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Supertall Building Difficulties and Control Points
超高层综合体难点与管控要点

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贾朝晖：毕业于哈尔滨工业大学，建筑学硕士，曾在机械工业设计研究院上海分院、巴马丹拿（上海）咨询有限公司工作，2003年9月进入绿地集团，2004年8月-2010年8月作为技术总监负责世界第七高楼紫峰大厦（450米）全程技术管理工作，2010年8月开始在绿地集团技术管理与产品研发部工作，作为总经理助理目前负责600多米武汉绿地中心、300多米的吴江超高层、长春超高层等多个300米以上超高层技术直管和五星级酒店技术直管工作以及东部区域技术管理工作。曾参与中国第四届、第五届超高层峰会、重庆城市综合体与超高层论坛等多个论坛作为主讲嘉宾。

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唐敏：2007年3月毕业于同济大学，建筑学硕士，2007年4月进入绿地集团，至今在绿地集团技术管理与产品研发部担任技术总监，负责参与600多米武汉绿地中心、300多米的吴江超高层、长春超高层等多个300米以上超高层技术直管工作以及集团内300米以上超高层项目的研发工作。曾代表绿地集团参与中国第四届、第五届超高层峰会、重庆城市综合体与超高层论坛等多个论坛，并作为主要嘉宾。

Abstract

This paper takes the world's seventh supertall, Zifeng Tower, as an example and integrates the authors' management experiences in more than ten supertall buildings in order to analyze the difficulties of the entire construction process from the perspective of the architect and estate owner. This paper proposes specific ideas and methods to ensure quality during the whole process of arrangements in the early stages such as: design firm selections, designs, and construction processes.

Keywords: Zifeng Tower, Management experience, Design quality assurance

摘要

本文结合绿地集团已经建成的世界第七高楼紫峰大厦和在设计和建设过程中的十余幢超高层管理经验，从房地产业主建筑师角度对整个建设过程中的难点进行剖析，提出了在前期定位、设计单位选择，设计过程把控及建设过程中如何保证设计品质等具体思路与措施。

关键词：紫峰大厦、管理经验、设计品质保证

Introduction

Since supertall buildings are sought after by mankind as a medium to stretch the laws of physics, these supertall buildings have already gone far beyond conventional construction methods. Supertall buildings often carry the representational expectations of a city or a country. As the economy and development of related technologies continue to thrive in Asia, China has already become the main field of competition for supertall building construction. Currently, more than one-third of the one hundred tallest buildings and over half of the ten tallest buildings in the world are in China. China is entering the supertall building era at an unprecedented pace.

As one of the top five hundred companies in the world, Greenland Group is among the first few real estate companies in China to enter the supertall building field. Greenland Group has established working relationships with SOM, Adrian Smith + Gordon Gill, Thornton Tomasetti, ECADI, and many other famous design institutes. The Group has also been working with the Shanghai Construction Group, China State Construction Corporation, and many other large construction companies since 2004. Greenland Group has grown from a "freshman" to an experienced developer with

引言

超高层建筑作为人类高度追求的载体，在标志性方面已经超越常规建筑的意义，往往承载着一个国家或城市的期望，随着亚洲经济的腾飞与相关技术的日益成熟，中国已经成为超高层的主要战场，在已经建成最高的前一百座超高层中有超过三分之一在中国，在已建成的最高的十座超高层中有超过半数在中国，中国正以一种前所未有的步伐进入超高层时代。

绿地集团作为世界五百强企业，是中国最早进入超高层领域的房地产企业之一，二千零四年就进军超高层领域，在过程中同SOM、AS+GG、TT、华东院等著名设计单位，上海建工集团、中建总公司等特大型施工企业以及各个方面的资源建立良好的合作关系，绿地集团也从一个领域新兵逐渐成长为具有完善的超高层管理体系和丰富经验的开发商，超高层已经成为集团的核心竞争力之一，目前建成与建设中二百五十米以上的超高层超过十五幢（请见图1），其中包括已经建成运营的四百五十米的南京紫峰大厦（请见图2）和已经结构封顶即将交付使用的郑州千禧广场（请见图3）。在设计建设过程中著名的有超过六百米的武汉绿地中心、超过五百米的大连绿地中心等。

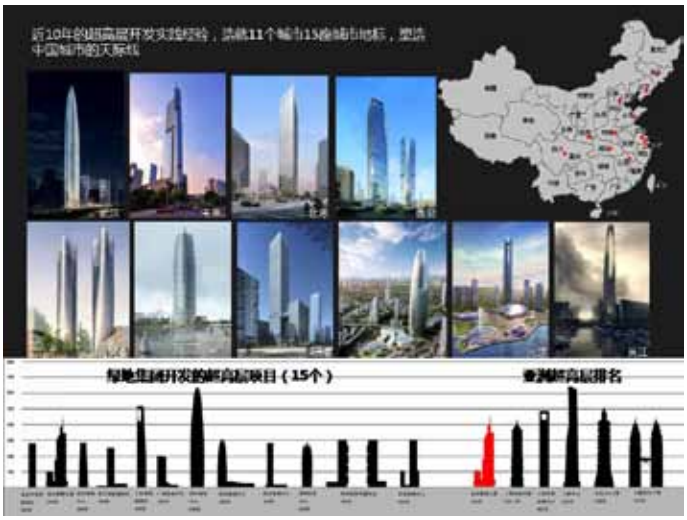

Figure 1. Supertall building practices of Greenland Group
图1. 绿地集团超高层实践

a well-established supertall building management system through this process. Supertall buildings have become one of the Group's core strong points. More than fifteen supertall buildings over 250 meters tall have already been completed or are currently under construction (see Figure 1); this includes the completed 450-meter Zifeng Tower, which has been put into operation (see Figure 2), and the Zhengzhou Qianxi Square which recently topped out and soon will be put into operation (see Figure 3). The 600+ meter-high Wuhan Greenland Center and the 500+ meter high Dalian Greenland Center are among some of the well-known under construction projects of the Greenland Group.

Architectural characteristics and difficulties of supertall buildings

Supertall buildings usually have enormous volumes, generally over 200,000 square meters, and complex functions, which usually include hotels, apartments, offices, business clubs, and tourist observatories.

These structures require large capital investments, easily over tens or hundreds of billions RMB and have long periods of return because only offices and apartments within the building are for sale. The rest of the building is only leased out for hotels, retail, and tourist functions. In earlier years, the majority of completed supertall buildings were all leased properties. Recently, some supertall buildings are beginning to sell part of their property such as the Burj Dubai, Hong Kong Finance Center, Zifeng Tower, and the World Financial Center.

It is also more difficult to operate and manage supertall buildings, and they have higher operating costs in comparison to regular projects,

Figure 2. Nanjing Greenland Square Zifeng Tower
图2. 绿地南京紫峰大厦

超高层建筑特点与难点

体量巨大，一般都超过二十万平方米。功能复杂，一般包括酒店、公寓、办公、商业、会所和观光功能等其中的几种。

资金投入大，动辄数十亿甚至上百亿，回报周期长，除部分办公、公寓可销售外，酒店、商业、观光等作为持有物业。从早期已建成的超高层来看，绝大部分作为持有物业来考虑， 近年来所建超高层则考虑部分销售，如哈利法塔、香港金融中心二期、紫峰大厦、环球金融中心等。

未来运营难度和管理难度大，其运营成本也比一般项目要大的多，年能源费用在数千万不等，由于超高层综合体功能复杂，除了大物业以外还有商业管理公司、酒店管理公司等专项管理物业，未来的运营整合比较复杂，尤其涉及持有和销售部分，后期运行管理难度就更大。

建设周期长，经济形势与政策调控对项目影响大。从目前已经建成的超高层来看，大部分建设周期都在5-8年，往往会经历至少一次的经济危机和政策调控。

设计与施工技术难度大，审批流程复杂。超高层综合体设计除了常规的建筑、结构、机电、专业外，还涉及深基坑维护设计、电梯流量设计、幕墙设计、灯光设计、声学设计、管线综合设计、钢结构设计等数十项专项设计。除常规审批外，消防、抗震设计

Figure 3. Zhengzhou Qianxi Square
图3. 郑州绿地千禧广场

Figure 4. Seismic expert review meeting of Nanjing Zifeng Tower
图4. 南京紫峰抗震评审会现场

Figure 5. Fire protection assessment meeting of Nanjing Zifeng Tower
图5. 南京紫峰消防评审会现场

including energy cost which could go beyond tens of millions. Due to the complexity of programs in supertall buildings, some of the properties are run by program-specific management companies in addition to having the building's general property management company. Future operations are very complicated, especially when buildings are split between owner and tenant occupants.

The long construction period of supertall buildings has great impacts on the project due to the potential variance of economy and government policies in this period. Most construction periods ranges from five to eight years and generally experience at least one economic crisis or change in governmental policy.

Design, construction, and government approval for supertall buildings The design process not only involves architectural, structural, mechanical, and electrical designers, but also deep foundation excavation, vertical transportation, façade system, and other highly specialized professionals. In addition to the basic reviews and approval processes, fire protection and seismic designs require a independent national approval (See Figure 4 and Figure 5). Challenges such as slip-form construction, assembly and disassembly of the tower crane, high-grade concrete pumping, vertical transportation of materials, and high-altitude safety measures during supertall construction rarely happen in conventional projects (see Figure 6 and Figure 7).

Numerous project-related parties make comprehensive integration and management difficult. For a supertall buildings, related design firms, construction companies, and material suppliers are generally over a couple hundred. Although it may not be difficult to complete the construction of a project with ample funds, it becomes difficult to build a high-quality project with a reasonable cost distribution and limited funds.

Large political influences of supertall buildings can draw more attention from the public. Supertall buildings are usually icons of their city and often receive a lot of attention from local governments. For instance, throughout Zifeng Tower's construction process, provincial and municipal officials visited the site several times. Therefore, there are more stringent requirements on the design quality, construction quality, and on-site management than general projects.

There is a lack of qualified professionals and a narrow selection of design and construction companies with related experience in similar projects. Although there are many supertall buildings designed or planned for construction, there are only a few of them that are actually

Figure 6. Nanjing Zifeng Tower under construction
图6. 施工中的南京紫峰大厦

Figure 7. Nanjing Zifeng Tower under construction
图7. 施工中的南京紫峰大厦

需要进行国家级专项审批（请见图4和图5）。施工过程中滑模技术、塔吊多次拆装、高标号混凝土泵送、大量材料垂直运输、高空安全维护等多项难题，都是常规项目中难以碰到的（请见图6和图7）。

相关单位众多，综合整合与管理难度大。超高层综合体相关设计、施工、材料供应单位多达数百家，应该说在资金充裕的情况

built and under good operations. It is hard to judge whether it is a good design or not with limited operational testing, references and case studies. Personnel with relevant experience are even scarcer. There are only a few design companies at home and abroad with relevant supertall experiences. The ones that have the ability to integrate the general contracting and sub-contracting are even rarer.

Key points of supertall building management

Project positioning and major technical index

A good beginning wins half the battle; pre-positioning for supertall complexes must meet the requirements for both macro planning and the designated operations of the developer. Effective positioning requires detailed market research and operational experiences. Positioning reports require technical analysis and preliminary cost estimations at the beginning of the design phase based on previous project experiences. Thorough research needs to be done in aspects such as mechanical and electrical systems, curtain wall types, structural systems, and interior decoration standards. These elements have a significant impact on cost and quality that can create a difference in pre-positioning outcomes in theory and in reality which may result in an unforeseen gap due to unsystematic cost cuts.

Supertall complexes carry the expectations of a city. There are many political factors and empirical data of supertall buildings which have huge differences in comparison to general projects. Deficiencies in the directory of planning indexes such as floor area ratio, coverage rates, parking, structure gauges, power transmission loads, vehicle entrances, and building setbacks are all likely to be problems. Therefore, effective communications with corresponding departments about the rationality of the quota for each component at an early stage of the design can contribute to a better and more effective design.

Major design consultants and proposal selections

Eighty percent of the project costs are largely decided during the schematic and design development phases of the project. To a certain extent, the costs and qualities are determined by the selection of the design company and the scheme. From the experience of existing supertall buildings, it is obvious that the quality of the design has a huge impact on project costs. If an inexperienced owner chooses an inexperienced design company to save on fees, the quality of construction, efficiency of operation, and rationalities will be difficult to guarantee. Moreover, construction costs will increase as well (see Figure 8).

Design process management and restoration control

To an extent, the design process management is a procedure that involves continuous choices and decisions. Influential factors include usability, aesthetics, economics, constructability, and safety among many other factors. The owner should respect the design company's judgments but at the same time should not blindly follow everything they say. Design companies may have experience in creating proposals, but could lack knowledge of operation, integration of resources, financial operations, and market acceptability. On one hand, the owner should consider issues from a more comprehensive point of view, such as a technical general contractor integrating related designs and carefully balancing the overall project. On the other hand, the owner also needs to understand how to manage the design process in order to have more effective communications with relevant companies to ensure the validity and rationality of the final decisions.

Finishing construction drawings implies 90 percent completion of the entire project in conventional projects, but it might only imply

下建成不难，但在合理的经济性价比下建成好用、耐看的项目很难。

政治影响大，受到相关关注多。超高层综合体一般做为城市的标志和最有影响力的项目，往往受到省市政府的高度关注，如紫峰大厦在整个建设过程中省市领导先后来参观考察就多达数十次，无论从设计品质、施工质量、现场管理都会要求比一般项目更严。

人力资源匮乏，相应参考经验少，设计和主要施工单位选择面窄。目前虽然在国内设计和规划过程的超高层项目很多，但真正建成并良好运营的并不多，没有经过实际运营检验的很多设计经验很难说是对是错，相关参考和学习的案例很有限，具备相关经验的管理人员更是匮乏。设计单位在国内外具备相关经验的设计单位也屈指可数，真正具备整合能力的总包、钢结构、幕墙等单位国内也寥寥无几。

超高层管控要点

项目定位与主要技术指标确定

良好的开端是成功的一半，超高层综合体前期定位既要满足规划宏观的要求，又要符合开发商的实际运营的需要，因此有效的定位需要进行详细的市场调研与运营经验作为支撑。在设计之初应结合以往的项目经验对定位报告进行技术分析与造价初步估算，尤其涉及对造价、档次影响较大的机电系统、幕墙类型、结构体系和室内装修标准等方面进行仔细研究，尽可能避免前期定位过高，而后期有无系统性的削减成本造成前后脱节的情况。

超高层综合体在产生过程中就承载着一个城市的期望，其产生的过程中有很多政治因素，加上超高层综合体的经验数据和一般项目有较大区别，因此往往在规划指标上会出现先天不足，如容积率、覆盖率、停车指标、建筑退界、送电负荷、机动车出入口、地下室退界等主要指标都有可能会出现一定的问题。在设计启动或设计前期有效的同相关部门沟通尽可能保证规划指标的合理性才能有效推进设计，保证设计品质。

主要设计单位与方案选择

设计工作在方案和扩初阶段基本决定了项目成本的80%，因此合适的设计单位、设计方案选择在很大程度上决定了项目的品质与成本，从已经建成的超高层项目成本来看，设计水平优劣对项目成本的影响巨大，如业主经验不丰富又因节约设计费用选择没有经验的设计单位，设计费用虽有所节省，但建筑品质、使用效率和合理性都很难保证，后期建设成本也会大幅增加（请见图8）。

设计过程管理与还原把控

设计阶段管理在某种程度上是一个不断决策和选择的过程，有使

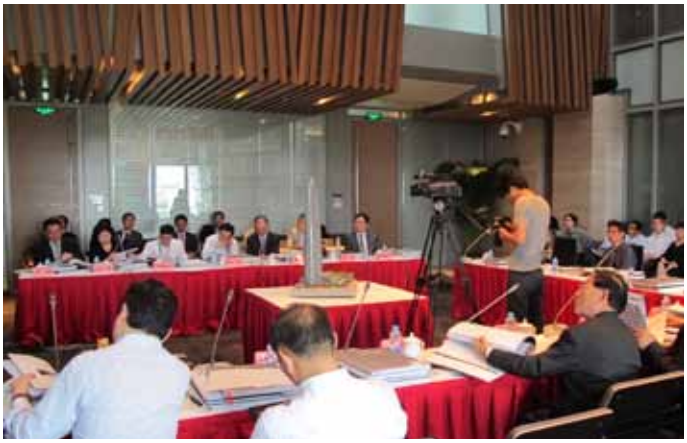

Figure 8. International bidding conference for supertall building design scheme
图8. 超高层方案国际招投标会议现场

50 percent completion in supertall building projects. There is much more further development needed in the tendering and construction processes, including curtain walls, electrical engineering, balance of mechanical and electrical pipelines, replacement of interior materials, large equipment space developments, hotel kitchens, laundry facilities, etc. It is a significant transformation from the drawings to real life. During the construction phase of a hotel zone, there are a lot of material substitutions and confirmations to be made. It is vital to find the balance among quality, schedule, and cost. A large number of mechanical and electrical equipment need substantial amount of further development from requesting proposals to finalizing manufacturers. The equipment utilized needs to satisfy the operational requirements and also must have a variety of selections; otherwise, business negotiations cannot be effectively carried out.

External coordination

The owner has a lot of external coordination work to do, such as early stage project establishments, schematic design approval, plan approvals, obtaining construction licenses, and the completion acceptance of the final project (see Figure 9). It is necessary to maintain project quality, ensure consistent progress, and meet the demands of the government and relevant departments for approval. It is essential to master the profession and grasp the scale of external coordination that is required.

Bidding and construction management work

Supertall complexes are much more complicated than general projects, such as the Zifeng Tower. There are over 300 related contracts for the project and dozens of these contracts are worth over ten million RMB. There are separate contracts for the general contractor, curtain wall contractor, steel structure contractor, elevator suppliers, and installations which are all over billions of RMB. The complexity and diversity of the project are determined by the distinctiveness of the project. There is a lot of work required to control the technical product requirements and accuracy of material samples before the bidding process can begin. In the selection process, analysis and preparation of the bidding documents with trial and error can gradually improve the consistency between the bidding and selection of proposals. After the analysis and comparison of different proposals, the owner and developer decide what type of technologies are required of the project so that they can eliminate technology proposals that do not meet the selection requirements. After knowing what types of technologies are required and provided by such selected proposals, comparative evaluation of these remaining proposals can avoid higher expenses in selecting the wrong proposals before narrowing down what technologies are needed in design. Selecting the cheapest proposal without research of what technology is needed can increase post-operational costs due to lesser quality of technology. There are two extremes to this selection - to select a proposal based on cost only without prior research to necessary technologies, or to select the proposal based on technology advantages only with proper research on what is needed for the project.

There are usually hundreds of companies involved during the construction process, including the general contractor and multiple subcontractors. It is impossible to let the owner manage everything, but the quality and cost cannot be guaranteed if the general contractor manages the entire project. Thus, it is important to explore the advantages and disadvantages of the general contractor in order to find a balancing point to ensure a methodical progress. During the contract management process, simultaneous compliments and penalties, means of an overall schedule, quality monitoring, and vast technical meetings can effectively regulate the project.

用性、美观性、经济型、建设可行性、安全性等多种因素，业主应尊重设计单位而不是迷信设计单位，优秀设计单位在专业设计上具有优势，但在功能定位，后期运营、资源整合、资金运作、市场接受度等方面缺乏足够的了解。因此业主一方面需要站在更高更广更综合的角度考虑问题，作为技术总包，整合相关设计，综合平衡把控整体效果。另外一方面要加强专业学习，才能和相关单位进行有效沟通，确保决策的合理性有效性。

常规项目设计施工图完成后整个设计工作已经完成了90%，但在超高层综合体项目中可能只完成了50%，在招标和施工过程中有多达数十项的设计深化工作，幕墙深化、弱电设计深化、机电管线平衡、室内设计材料替换、大量设备用房深化、酒店厨房、洗衣房深化设计等，是从图纸层面向实际效果转化的重要过程。在酒店室内施工阶段，存在大量材料替换、确认工作，要在品质、进度、造价三者间找到平衡点。 大量的机电设备从招标到确定品牌也需要大量深化工作，一方面要满足使用的要求，另外又要有一定的选择性，否则商务谈判也无法有效进行。

对外协调

在项目建设过程中，从前期立项、方案送审、规划审批、专项审查到施工证照办理、竣工验收，业主有大量的对外协调工作（请见图9），既要维护项目品质，确保进度又要符合政府及相关部门审批诉求，在对外协调中既要精通专业又要把握进退尺度。

招标与施工管理工作

超高层综合体相对一般项目复杂的多，如紫峰大厦相关合同多达300多个，超过千万的合同多达几十个，其中总包单位、幕墙单位、钢结构、电梯供应与安装都在亿元以上。 项目的特殊性决定了产品的复杂性与多样性，需要投入大量的精力在招标前期把控产品技术要求、材料样品的准确程度。招标过程中做好技术回标文件的分析、对比工作，反复答疑与逐步完善投标方对招标文件的响应程度，尽可能避免漏项与技术不符合情况，在技术基本满足情况下再进行评比，避免了单独价格因素和唯技术论。

在整个施工过程中总包、分包等相关单位多达数百家，完全由业主管理不可能，完全由总包来管理，品质、造价又不可控，有效切分界面发挥总包之长，弥补总包之短形成有效互补才能确保项目的有序推进。合同管理与人情并重，恩威并施，以整体进度计划、质量监控、大量的专项会议等手段来进行把控。

从绿地集团超高层项目建设过程来看，既有很多成功的经验也有很多的遗憾与不足。一个精品项目的成功因素太多，除了业主的管理水平以外，城市规划管理水平，设计与施工单位的综合素质，社会的基建基本水平、相关产业的成熟程度都是必不可少的因素。新的时代给了我们更多发展的机遇与平台，但我们也承担

Figure 9. Preliminary review of Nanjing Zifeng Tower design scheme
图9. 南京紫峰扩初评审会现场

There have been many successful design practices of supertall building projects from the Greenland Group among some regretful design practices as well. The success of a project can be affected by a lot of factors. In addition to the owner's management skill, the overall quality of urban planning, the management ability of design and construction companies, the general quality of the city's infrastructure, and the maturity of related industries are also indispensable. The new era has provided opportunities and a stepping stone for future developments, but at the same time, there also comes greater responsibility and obligation. "The road ahead will be long and the climb will be steep" is the Greenland Group's motto and mission they hope all colleagues live by.

着相应的社会责任与义务。“路漫漫其修远兮，吾将上下而求索”应该是绿地集团和相关同仁需要不断追求的理想与境界.