年、164.8米、图1）等项目，对单栋多功能和建筑综合体进行了探索。

在建筑技术方面 。在结构技术方面，结构体系形式多样，以上海金茂大厦为例，出现了包括巨柱框架+核心筒+伸臂桁架组合，带支撑框架+核心筒+伸臂桁架组合等，同时开始采用钢—混凝土混合结构 。在施工技术方面开始采用逆作法施工。在消防技术方面，从1982年开始《高层民用建筑设计防火规范》试行，在1995年正式颁布实施。在电梯设备技

In the first decade of this period, the representational products in the Pearl River Delta Region were the Shenzhen Development Center (completed in 1987, 165 meters) and the Shenzhen International Trade Building (completed in 1987, 160 meters). During this period, there were 12 rtall buildings completed with heights between 100 meters and 200 meters nationwide.

In the last decade of this period, Shanghai, Guangzhou, Shenzhen and other cities participated in an interactive competition to build supertall towers with heights between 200 meters and 400 meters. The Shanghai Jin Mao Tower (completed in 1999, 421 meters) was the second tallest building in Asia and the third tallest building in the world in this era; the Guangzhou CITIC Plaza (completed in 1996, 390 meters) and Shenzhen Diwang Tower (completed in 1996, 384 meters) followed closely.. There were 124 tall buildings over 100 meters completed nationwide , including 27 of more than 200 meters.

Construction Principles and Building Technology Characteristics.
Construction Principles. During this period, high-rise building projects were small in quantity and scattered in location. The construction concept was based on the layout of one function for one building.Only exceptional cases like the Shanghai Jin Mao Tower and the Shanghai Center (completed in 1990, 164.8 meters, see Figure 1) explored multi-function designs and complexes.

Building Technology. In terms of structural technology, various forms coexisted. Taking the Shanghai Jin Mao Tower as an example, a "mega frame + core tube + outriggers" system was used, as well asthe steel-concrete composite structure. Top-down construction methods were utilized. Fire-protection technology advanced with the release of the Code for Fire Protection of Civil High-Rise, which went into a trial phase in 1982 and formally implemented in 1995. Elevator equipment technology also improved, with the first VVVF Control Elevator in mainland China installed in 1988. Double-deck elevators were introduced in 1994, followed by the round-shape sightseeing high-speed elevator with three-cables and a speed of 7.00m/s, followed by a 9.00 m/s super high-speed elevator. In the area of mechanical equipment, before the 1980s the air conditioning system composed of fan coils and air dandling unit s were utilized. Cooling and heating sources were provided by centrifugal chillers and coal-fired boilers, or an urban heat supply network. Partial control systems were introduced for mechanical and electrical systems. By the 1990s, VAV air conditioning systems and the BA systems were used while coal boilers were replaced by fuel boilers.

Prosperity Period (2000 until now)
Background of the Era and Representational Product. During this period, the economy of first-tier cities in the Pearl River Delta Region, Yangtze River Delta and the Bohai Bay Area continued to develop, while other second-tier cities started catching up. The total number of completed buildings over 200 meters was 143 and there were 331 buildings under construction. In comparison to the "Development Period," this era had an exponential growth in the number of buildings constructed, which was hundreds more than the previous period. Construction principles and building technologies also gradually improved, supertall buildings entered the prosperity period.

The representational product in first-tier cities, such asShanghai, Guangzhou, Shenzhen, Beijing, and Tianjin included the 492-meter Shanghai International Financial Center (see Figure 2), which became the tallest building in China when it was completed 2008. The Shanghai IFC was followed by the Shenzhen Kingkey Tower (completed in 2011, 442 meters), the Guangzhou Financial Center (completed in 2010, 439 meters), and the Tianjin World Financial Center

术方面，1988年出现了中国大陆地区第1台变压变频控制电梯，1994年出现了双层轿厢电梯、圆形轿厢三导轨观光电梯和7.00m/s的高速电梯，随后又出现了9.00m/s的超高速电梯。在机电设备方面，在1980年代，采用以风机盘管和空调箱为主的空调系统，冷热源采用离心式冷水机组和燃煤锅炉或城市热网，机电系统引入局部就地控制。1990年代采用变风量空调，并使用BA系统，燃油锅炉取代燃煤锅炉。

繁荣阶段（2000年-至今）：
时代背景和代表作品 。 这个时期长三角、珠三角、环渤海区域的一线城市经济继续发展，其他二线城市经济也不甘落后。全国共建成200米以上建筑143座，还有在建的200米以上有331座。与“发展阶段”相比，在数量上实现了百位数的爆发式增长，建设理念和建筑技术也日益进步，超高层建筑进入了繁荣期。

一线城市的代表作品（如上海、广州和深圳、北京和天津等）有：上海环球金融中心（2008年、492米、图2）成为当时中国大陆地区第一高楼。紧接其后的有深圳京基大厦（2011年、442米）、广州国际金融中心（2010年、439米）、天津环球金融中心（2011年、337米、图3）、北京国贸三期（2010年、330米）等。

二线城市的代表作品（如南京、无锡、温州和武汉等）有：南京紫峰大厦（2010年、450米、图4）、空中华西村（2011年、328米）、温州世贸中心（2011年、348米）、武汉民生银行大厦（2008年、330米）等。

建设理念和建筑技术特征：
在建设理念方面 。这个时期，通过区域集群、建筑综合体（包括商业综合体、交通综合体等）等实践，出现了2种值得研究的新型模式：

- 第一种“区域集群模式”
  这种模式根据整体规划、整体开发原则，形成超高层建筑区域集群。代表案例有天津滨海新区于家堡金融区（建设中）、北京华贸中心（2008年、图5/6）等。

  天津滨海新区于家堡金融区规划占地386万平方米， 120个地块，总建筑面积950万平方米。整个建设过程将地上和地下的空间和交通进行整体规划，地上空间采用适宜的道路尺度、路网密度，具有街区特色；地下商业空间和3纵2横的地下轨道交通整体设计并相互连通。北京华贸中心占地30多万平方米，建筑面积达100万平方米，包括3栋超5A智能化办公楼、2栋丽思卡尔顿和JW万豪酒店、华贸商城、国际公寓楼等。

- 第二种 “建筑综合体模式”
  这种模式是将多种功能整合在数栋建筑联合体或单栋建筑中，形成超高层建筑综合体。代表案例有上海国际金融中心（2010年、259.9米）、天津高银117金融大厦（建设中、597米）等。

  上海国际金融中心由4栋建筑联合组成，总建筑面积40万平方米。包括2栋甲级办公楼，1栋丽思卡尔顿酒店，1栋商业建筑等。天津高银117金融大厦由国际级标准办公楼、六星级酒店、高档商场、商务公寓、会展中心、剧院等综合体组成。

在建筑技术方面 。 在结构技术方面，出现了纯钢板剪力墙、钢支撑筒体、筒中筒 等结构体系，巨型结构体系也更为成熟，钢-混凝土混合结构成为主流。在地基基础方面，采用超长桩及后注浆技术，深基坑围护技术。在消防技术方面，人员疏散和烟雾模拟等参数化模拟技术和性能化设计理念应用。在抗震防灾方面，消能减震技术、弹塑性时程分析、防连续倒塌、性能化设计、抗爆和抗风设计、数值风洞模拟等方法大量运用，反恐技术逐渐重视。在设备技术方面，燃气锅炉、移峰蓄能技术、地源热泵、太阳能、新风供冷、余热

(completed in 2011, 337 meters (see Figure 3).

The representational products in second-tier cities such as Nanjing, Wuxi, Wenzhou and Wuhan included the Nanjing Zifeng Tower (completed in 2010, 450 meters, see Figure 4), the Huaxi Village Tower (completed in 2011, 328 meters), the Wenzhou World Trade Center (completed in 2011, 348 meters), and the Wuhan Minsheng Bank Tower (completed in 2008, 330 meters).

Construction Principles and Building Technology Characteristics:

Construction Principles. Two new patterns emerged in this period that are worth more in-depth comment: Regional clusters and different building complexes, including commercial complexes and transportation complexes.

- First Type: "Regional Cluster Pattern"
  Based on overall planning and developmental principles, local governments began to develop regional clusters of supertall buildings. Representative cases include the Yujiapu Financial District in the Tianjin Binhai New Area (still under construction) and the China Central Place in Beijing (completed in 2008, see Figures 5a and 5b), among other projects.

  The Yujiapu financial district of the Tianjin Binhai New Area has a planning area of 3.86 million square meters, taking up 120 land parcels with a total construction area of 9.5 million square meters. During the planning process, an overall plan integrated the space above and below ground, along with traffic. The space above ground adopted an appropriate road scale, road density and neighborhood characteristics; the

回收、雨水利用等各项节能技术得到应用。楼宇智能化系统以及智能灯光控制全面发展。

上海环球金融中心根据钢-混凝土混合结构，采用了经济合理的核心筒+巨型柱+外伸臂桁架的巨型结构体系；安装了中国大陆地区首座超高层建筑自动控制风阻尼器装置；采用中国大陆地区最快的10米/秒双轿厢电梯；在施工中采用整体提升钢平台模板体系和液压自动爬模体系等。

中国现代超高层建筑的发展趋势

经过了准备、萌芽、发展和繁荣等4个阶段，展望未来，中国的超高层建筑将日趋成熟、继续攀登并创造新的纪录。

在建设理念 方面

在商业需求、城市基础设施和土地集约利用的引导下，超高层建筑将进一步探索“空中城市”的新理念。

南京河西金鹰天地（建设中、350米、图7）的创新理念，形成了“空中城市”的雏形。项目总建筑面积90万平方米，包括1栋办公酒店主楼、2栋办公楼以及商业裙房。最具特色的是，建筑群在200米高度由空中联接体将3栋主楼连接起来。整个建筑采用了立体交通规划，城市快速高架直接引入地上三层，城市地铁引入建筑地下空间。

今后“空中城市”的新理念将从人口规划、产业构成、空间布局、能源交通、文化卫生、低碳环保等进行全方位探索，真正提高城市土地集约化利用的效率。

在建筑技术方面

Figure 2. Shanghai WFC
图2. 上海环球金融中心

Figure 3. Tianjin IFC
图3. 天津环球金融中心

Figure 4. Nanjing Zifeng Tower
图4. 南京紫峰大厦

underground commercial space included three vertical and two horizontal underground railway traffic systems to keep them interconnected.

The China Central Place in Beijing has more than 30 million square meters of space and cover more than one million square meters, including three super-5A intelligent office buildings, Ritz-Carlton and JW Marriott hotels, a Central Place Mall, and international apartment buildings, among other programmatic elements within the cluster.

- Second Type: "Building Complex Pattern"
  This pattern integrates various functions in several buildings or a single building to form supertall building complexes. Representative cases include the Shanghai International Financial Center (259.9 meters, completed in 2010) and the Tianjin Goldin 117 Financial Tower (under construction, 597 meters) among other projects.

  The Shanghai International Financial Center is a combination of four buildings with a total floor construction area of 400,000 square meters. The building functions include two Class A office buildings, a Ritz-Carlton Hotel and a commercial building. The Tianjin Goldin 117 Financial Tower is composed of a world-class level office building, a six-star hotel, an upscale shopping mall, business departments, exhibition center and theaters.

Building Technology. During this period structural technology became more mature with the introduction of pure steel plate shear walls, steel supporting tubes, a tube-in-tube structure system, and a mega structure system. Steel - concrete composite structures became mainstream. For foundations, long pile and post-grouting techniques were used, along with a deep foundation pit technology. In terms of fire protection technology, performance-based evacuation applications and smoke simulation parameter technologies were used. Earthquake and disaster prevention techniques also improved. Energy dissipation technology, elastic-plastic time-history analysis, anti-progressive collapse, performance-based design, anti-explosion and wind-resistant design, and numerical wind tunnel simulation methods were used extensively, with an increasing emphasis on counter-terrorism technologies. In the area of equipment technology, gas boilers, energy storage technology, ground-source heat pumps, solar energy, fresh air cooling equipment, waste heat recovery, and rainwater utilization were among the various energy-saving technologies applied. Intelligent building systems and intelligent lighting controls were also fully developed.

Based on its steel-concrete composite structure, the Shanghai World Financial Center (WFC) utilized an economic and reasonable "core tube + mega column + outrigger" structural system. It included the first automatic wind damper device controllers installed in a supertall building in mainland China. It; it also installed elevators in mainland China at 10 meters per second. During construction an integral steel platform modular system and automatic hydraulic climbing formwork system wereused with other systems.

The Emerging Trends of Modern Supertall Buildings in China

After the four periods of preparation, germination, development, and prosperity, there is no doubt that supertall buildings in China will become increasingly mature, continue to prosper, and break new records.

超高层建筑的各专项技术集成化趋势将更加强化，包括“区域能源中心技术”、“建筑环境数值模拟技术”、“非传统水源利用等节水技术”、“物联网技术”、“建筑能耗分析技术”等技术将进一步得到发展和应用。

同时，超高层建筑将继续突破新的高度，正在兴建的有：深圳平安金融中心（660米）、上海中心（632米）、武汉绿地长江中心（606米、图8）、天津高银117金融大厦 （597米、图9）、广州国际金融中心（530米）、天津周大福滨海发展中心 （530米、图10）、大连绿地中心（518米、图11）等7座500米以上的超高层建筑。还有中国本土的建筑设计公司原创设计的武汉中心（438米、图12）。

在可持续发展方面

超高层建筑将成为进一步探索和研究绿色与可持续发展人居环境的重要载体之一。2012年2月《绿色超高层建筑评价技术细则》编制完成，这是中国首次在减少对城市能源资源和微气候环境的影响方面，为超高层建筑的发展指明了方向，具有非常重要的指导意义。超高层建筑作为人类最新最高建设技术成就的代表之一，应该成为重要的技术实验平台和载体，为进一步探索和寻找更低能耗、更加美好的人居环境做出应有的贡献。

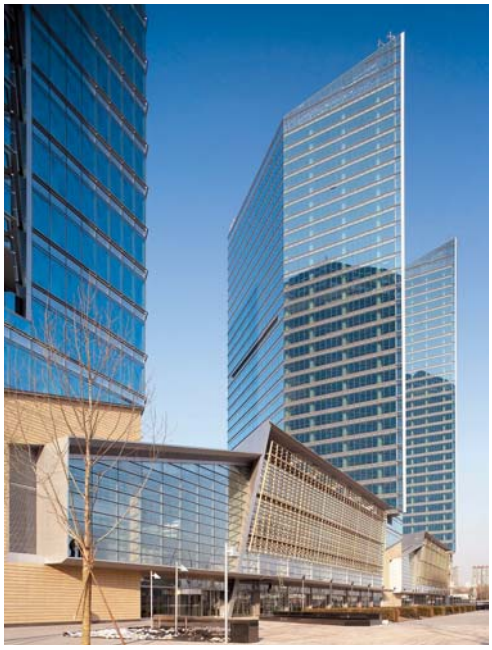

Figure 5. China Central Place - Office
图5. 华贸中心–办公楼

Figure 6. China Central Place - Hotel
图6. 华贸中心–酒店

Construction Principles

Guided by commercial demands, urban infrastructure and intensive land uses, supertall buildings will further explore the new concept of a "city in the sky."

The innovative idea of the West Golden Eagle Plaza on the Nanjing River (under construction, 350 meters tall, see Figure 6) has formed a "city in the sky" prototype. The total area of the project will be 900,000 square meters including one office-hotel main building, two office buildings, and one commercial annex. The most unique feature is that the three main building complexes are connected in the sky at the height of 200 meters. A vertical transportation planning system is applied to the whole complex including elevated high-speed viaducts directly integrated into three levels above ground and a city subway is introduced beneath the buildings.

Figure 7. Nanjing River West Golden Eagle Plaza
图7. 南京河西金鹰天地

Figure 8. Wuhan Greenland Changjiang Center
图8. 武汉绿地长江中心

Figure 9. Tianjin Golden Finance 117
图9. 天津高银117金融大厦

Figure 10. Tianjin Chow Tai Fook Binhai Center
图10. 天津周大福滨海发展中心

In the future, the new principle of a "city in the sky" will focus on population planning, industry composition, space distribution, energy, transportation, culture, health, low-carbonization, environment protection and other aspects in order to improve the efficiency of the intensive usage of urban land.

Building Technology

During this new growth era, different technologies will be further developed and integrated into supertall buildings, including regional energy centers, numerical simulation technology on building environments, non-traditional water usage plans, networking technology and building energy consumption analysis techniques.

Meanwhile, supertall buildings will continue to breakthrough new heights. The seven buildings over 500 meters under constructionShenzhen Ping An Financial Center (660 meters), Shanghai Tower (632 meters), Wuhan Greenland Chang Jiang Center (606 meters , see Figure 7), Tianjin Goldin Finance 117 Tower (597 meters, see Figure 8), Guangzhou International Finance Center (530 meters), Tianjin Chow Tai Fook Binhai Center (530 meters, see Figure 9), and the Dalian Greenland Center (518 meters, see Figure 10). The list of projects in development also includes Wuhan Center (438 meters, see Figure 11), an original design produced by a Chinese architecture company.

Sustainable Developments

Supertall buildings will become one of the most important mediums for further exploration and research of green and sustainable developments and the human living environment. The Technical Details of Green Supertall Building Evaluation, completed in February of 2012, has become China's first guidance for reducing urban energy resources and micro-climate environmental impacts. The evaluation guide points out the future direction for supertall building developments with vital significance for China's cities. As the human representative of the highest technical construction achievements, supertall buildings should be an important experimental platform and vehicle to make contributions to the advancement of more low energy consumption methods and to create more beautiful living environments.

Figure 11. Dalian Greenland Center
图11. 天津高银117金融大厦

Figure 12. Wuhan Center
图12. 武汉中心