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Author:	Kristen Whittle, Director, Bates Smart
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A Case Study on Designing Superslim in Melbourne
墨尔本超修长高楼设计案例

Kristen Whittle
Director | 总设计师

Bates Smart | Bates Smart建筑师事务所

Melbourne, Australia | 墨尔本，澳大利亚

Kristen is a British trained architect with a Masters of Architecture from SCI-arc in Los Angeles. He worked with Herzog & De Meuron on the Tate Modern, winning the UK's National Prize for architecture, the RIBA's Stirling Prize. Kristen became a Director of Bates Smart in 2005. Kristen's work includes Collins House, the world's second-most slender residential tower at 466 Collins Street Melbourne, as well as high-end luxury projects including Capitol Grand, 35 Spring Street, Eastbourne, Crown Metropol and Crown Mahogany Room. In 2012 Kristen won more than 35 awards for his work on The Royal Children's Hospital.

Kristen 是一位英国建筑师，毕业于洛杉矶南加州建筑学院。他曾就职于赫尔佐格 德梅隆建筑事务所从事泰特现代艺术馆的设计，并因此获得了英国国家建筑设计奖和英国皇家建筑师协会斯特灵设计奖。2005年至今，Kristen 就职于Bates Smart 担任总设计师一职。 Kristen 的主要工作包括：墨尔本科林斯街466号，世界上最修长的高楼的设计；35 Spring Street，Eastbourne，Capitol Grand 奢华国会高层；皇冠中心以及皇冠Mahogany Room。2012年Kristen设计的皇家儿童医院荣获了35项设计奖项。

Abstract | 摘要

Collins House Melbourne, the newest super slim tower to hit the global stage, will be the most slender tower in Australia and the fourth globally. The momentous ultra-slim line tower with a slenderness ratio of 1:16.5 is designed as an entirely integrated architecture, interior, engineering and construction design solution and employs world's first prefabrication and documentation methodologies. The narrow site required the team to invent a 3D prefabricated composite construction system that radically reduces construction timeframes, kick starting the viability of the development and overturning the traditional economic and development parameters of building tall structures. This revolutionary approach to the delivery of the project required the project team to assist in the development of innovative fabrication opportunities, using BIM to enable an accelerated construction process. "The design of this tower is uncompromising in its use of contemporary thinking almost unseen in today's world of high rise development."

Keywords: BIM, Design Innovation, Melbourne, Prefabrication, Residential, Superslim

墨尔本Collins House，是一个最现代的超修长塔楼，并将成为澳大利排行第一以及全球第四最修长的塔楼设计。 这个瘦高比1:16.5，拥有超乎思想的纤长线条的塔楼完整的集合了建筑设计，室内设计，工程设计，施工设计，预制和施工图制作于一体。 狭窄的基地对三维立体预制综合施工系统提出了要求，从而彻底加快了施工进度， 实现了发展的可行性，颠覆了高层建筑传统的经济和发展参数。 这个革新的设计手法要求整个团队在设计过程中的高度协作，运用BIM建筑信息模型加快整个施工的进程。 如今，世界上的高层建筑的发展已渐渐失去了对当代建筑的思考。而这个设计并没有向这种现状妥协。

关键词：BIM、设计创新、墨尔本、预制、住宅、超修长

The Architect's Brief

'Through engineering and systemization, we seek to create an adaptable, durable and sustainable ultra slim residential tower for Collins Street, Melbourne's foremost prestigious address.'

Melbourne's CBD is a world renowned Victorian cityscape, featuring a diverse classical palazzo, neo-gothic and arts and crafts building stock. Largely unified by a 40m height limit, the city has recently absorbed significant physical change through the technological construction innovations of the mid-20th century. Today, Melbourne is addressing the next generation of physical change, leading to a quest for super tall buildings and a significant scaling up of urban density. This new height is almost entirely built for the incoming demands of population growth (increasing by 90,000+ per annum into Melbourne alone) and to service Melbourne's appeal to offshore foreign property investment.

466 Collins Street, now Collins House, is centrally located on a compact site between King and William Street, immediately

项目建筑概要

"我们旨在通过工程化和系统化，在墨尔本极具声望的柯林斯街上创造一栋可适应的、持久的并具有可持续发展性的修长公寓楼。"

墨尔本市中心拥有世界闻名的维多利亚城市景观，充满多样的经典豪华宅邸，新歌特式建筑，以及艺术与文艺运动风格建筑。墨尔本在20世纪中期建筑技术革新的基础上已发生重大改变，大部分建筑的限高为40米。如今，这座城市正经历新一轮变化， 城市密度大幅上升，对修长高楼的需求也相应产生。 新的建筑高度几乎完全是为了迎合人口增长的需求（仅墨尔本每年的人口增长数超过90,000人）， 以及为海外房产投资的服务。

柯林斯街466号——即如今的Collins House公寓楼，坐落于国王街（King Street）与威廉姆街（William Street）之间的物业密集地，毗邻市中心的众多法律、金融和商业服务企业。

公寓楼附近聚集着丰富而华丽的建筑，这一区域在过去的几年中丧失了一些本有的活力和文化魅力。而如今，人们对市

adjacent to the CBD's legal, financial and business services sector.

The site's immediate vicinity has a rich and noble architectural pedigree, which has in recent times lost some of its energy and cultural appeal. However, there is now a renewed interest within the city in making this a relevant and highly attractive place to live and work, to finally complete the connection between the 'Paris-End' to Docklands.

The location presented an opportunity to deliver a highly contemporary and technologically innovative construction solution that would make inner city, small footprint sites viable for redevelopment.

Project Description

The Collins House site has an existing 11.5m Collins Street frontage and 480sqm footprint, with rear vehicle access from St. James Lane. The site comprises of one allotment, with adjacent party walls on either side of the title.

Figure 1. Site location (Source: Bates Smart)
图1. 基地位置（来源：贝茨玛）

Figure 2. Location plan (Source: Bates Smart)
图2. 位置平面（来源：贝茨玛）

中心地区重燃关注，令这一区域再度成为工作与生活的理想场所，也将完美连接市中心最繁华区域与墨尔本滨海港区Docklands。

这一地理位置带来实现高度现代化与革新建筑方案的机会，为内城区有限面积的土地提供开发的可行性。

项目描述

Collins House所在地临柯林斯街宽11.5米，空间占地480平米，车辆可从后方的圣詹姆士小巷（St. James Lane）进入。此场地由分割出的一小块土地构成，两边都有界墙。

被称为Makers Mark的三层楼建筑原是维多利亚运输公司Huddart Parker & Co的所在地，是一栋颇受人们喜爱的小规模建筑，其优美的外观设计源于新艺术运动及艺术与文艺运动。

这是一座建于商业区正中心的高端住宅楼。它在历史建筑Markers Mark大楼有限的占地面积上，应用了Equiset建筑公司在2013年建造墨尔本首座修长高楼Phoenix公寓楼时的经验。

正是出于Equiset曾有的经验，令他们对开发另一栋占地面积小但楼层更高的建筑充满了兴趣。Bates Smart 发现了这一未在市场上挂牌销售的场地，并向Equiset提出了合作建议，从而达成了最终的合作。

首要的任务是通过4D Workshop软件来分析构造工程，确认如何在面积有限的土地上建立最大规模的高瘦建筑。

接下来的工作是要制定一个可靠的计划方案。这一选址有众多的相互覆盖，需要谨慎对待；同时，开发策略需要经由墨尔本市政厅和维多利亚历史文物顾问审核协调，最大程度的保留现有的街景和独一无二的地方特点。

经济论证

在澳大利亚，尤其是墨尔本和悉尼市中心地区，由于公寓价格的上升，小规模场地开发变得势在必行。土地和建筑费用逐渐上升，使开发商的收入进一步降低，引发了对场地最大化利用的需求。与此同时，业主在买房时也更加慎重地平衡价格与地段。

因此，对高效率、系统化、更流畅的设计建筑流程、场外预制房屋等因素的重视，将有效促进开发的可行性。

本项目为澳大利亚地产行业创造了全新的建筑方式，令开发商有能力在更少的资金和更快的时间下，创造设计出独特的建筑。

An existing three-story building, currently known as Makers Mark building was formerly built to house a Victorian shipping company, Huddart Parker & Co, and presents as a well-liked lower scaled heritage building, whose embellished façades loosely derive from art nouveau and arts & crafts sources.

A premium luxury residential development on the site, right in the heart of the business district, capitalizes on the intimate scale of the Markers Mark building, and captures and extends the lessons learned by Melbourne's first completed slender tower, Phoenix apartments, built by Equiset construction in 2013.

This experience sparked an interest in Equiset to develop another small footprint site with a much taller proposition. Bates Smart found such a site and presented this opportunity to Equiset in an off-market sale, leading to our engagement.

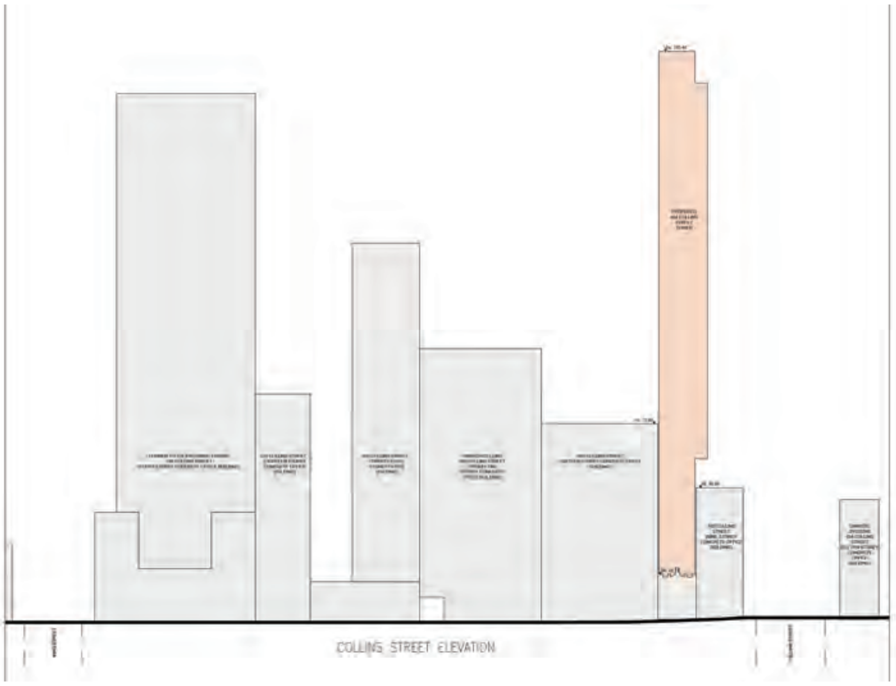

Figure 3. City context (Source: Bates Smart)
图3. 城市背景（来源：贝茨玛）

Figure 4. Heritage façade restoration (Source: Bates Smart)
图4. 历史建筑立面复原（来源：贝茨玛）

The first port of call however, was a structural engineering analytical review by 4D Workshop to ratify the theoretical basis of building of a maximum-sized, ultra-thin tower situated on its narrow footprint.

Work then began on the creation of a robust planning argument. The site had numerous overlays which had to be respected, and inevitably the development strategy was mediated through Melbourne City Council and Victorian Heritage advisors, to ensure the maintenance of good quality streetscapes and Melbourne's distinct sense of place.

The Economical Argument

Within Australia, particularly within the CBDs of Melbourne and Sydney, small development sites are becoming viable as apartment sale prices increase. Land and construction costs have likewise risen, leading to lower gross returns and driving a need to maximise site yield. Coupled with this, end users are becoming more discerning in balancing cost and location.

A focus on increasing productivity, systemization and a more streamlined design-to-production process with faster off-site prefabrication was therefore necessary to deliver development viability.

The project presents itself as an alternative construction proposition for the Australian property sector, offering the industry the ability to create and construct unique designs, with more competitive cost parameters and faster construction timeframes.

The Proposition

The tower is formulated using an 'H'-frame vertical cantilever structural strategy using four shear walls to provide structural integrity. A mass damper on top of the structure stabilizes its performance against live loads, principally the intense wind movements characteristic of Melbourne.

A robotized, single lifting car stacker rises up at the rear of St. James Lane, rising up 14 levels to create 115 car spaces with a three-minute delivery time.

A one-and-a-half-level basement is used to house the building's switch room, security room, pump and tank rooms. Bike storage and substation are on grade with the main foyer lounge entry off Collins Street. Three passenger lifts are centred on the western

提案

这座高楼由H型框架的垂直悬臂结构组成，使用四栋剪力墙来实现结构的统一性。上方巨大的阻尼器能承受重压，有效抵抗墨尔本的强风。

面向后方圣詹姆士小巷的全自动电梯式停车塔高达14层，拥有了115个停车位，并在三分钟内完成运作。

一层半的地下室用作配电室、保密仓、抽水机及水槽房；自行车存放处和变电所与位于从柯林斯街进入大堂的同一楼层；三个客用电梯位于西边界墙中央，正对一到九楼的剪刀式楼梯，有效地将住宅楼分割成前方的居住区域和后方的停车空间。

boundary wall, with scissor stairs located directly opposite for the first nine levels, effectively splitting the building footprint into front accommodation and rear car stacker volume.

Investigation of the simple box-like extruded form determined that the total gross floor area still fell short for financial viability. At this point, the client team began a negotiation with the adjoining heritage property owner to purchase air rights, allowing the built form to both cantilever over this property and gain permanently unencumbered views. It was found that a cantilever could off-set from the vertical structure by 4m, which subsequently increased the developable yield significantly by over 130 square metres per floor, just over 6000sqm total gross floor area.

The escape stair was then able to be moved back to sit on the western boundary wall alongside the lifts, releasing the prime real estate to the east. A combined waste shoot was incorporated into the core, to comply with new Melbourne city recycling policies. The remaining plant was distributed within the tower to maximise developable yield and frontage.

An important element in achieving planning approval was our approach to the existing heritage building. At the time, a number of high profile tower projects had gained permission to demolish all of the internal structure and finishes of old building stocks with the heritage retention had been limited to façade only. Here, we embarked on a more comprehensive retention strategy to take advantage of the unique interior, invoking the atmosphere of a private club. The boundaries between new and old structures were therefore brought into question. Rather than distinguishing the natural junction, a blurring strategy was instead chosen. The rear structure of the heritage building was to be demolished in order to build the tower above, but it was agreed to comprehensively map internal columns, encasements, cornices and coffered ceilings and rebuild these details in the completed building foyer.

The arts and crafts façade will be brought back to life, stripping off its black paint finish and returning it back to its original stone, clay tiled and masonry façade.

Debate with the city planning authorities surrounded the visual separation of the tower form to the three-storey heritage building below. An extensive street level view cone analysis was undertaken, leading to a stepped setback for levels 4 to 10. This 'ziggurat' stepping outline strategically worked to separate the forms whilst ensuring that a maximal development internal floor area was achieved.

The Final Design

The completed design rises up 57 levels and 195m total height from its base width of 11.5m, extending to 14.5m as it cantilevers over the adjoining building. Construction cost will total over $200M.

The development consists of 263 luxury one-, two- and three-bedroom apartments, including a 245sqm double-story penthouse on levels 56 and 57 featuring inbuilt fireplaces and opulent materiality, with 180' views over Melbourne's CBD. Four half-floor sub-penthouses make up levels 54 and 55. The penthouse comes with three car spaces, whilst the sub penthouses come with two car spaces with an option to buy one more. Resident amenities in the building reinforce the sense of a private club, including an executive lounge and roof terrace with views

我们对盒型的楼层区域调查之后，发现其总楼面面积依然满足不了合理的资金回报。此时，我们的客户团队开始与邻近历史建筑的业主协商上空使用权，在大楼的上部使用悬臂梁建造结构，同时获得永久性不受阻拦的视野。据发现，一个悬臂梁可以对冲4米的垂直结构，这大大提高了开发收益，每层增加了130平米，令整栋楼的面积增加了6,000 平米。

疏散楼梯得以后移至西墙电梯边，令东部保持高档的居住空间。主楼设有生活垃圾通道，遵循墨尔本市废弃物回收政策。其余的设施大楼内，实现效益与空间的最大化。

我们之所以能够取得建筑规划认可，其中一大重要因素是我们对历史建筑的改造方式。当时，许多历史高楼建筑获得许可改建所有内部构造与漆层，唯一仅在建筑外部保留其历史性。而我们则采用更全面的历史保存战略，利用大楼原有的独特内部空间，创造私密俱乐部的氛围。如何界定新老结构之间的界限成为我们的一大考虑，对此我们采用了相对模糊的方法，而不是明确区分二者。我们决定拆除这栋历

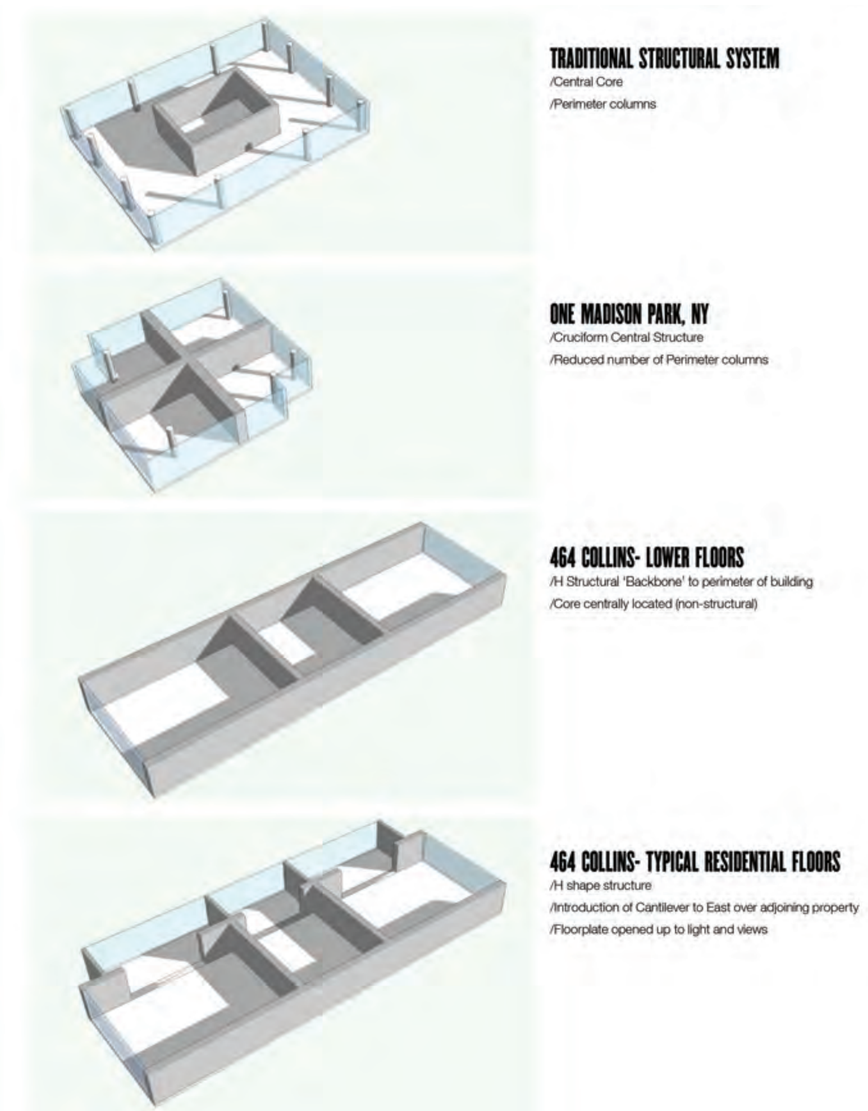

Figure 5. Structural concept (Source: Bates Smart)
图5. 结构概念（来源：贝茨玛）

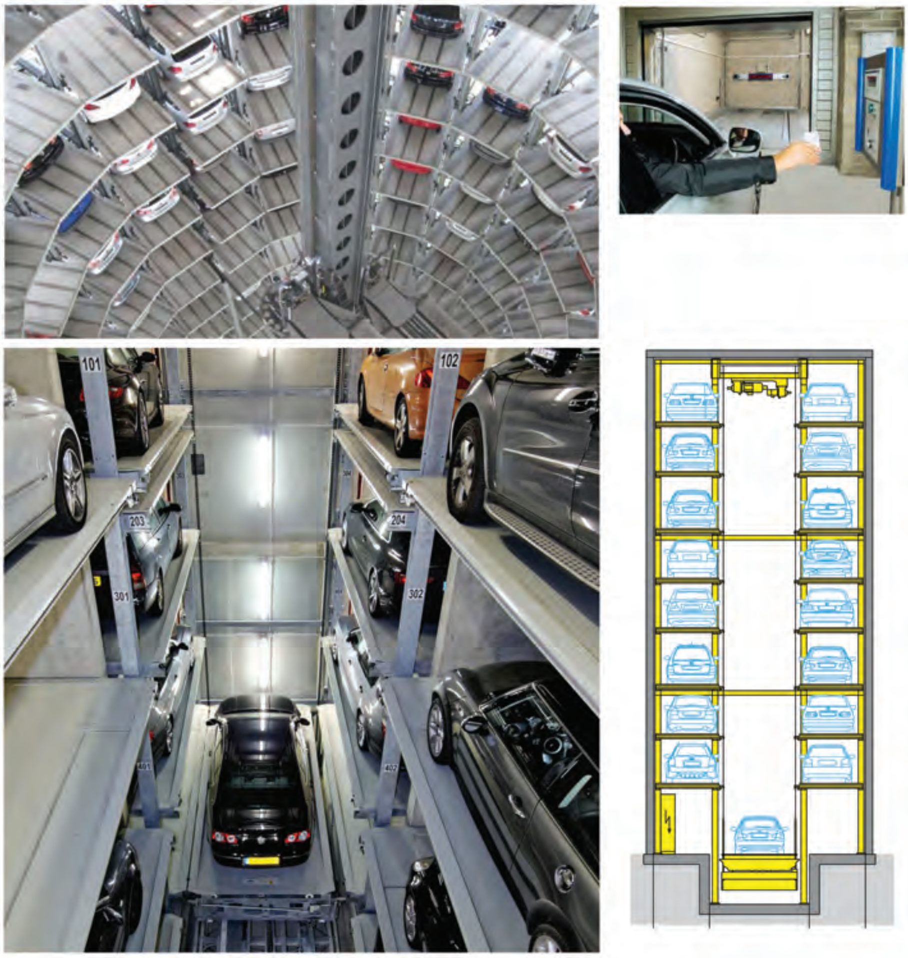

Figure 6. Carstacking system (Source: Bates Smart)
图6. 停车系统（来源：贝茨玛）

up and down Collins Street. Additional private dining and entertainment zones can also be booked at the level 27 club.

Originally put forward as an extruded in-situ cast concrete system conceived through an advanced slip-form shuttering construction strategy (incorporating simultaneous glazing installation), the structural strategy was eventually discounted due to cost, driven by the inherent slower and more complicated nature of in situ concrete and lack of lay-by space on site. A hybrid, primarily prefabricated, steel and concrete solution was instead pursued, which brought significant cost savings for the project and ultimately underpinned the project's commercial viability.

The final façade design reflects its prominent and premium location on Collins Street. Three of the façades are almost entirely encased by double glazed curtain wall system. The façade paradox was the blank façade to the west, left windowless to allow a plausible future tower development of the neighboring site, but remaining significantly prominent in the interim.

A large scale fret pattern was explored as a way to unify and invigorate the overall appearance of the building. A herringbone pattern was selected as subtly inferring the historic patination of the existing building. The fret pattern will be a highly polished aluminum fascia element sitting flush with the surface of the glass and concrete almost like an embossed finish. This continuous wrapping patterns sits within the curtain wall breakup and is articulated to maintain open views from within.

The strategy becomes more embellished further down the building, as it descends into the rear laneway environment. An important component of the planning strategy was to bring a unique visual activation quality to the laneway, verging on a public artwork. The fret work evolved into an extruded form, pushing outward to form texture and grain.

Development Conclusions

- The progression of the project's development has been enabled through teamwork and the desire to create a breakthrough building in Melbourne.
- The basis and viability of the project is still to be entirely ratified and it awaits construction.

史建筑的后面部分，来建造高楼，而保留大楼内部的支柱、装箱、檐板、镶板装饰的天花板，将这些元素巧妙地融入新住宅楼的大堂设计中。

我们除去建筑表面的黑色漆层，代之以原始的石料、黏土瓷砖和砖石表层，令艺术与文艺运动时期的建筑外墙设计重新展现活力。

就如何将公寓楼与最底下的三层历史建筑从视觉上的离开 如何实现公寓楼与底部三层历史建筑视觉上的分离，我们与城市规划部门展开了激烈探讨。进过大量的街景模拟分析后，决定将四至十层的结构向内缩进。这个阶梯型大厦战略性地将现代公寓楼建筑与底层的历史建筑分离开，同时确保内部空间的最大开发。

最终设计

最终的设计共有57层楼，从地基算起共高195米。借用相邻建筑的悬臂梁设计令空间宽度从11.5米延伸至14.5米。总体建造花费将超过2亿澳元。

住宅楼中共有263套一、二、三居室奢华公寓，包括56及57楼的双层套房，配有内置壁炉和丰富设备，180度俯瞰墨尔本市中心。54和55层楼共有四间小套房，每间占据半层楼面。顶层套房配有三个停车位，小套房自带两个停车位并可以选择多买一个 。 住宅楼中的丰富设施强调了私密俱乐部的氛围，其中包括行政酒廊和可以欣赏到整个柯林斯街景色的露天花园。另外还能在27楼的俱乐部中预定私人用餐和娱乐设施。

最初我们提出的策略是先进的滑动模板施工技术（采用同时抛光装配），在现场浇注混凝土系统，但这一策略由于费用过高而最终被摒弃。费用主要来自现浇砼本身的缓慢性及其复杂的属性，以及工地现场缺乏停靠空间。取而代之的是混合式的提前预制钢筋混凝土方案。这个方案为项目节约了大量开支，并最终为项目的资金可行性奠定了基础。

建筑正面的设计映衬柯林斯街优越的地理位置与环境。三面外墙几乎完全由双层玻璃幕墙系统装置而成，而西面外墙则恰恰相反，特意不设窗户，一方面考虑到相邻场地将来会要建起的高楼，另一方面也能在过度时期保持显赫的外观。

我们在设计中大面积采用回纹饰元素，形成统一性，并为建筑的整体外观注入生命力；人字形图案的应用也映衬出建筑的历史沉淀。铝制的回纹饰图案表面高度抛光，在玻璃与混凝土的表层形成浮雕式的效果。这一相互包裹的图案位于幕墙之间，确保开阔的视野。

我们的策略在建筑过程中逐渐完善，再度考虑到后部街巷的环境。我们建筑规划的

Figure 7. External view (Source: Bates Smart)
图7. 外墙视图（来源：贝茨玛）

- The unique circumstances of site size, innovative construction technology, economic viability, marketing strategy and town planning systems have efficiently synchronized to make this the most unique construction being undertaken in Melbourne, if not Australia.

The Structural Engineering Brief

4D Workshop was introduced to the Collins House project by the initial developer Equiset, to push the engineering of the prospective tower to its absolute engineering limit without any encumbrances. 4D Workshop set about creating a structural system that maximized the site footprint of 11.7m x 40m, whilst being mindful of the limited site access.

To maximize building height, a number of engineering principles were established:

- Utilize the entire site footprint to create the primary stability system thereby maximizing building stiffness.
- Utilize the full weight of the building to ensure vertical elements do not experience tension under serviceability conditions, so that the structure remains elastic under service loads.
- The shear centre and centre of mass shall be co-linear for the full height of the building to ensure there is no magnification of accelerations due to torsional effects.
- Structural stiffness should remain relatively constant for the full height of the building.
- Utilize story drift limits for façade, lifts and internal finishes systems.
- Utilize the maximum potential of damper systems to meet ISO standards for building motion limits.

The Original Scheme

The original scheme utilized concrete shear walls on each side boundary, located 100mm inside the site to allow for construction tolerances and earthquake pounding requirements, the north and south elevations were column-free and open to maximize available light and views. The side walls were connected by two transverse shear walls creating a box for tensional rigidity and an overall H section for maximum stiffness in the critical east–west direction. An overall building height of 225m above Collins Street ground level was deemed feasible. With a structural footprint of 11.5m, the tower's slenderness ratio was 20. The tower consisted of 65 levels of mixed-use office and residential levels, with an average floor-to-floor dimension of 3.5m.

Buildability is also a critical design consideration for tall slender buildings, because inherent to tight building sites are a lack of access for construction activity, including deliveries and materials handling. The entire structure was to be constructed as a jump form to enable the structure to be extruded from foundations to the top. Façade installation was to occur within the climbing screens below the jump system to close off the building progressively.

一个重要部分就是使用设计中的艺术美学，为街巷增添独特的视觉体验。回纹饰元素在建筑外部延展，形成美观的质地与纹理。

结构工程概述

开发商Equiset 在Collins House项目中使用4D Workshop系统，最大程度实现大楼的工程建造潜力。4D Workshop软件设计出的结构系统，可最大化利用11.7米 x 40米的工地面积，同时考虑到选址的交通流动性。

我们设立多项工程准则，来实现建筑的最高高度：

- 利用整个工地空间搭建基础稳固系统，实现建筑稳固性的最大化。
- 利用建筑的总体重量来确保大楼不会在施工时受到过大压力，令建筑结构在施工负重下仍保持灵活性。
- 剪力中心和质量中心在整栋建筑中呈共线关系，确保不会因扭力因素出现过大的加速性。
- 建筑的稳固性在整栋楼体中保持相对不变。
- 在建筑外墙、电梯和内部抛光系统的设计中使用层间位移限值。
- 充分利用气闸系统，达到国际标准化组织（ISO）对建筑抗震动的限制标准。

初始计划

最初的计划是在工地边界内100毫米处建设混凝土剪力墙，来满足建筑负重和抗震要求，其中朝南北两面的墙体不使用任何支柱，实现采光和视野的最大化。另两面的界墙由两面横向剪力墙连接，盒型的结构达成高度刚性，而H形设计为建筑关键的东西方向带来最大的稳固性。这一计划下，在柯林斯街上建筑一栋225米高的大楼具有可行性。整栋建筑构造的宽度为

Figure 8. Plan (Source: Bates Smart)
图8. 平面图（来源：贝茨玛）

Development of the Design

The purchasing of air rights created a development opportunity at the expense of structural efficiency. The floor system above level 14 now cantilevers out 4.5m beyond the eastern edge, shifting the building's centre of mass off centre. Openings in the east wall caused a reduction in building stiffness and shifted the centre of rigidity in the opposite direction. These combined effects contributed to a magnification of accelerations due to torsional effects. In response, stiff floors with reduced openings in the east wall were introduced at levels 27 and 47 to improve torsional rigidity.

Planning restrictions subsequently limited the building height to 190m from the Collins Street level, resulting in a slenderness ration of 16.5. With a reduction in floor-to-floor heights, the reconfigured scheme comprises 60 levels. The reduction in building height partly offset the structural compromises created by the introduction of cantilever floors over the east boundary.

Two large liquid tuned damper tanks are required, one in each direction. A 400 tonne damper tank of approximately 15m long x 5m wide x 6m high is required to control accelerations in the north–south direction, and a smaller damper tank is required to control accelerations in the east–west direction. These tanks are located at the plant room levels to the top of the tower.

Structural Engineering Conclusions

- Collins House is a narrow site on a busy street in Melbourne's CBD with limited access for construction deliveries and materials handling.
- Build narrow and tall, to cantilever over the adjacent heritage building and to construct using the benefits of offsite construction by utilizing precast and modular systems.

Figure 9. External view (Source: Bates Smart)
图9. 外墙视图（来源：贝茨玛）

Figure 10. Luxury apartment (Source: Bates Smart)
图10. 豪华公寓（来源：贝茨玛）

ECI Strategy and Design to Fabrication

The Bates Smart team developed the design up to a 40% design development level prior to a pre-tender ECI (Early Contractor Involvement) process. The ECI strategy was established due to the project's overall complexity, desired construction timeframe and the challenging constraints of the narrow inner city site and thus the Hickory Group was introduced to the Collins House project as part of the ECI strategy.

Hickory identified opportunities for a prefabrication strategy (as articulated by 4D above) for floor and façade components, which was taken into account at tender time. The design team developed the floor and façade prefabricated modules with the Hickory Group using advanced parametric BIM tools. This process lead to a unique design to fabrication approach for the Collins House project, and established the Hickory Group as the successful tenderer.

Advanced Parametric BIM

The parametric modelling systems can be best described by its ability to handle inter-object dependencies. The development of these geometrical arrangements, capable to build anticipated variations between objects through an evolutionary design process, are at the centre of focus of a design to fabrication approach for the Collins House project.

Parametric modelling capability allowed the design team to explore multiple design iterations very quickly based on chain-linked objects, optimise building components including façade breakup, and ensure an

11.5米，长细比为20。高楼共有65层商用与居住空间，平均层高为3.5米。

与此同时，可建造性是建造细高建筑时的一个重要考量因素，需要考虑到有限面积的工地缺少运输及卸载货物等建筑活动空间等因素。我们的整个建筑从基地到顶端应用跳跃式结构，跳跃式系统下方的钢筋结构中嵌入外墙装置，在大楼外观上呈现逐步的过度。

设计理念的发展

对上空使用权的购买，在牺牲结构效率的前提下创造了更大的开发机会。14层以上的楼面系统使用悬臂梁将东部的边沿向外凸出4.5米，但这导致了建筑的质量中心偏离中心，使建筑的稳固性降低，并令刚性中心向反方向移动。这些因素一起会形成扭力导致的加速度增大。为解决这一问题，我们在27至47层减少东部墙面的延展，增强防扭力的刚度。

接着我们取得的建筑规划限制建筑的高度为190米，这令大楼的细长比降为16.5。于是我们决定减少层高，将楼层增加到60

optimised and rationalised façade design and structure with a high level of repetition, hence allowing for an efficient design without compromising the design outcome.

BIM Workflow

The team designed, with Hickory Group, prefabricated floor components using a single parametric model (Revit family) capable of reflecting various design scenarios to a level of detail that directly translate into the fabrication process of the composite structure.

A critical aspect in the early stages was the crane/ lifting capacity, which informed the size of prefabricated elements.

The Revit model is based on a federated model approach, meaning that the overall model is comprised of a number of linked, separate 3D models. The integration of the prefabricated elements into the federated model was undertaken as an additional, separate model, in addition to the already established base build, façade, heritage and interior model. Working in parallel with the already established models, the prefabricated floor components replaced step by step the existing floor geometry in the base build model.

The Revit family (3D parametric model) includes the actual member sizes, slab thickness, and services penetrations for each of the up to 11 components per level.

A clearly structured, phased review process allowed for the prefabricated floor components to be coordinated against architectural, structural and service requirements. The level of detail in the Revit families was increased following each coordination/sign-off gate. The Revit families are issued to the Hickory Group for the fabrication process following the coordination/sign-off process.

Conclusion

- Digital design and documentation platforms offer new ways to collaborate.
- BIM deliverables leading to 'design to fabrication' can significantly contribute to the accelerated delivery of projects.
- Traditional project phases and deliverables need to be reviewed and adapted to respond to, and foster, innovation in the market.
- The architect's role can extend into the shop drawing and fabrication process.

An aspect ratio of 16 makes Collins House the slimmest tower in Australia, and one of the slimmest in the world. The unique development proposition of Collins House has been enabled by developers who have shared the vision, passion and technological appetite to take on this unorthodox project and bring it to reality. It demonstrates the increased viability of developing ultra-thin towers, as modular construction technology resolves how to build more economically and collaboration with planning authorities to address urban accommodation pressures leads to radical design concepts.

Overall Conclusions

- The project is classified as a 'skinnyscraper' or 'ultra-thin tower', due to its exceptional aspect ratio of 1:16.
- The development proposal relied on the purchasing of air rights and adopting a large cantilever to gain more floor area.
- Retaining built form heritage was key to a positive planning outcome - integrating and harmonizing the superslim tower into its inner CBD prestigious address.
- The documentation, which has seen the extension of Bates Smart's documentation into shop drawing stages, has been based on using a parametric BIM model developed by Hickory Group. It is shaped around the use of a hybrid, prefabricated building system, which unites the steel framing and prefabrication assembled components into a 3D, highly adjustable virtual model, jettisoning the need for shop drawings.
- Contemporary modular assembly systems can support the viability of constructing multiple unique crafted 3D structural assembly of elements, allowing for diversity in unit planning.

As an interesting aside, and following the planning approval for Collins House, the recent Amendment C262 to the Melbourne Planning Scheme has instituted new rigorous controls and restrictions with regards to plot ratio and mandatory setbacks, which will limit other ultra slim towers from being construction in Melbourne for the foreseeable future.

层。层高的降低同时也减轻了东部悬臂梁对大楼结构造成的冲击。

此外，我们需要配置两个大的液体调节阻尼器贮水池，各朝一个方向。在南北方向需要一个重400吨、体积约为15米长、5米宽、6米高的阻尼器贮水池来控制加速度；东西方向则需要一个较小的阻尼器贮水池来控制加速度。这些贮水池位于储物室楼层并通向大楼的顶端。参见下图中结构稳定系统。

结构工程总结

- Collins House 是位于墨尔本市中心繁忙街道上的窄小场地，建造运输和材料操作的空间有限。
- 建造瘦高大楼，使用悬臂梁与相邻历史建筑相连，并通过利用预制和模板化系统进行场外建造。

早期承包商策略、设计及预制

Bates Smart团队在早期承包商竞标之前，已制定出40%的设计策略。由于该项目整体的复杂性、严格的建造时间以及内城区窄小面积的限制，我们制定了早期承包商策略，并邀请Hickory Group 参与Collins House项目。

Hickory发现了对楼层和外墙元素进行预制的机会（遵循4D系统描绘出的蓝图），在竞标时采用了这一策略。设计团队打造出楼层和建筑外观的预制模型，此外Hickory Group还使用了先进的BIM参数工具。

这一策略为Collins House 项目提供了独特的设计与建造的方案，令Hickory Group竞标成功。

先进BIM参数工具

参数模型体系的主要作用是能够解决物体间的相关性。我们建立出几何模型，并通过不断的革新设计过程模拟各个环节间的预期变化能力，成为Collins House项目从设计到建造的核心。

参数模型令设计团队得以发掘不同的设计方案，考量各个环节的相互连接、建筑结构最优化（包括建筑外墙的设计）、可重复使用的外墙设计与构造等，在不牺牲设计效果的同时，找到更有效的设计方法。