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Authors:	Vanich Nopnirapath, Director, Beca Group Richard Shonn Mills, Director - Head of Buildings, Ramboll Group
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Nimit Langsuan: High Performance High-Rise – Columns of Curved Glass | 尼米郎双(Nimit Langsuan)：高性能高层建筑——曲面玻璃柱

Richard Shonn Mills
Director - Head of Buildings
总监 – 建筑部门主管

Ramboll Group

Singapore
新加坡

Richard Shonn Mills has over 25 years of experience in the design and management of large building and transport infrastructure projects. His international career features experience with long-span bridges, high-rise buildings and the design of large public buildings including airport terminals, metro stations and stadiums. He is one of the founding Directors of the Ramboll office in Singapore and one of the leaders in the Ramboll High-Rise sector.

Shonn Mills 在大型建筑和交通基础设施项目方面有着超过25年的设计和管理经验。他参与的项目遍布全球：大跨度桥梁、高层建筑和大型公共建筑，包括机场候机楼、地铁站和体育场馆。他是RAMBOLL公司在新加坡办公室的创始董事之一，同时是公司高层建筑部门的领导者之一。

Vanich Nopnirapath
Director | 总监

Beca Group

Bangkok, Thailand
曼谷，泰国

Vanich Nopnirapath has 25 years of experience in the design of high-rise buildings, deep basements, low-rise buildings on steep slopes, and also bridges.

Project work undertaken includes various high-rise building in Bangkok; large industrial facilities in Rayong; commercial complexes in Pattaya; on-site supervision of the Rama 3 Bridge, Chao Praya River, Bangkok; a cement factory in Dubai; and high-rise buildings in Kuala Lumpur Malaysia and the UK. Vanich's experience includes secondment to Zurich, Switzerland.

He was one of the founding Directors of Warnes Associates, which joined the Beca Group in 2015.

Vanich Nopnirapath 拥有25年高层建筑、深基础、陡坡上的低层建筑、桥等的设计经验。

参与项目包括在曼谷的各种高层建筑，在罗勇的大型工业设施，在芭堤雅的商业综合体，现场监督了曼谷湄南河拉玛3桥以及迪拜的水泥厂项目，并在马来西亚吉隆坡和英国都有着高层建筑的经验。Vanich曾借调到瑞士苏黎世。

他是Warnes Associates的创始董事之一，Warnes Associates于2015年加入了 Beca集团。

Abstract | 摘要

Nimit Langsuan Residences project, located in Bangkok, Thailand, is a 210-meter-tall high end residential with over 50,000 square meters of accommodation. The tower will be unique in the Bangkok landscape and is characterized by a three-dimensional curved glass façade. These 3D curved glass elements form a repeating grillage on the building envelope and are highlighted by a corner treatment where the structural design is integrated with the concept to provide structure free views of the city. The drama of the corner treatment is enhanced further by the transparent columns of curved glass which span from the podium level over 40 stories to the crown of the building.

This paper explores the development of the High Performance High-Rise design philosophy and technical challenges of this ground-breaking integration between engineering and architecture. This paper describes the key techniques and strategies to improve the comfort of the inhabitants and quality of the space.

Keywords: BIM, Curved Glass, Façade, High-Performance, High-Rise, Seismic

位于泰国曼谷的尼米朗双是一个高210米，总面积超过 5万平方米的高档高层住宅项目。 该建筑将成为曼谷独特景观，其特点为三维曲面玻璃幕墙。 这些3D曲面玻璃在建筑围护结构采用了重复格排处理并且在边角凸显了独特的结构理念，即在结构设计上实现城市自由观景。从建筑第40层跨至顶部的透明曲面玻璃进一步加强了边角处理的戏剧性和观赏性 。

本文意在探讨高性能高层建筑的设计理念以及工程和建筑间的突破性融合的技术挑战。本文阐述了提高居者舒适度以及空间品质的关键技术和设计战略。

关键词：建筑信息模型（BIM）、曲面玻璃、幕墙、高性能、高层建筑、地震

High Performance High-Rise

Urbanization is one of the most prominent megatrends that drive the global economy as well as shaping the way we live and impacting the environment. This drive of densification of our urban areas from cities to megacities is certain to continue and creates challenges for today's designers and engineers to develop systems and solutions that will positively influence the evolution of our living and work spaces.

The increased population in our cities is driving our housing and accommodation to go taller, but tall alone is no longer enough to meet the demands for quality of space and environment for occupants. The new market driver beyond just taller is tall coupled with "High Performance." A "High Performance Building is a building that integrates and optimizes the major components to provide superior space planning, energy efficiency, life-cycle performance and improved quality of life for the inhabitants" (Department of Energy, 2005).

高性能高层建筑

城市化是全球经济发展的最显著趋势之一，它塑造着人们的生活方式以及影响着环境。 从城市到特大城市的密集发展将持续进行，并挑战当今的设计师和工程师，要求他们设计出系统解决方案，从而能够促进生活工作空间的发展演变。

城市人口的增长推动建筑和住房变得更高，但高度本身不再能够满足居住者对空间品质和环境的要求。 新的市场驱动力不仅仅是楼层的高度而是 “高性能”的高层建筑。“高性能建筑能够通过集成化和优化空间规划， 从而提高能源效率，改善使用性能并能提高居民的生活质量”（能源部，2005年）。

尼米郎双（Nimit Langsuan）

Nimit Langsuan 在泰国曼谷是一个崭新的具有突破性的项目，旨在树立“高性能”建筑标准的新标杆。 Nimit Langsuan的卓越表现不仅使用了可再生

Nimit Langsuan

Nimit Langsuan is a new ground-breaking project in Bangkok, Thailand that seeks to set a new benchmark for "High Performance" in building systems. The performance strategy for Nimit Langsuan is more than just the implementation of renewable technologies, it is focused on a holistic strategy to create a building which improves quality of life for the occupants in a cost effective manner to deliver added value for the buyer as well as the seller. This paper describes the options studies and the strategies employed for the Nimit Langsuan tower to define a new typology of High Performance High-Rise in Asia.

The Nimit Langsuan tower is a 55-story (210m tall) luxury apartment building adjacent to Langsuan Road, in the historic residential neighborhood adjacent to Lumpini Park, one of the most prominent green spaces in Bangkok. The building is appropriately named Nimit, which in the Thai language is translated as intuition or premonition which speaks to the goals of PACE Development, realized by the architect by employing cutting edge design and engineering techniques (Figure 1).

High Performance through Integration

The key to developing high performance in tall buildings is integration of design and a clear and tested implementation strategy that is formulated to succeed in the local context. Design integration is about developing a philosophy and a set of criteria that improves the quality of the internal and external spaces of the development as well as the way it interacts with the larger city environment. True high performance can only be achieved through multi-disciplinary thinking and collaboration to ensure all of the building's design elements and systems are optimized for the project goals.

Figure 1. Nimit Langsuan (Source: PACE)
图1. 尼米朗双（来源：PACE）

Architecture

The starting point for all great buildings is a strong and clear architectural vision. Good architecture creates space and an environment that is functional, inspiring and thought provoking, and therefore is a necessary component for high performance. Truly high performance buildings include architectural language that provides an appropriate response to the local context and environment.

Nimit Langsuan employs several techniques to create the architectural concept. The most prominent of the techniques is in the façade treatment, which while at a distance creates a simple grillage on the building envelope; closer inspection reveals that elements of the grillage are constructed using transparent three-dimensional curved elements. The façade includes 3D curved glass on a size and scale that is unique in high-rise buildings. This unique architectural statement and the way it has been utilized is a key element of the high performance strategy for Nimit Langsuan.

The architectural design then takes the concept of transparency a step further and illustrates how design integration can strengthen the overall architectural concept. To punctuate and enhance the effect of the 3D vertical curved façade elements the building structure has been eliminated from the corners of the tower. This provides inhabitants with unobstructed views of the Bangkok skyline from the main apartment living space, highlighted only by the transparent 3D curved column at the corners (Figure 2).

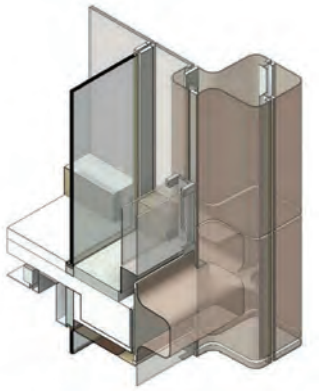

Figure 2. 3D curved glass corner columns (Source: PACE)
图2. 三维曲面玻璃角柱（来源：PACE）

能源技术，更是创造了低成本高收益的优质居住质量，同时为买家和卖家提供增值服务的整体策略 。 本文通过介绍Nimit Langsuan所用的方案研究和选择策略，来探索亚洲高性能高层的发展。

Nimit Langsuan是55层（210米高）的豪华公寓大楼，与朗双大道（Langsuan）相邻，同时与历史悠久的住宅区相接，该住宅区位于曼谷知名的Lumpini公园旁。 该塔楼的名字Nimit恰如其缝，在泰语翻译为直觉或预感， 充分体现了建筑师采用的前沿设计理念以及尖端工程技术，切合实现了PACE 开发公司的项目计划（图1）。

集成化高性能

集成化的设计和明确有效的实施策略是开发高层建筑并且在不同个案中成功的关键。 集成化设计是为了提高建筑室内质量和室外空间而形成的一种理念和一套标准，也是一种建筑与城市大环境相互作用的模式。 真正的高效能需要通过跨领域的思维方式和团体协作来实现，以确保建筑所有的设计元素和系统的最优化。

建筑设计

明晰且强有力的建筑憧憬是所有伟大建筑的出发点。 优秀的建筑设计能够创造功能实用，激发灵感的空间环境。 所以这是高性能建筑的必要组成部分。 真正的高性能建筑能够根据具体情况与个案环境作出适当的反应。

Nimit Langsuan采用多种技术来实现建筑设计憧憬。 最突出的技术之一是在近距离对围护结构进行简单梁格立面处理；若仔细观察，梁格板使用了透明三维曲面元件构成。 幕墙由尺寸规模为高楼所特用的3D曲面玻璃所构成。 这种独特的建筑风格，以及其实现方式是Nimit Langsuan高性能表现的一个关键要素。

接下来的建筑设计进一步推进了透明度概念，并由此证明设计集成化可以加强建筑设计的整体概念。 为了精确表达和增进3D曲面幕墙效果，塔楼的四角并无安排结构元件。 这让居住者能够从公寓主体生活空间把整个曼谷的天际线尽收眼底，而这只可能通过在透明3D曲面角柱来实现（图2）。

优秀高层建筑也非常注重与地面层相连的设计。 Nimit Langsuan的建筑设计理念还包括温室绿地元素，这将在曼谷市中心提供独特的公共空间，同时营造到达地面层的现实感（图3）。

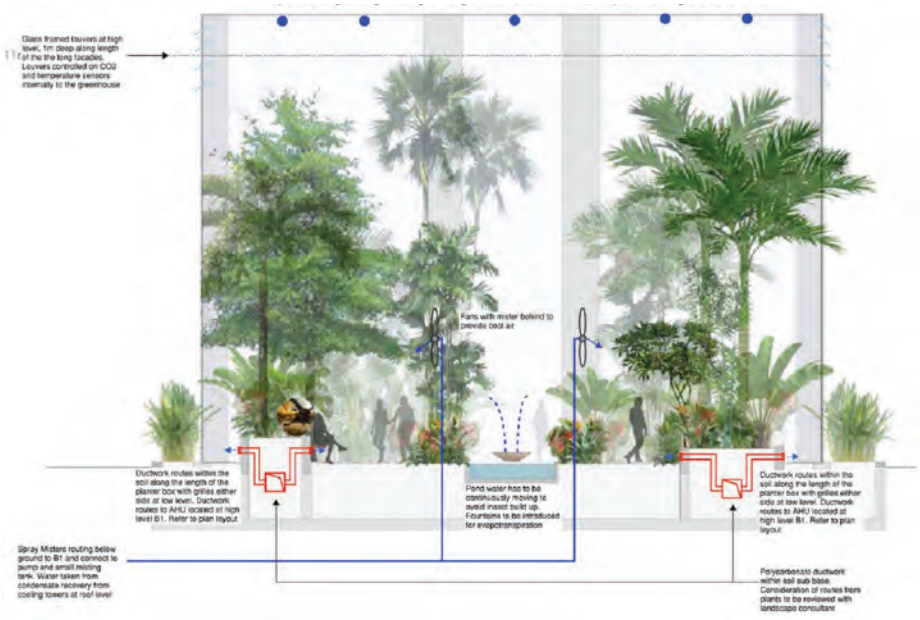

Figure 3. Nimit Greenhouse (Source: PACE)
图3. 尼米温室（来源：PACE）

Successful tall buildings also place close attention on the interface with the ground plane. The architectural concept for Nimit Langsuan also includes a feature Greenhouse structure that will create a garden sanctuary in the middle of Bangkok which will be a unique element of public space and enhance the sense of arrival to the ground floor (Figure 3).

Structural Frame

High-rise buildings are defined by the structural frame and while high performance materials like high-strength concrete and composite elements have been in use for decades, the High Performance Structural philosophy for Nimit Langsuan is developed to use conventional building technology in innovative ways. The key driver for the structure is of course safety and comfort for the occupants with a close eye on the impact of the structure on the net to gross ratio for sellable area. This philosophy ensured to the performance of the frame structurally and to maximize the return on investment for Pace Development.

The structural design of the Nimit Langsuan Residences is comprised of reinforced concrete (RC) with floor plates designed as thin flat light-weight reinforced concrete slabs with local post-tensioning where required to meet deflection criteria. On the perimeter of the floor plate a post-tensioned reinforced concrete ring beam supports the corner cantilevers and enables the corner views. Lateral forces are resisted by a dual system which utilizes the central core of the tower and additional shear walls strategically placed in the floor plate.

The building includes a two-story basement under the main tower footprint and adjacent to it below the feature greenhouse. The basement will be constructed using diaphragm walls to limit the ground movement on the adjacent structures in the neighborhood. The tower section will be supported on a deep reinforced concrete raft on 1500mm diameter bored piles. The basement will be supported on smaller 600mm diameter piles located directly under the basement columns.

Vertical Elements

The vertical elements of the tower are banded into structural zones to balance efficiency and simplicity of construction with maximizing the sellable areas. Column dimensions decrease in each zone as gravity loading and required stiffness for lateral performance decrease. At the lower levels composite steel columns have been introduced to minimize the column footprints.

The structural zones have also been optimized with the unit mix to allow flexibility to change or modify the distribution of unit types to maximize the sales price.

Floor Plates

In high-rises, the floor plate contributes by element the largest volume of structural material. For high performance buildings close attention must be paid to the column arrangement and slab properties. For Nimit Langsuan optimization of the structural slab led to a reduction of the floor-to-floor dimension, which allowed the addition of two more levels of sellable apartments.

As stated previously the floor plates are designed as thin, flat light-weight reinforced

结构框架

高层建筑是由结构框架定义的，高强度混凝土和复合元素的高性能材料已使用了几十年，而Nimit Langsuan项目的高性能结构理念是通过以创新方式使用传统建筑技术而实现的。结构设计的主要驱动力显然是居住者的安全性和舒适性， 同时合理化可销售土地上的净使用面积。 这一理念能够确保结构框架的性能，并最大限度地提高PACE开发商的投资回报。

Nimit Langsuan的结构设计由钢筋混凝土与扁平超薄轻质钢筋混凝土楼板组成，该楼板的局部通过施加后张预应力来满足变形挠度要求。楼板周边是后张预应力的钢筋混凝土圈梁，它能够支撑角落悬臂同时也能使四周角落成为一个景观。横向力是由核心筒结构和附加剪力墙的双系统来共同抵抗的。

在主体塔楼以及相连的极具特色的温室绿地区域之下，还建有两层地下室。 地下室将采用地下连续墙来限制地面运动对附近相邻结构的影响。 塔楼部分将由直径为1.50米的钻孔灌注桩之上的大体积钢筋混凝土筏板所支撑。 地下室将由直接位于地下室桩柱下方的，直径略小的0.6米的钻孔灌注桩所支撑 。

垂直杆件

为了平衡施工的效率和难易程度，塔楼的垂直杆件被整合到结构构件区域进行统一考虑，同时最大化可供出售面积 。 由于载重和所需横向刚度的降低，桩柱的尺寸在每个区域中递减。 在较低层引入钢混凝土组合构件，以使柱的尺寸尽量小。

结构区域也因各杆件的混搭而优化，通过灵活变换或修改杆件类型以最大化销售价格。

楼板

高层建筑中的楼板在使用的结构材料中占据最大的体积 。对于高性能的建筑，必须密切关注柱的布置和楼板性能。Nimit Langsuan的结构楼板优化使得保证楼层净高的前提下层高最小，从而多出2层可销售的公寓楼层 。

如前所述，楼板被设计成轻薄的轻质钢筋混凝土平板，在较大跨距上有着局部的后张预应力钢绞线。住宅楼板的垂直结构随着层高的增加而减少，这需要在高楼层使用比低楼层更大的跨距。

实现观景角以及为40层高楼的曲面玻璃柱提供支撑是结构设计的关键点 。经过辛苦的筛选过程，最终的解决方案是在角落使用悬臂长于6米的后张预应力圈梁。曲面玻璃方面，强化和钢化玻璃的使用需要对结构框架运动进行严格控制。非线性分析被用来预测底板和周边梁的长期变形和其对曲面玻璃的影响（图4）。

concrete slabs with localized post-tensioning strands in the longer spans. The vertical structure of the residential floor plates reduces as the building increases in height, which requires longer spans in the upper floors than the lower floors.

The key structural driver was for integration with the architectural themes, which was primarily to enable the corner views and provide support to the 40-story curved glass columns that dominate the elevation. After an exhausting optioning process, the final solution is a post-tensioned ring beam which cantilevers over 6 meters at the corners. The curved glass elements, although strengthened and toughened, require tight control of movements in the structural frame. The floor plate slabs and perimeter beams were designed using non-linear analysis to estimate the long-term deflections and effects on the curved glass elements (Figure 4).

Podium Transfer

In high-rise buildings, good structural practice dictates aligning the vertical structure in the building all the way to ground. The challenge for most tall buildings comes when there is a change of use throughout the elevation of the tower. This change of use typically requires a different structural grid to optimize the efficiency of the floor plates.

Nimit Langsuan is no exception to this trend, where the compact site requires 10 podium parking floors stacked below the 40+ floors of high-end residential. The two uses require different column arrangements, which led to development of a transfer structure at the top of the podium. Several options were considered during development of the transfer structure including story deep shear walls, inclined concrete columns, and steel trusses. Final selection of the transfer structure was made in consultation with the contractor which recommended a conventional flat concrete slab and beam arrangement. While this conventional flat plate solution is over 1.5m deep in some locations, it was still selected to simplify the construction (Figure 5).

Lateral Force Resisting System

Nimit Langsuan, located in Bangkok, is subject to moderate earthquake and wind forces which make lateral forces one of the governing loads for sizing the vertical structure.

The Thai codified wind load values are designed to predict the pressures for standard size buildings with simple geometry. The Nimit Langsuan tower does not conform to the limits of the code and a site specific approach is required. Therefore, wind tunnel testing was employed during design development to study the wind movement around the site and the proposed building volumes.

The proposed LFRS for the Nimit Langsuan Tower is a dual system, with the lateral forces resisted primarily by the central reinforced concrete cores and shear walls, which house the vertical circulation and service distribution of the building. Walls which form the architectural premises in the apartments are also mobilized to form part of this primary system. The secondary system, which resists lateral forces, is a frame comprised of the perimeter ring beam.

Another key high performance strategy that was studied was the opportunity to utilize the water tanks in the upper technical floors as a sloshing damper. This design integration technique effectively makes the water tanks function as a mass damper for the tower. By specifying the size and shape of the tank, the water used as part of the building services

裙房转换

推荐的高层建筑结构设计需要满足各项垂直结构能够从顶部到地面对齐。 对于大多数高层建筑物，挑战来自于整个塔楼在不同高度有着功能性的变化。这种功能变化通常需要不同的结构布置以优化楼板的效率。

Nimit Langsuan也不例外，这紧凑的工程需要在40多层的高端住宅楼下容下具有10个停车层的裙房。 这两种不同的用途需要不同的柱布置，所以需要在停车场的裙房顶部设置转换结构。 在设计转换结构的过程中，考虑了包括与楼层等高的剪力墙，斜混凝土柱和钢桁架在内的各种选择 。在和施工方的协商后的最终选择是使用传统混凝土楼板和转换梁。 虽然在一些区域需要1.5米厚的水泥板，但这一传统解决方案仍得以简化施工（图5）。

抗侧力体系

Nimit Langsuan ，位于曼谷，受中等地震和风力影响，这使得侧向力成为设计垂直结构的主导因素之一。

泰国编纂的风荷载值旨在预测标准尺寸的简单造型建筑物所受的压力。 然而Nimit Langsuan并不在此范围并且需要特定的方法。 因此，在开发过程中，团队进行了模拟风洞试验，用以研究工地周围环境和所提议的建筑容积 。

Nimit Langsuan使用的是LFRS双系统，其横向力主要是由核心筒和剪力墙来抵御，这承担了垂直环流和建筑服务点的分布。 建筑上的分隔墙也被调动起来，构成本主系统的一部分。 第二抗横向力系统是一个由周边梁围成的框架。

高性能策略的另一个关键是利用上层设备楼层中的水箱作为晃动阻尼器。 这样的设计有效地使水箱成为整个塔楼的大型阻尼器。 通过指定槽的大小和形状，所用的水作为建筑服务系统的组成部分，也可以用

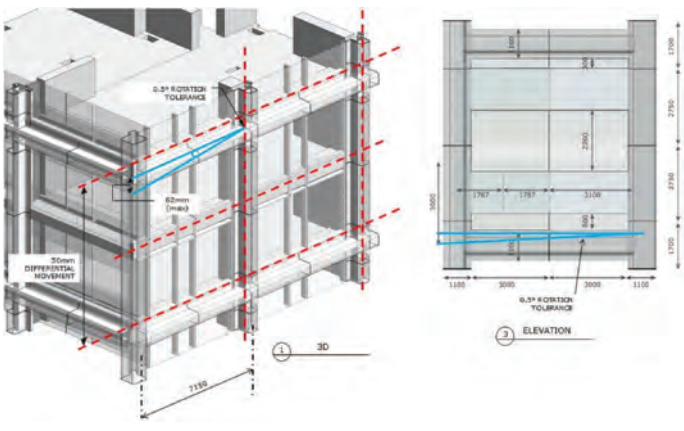

Figure 4. Floor plate deflection control (Source: PACE)
图4. 楼板挠度控制（来源：PACE）

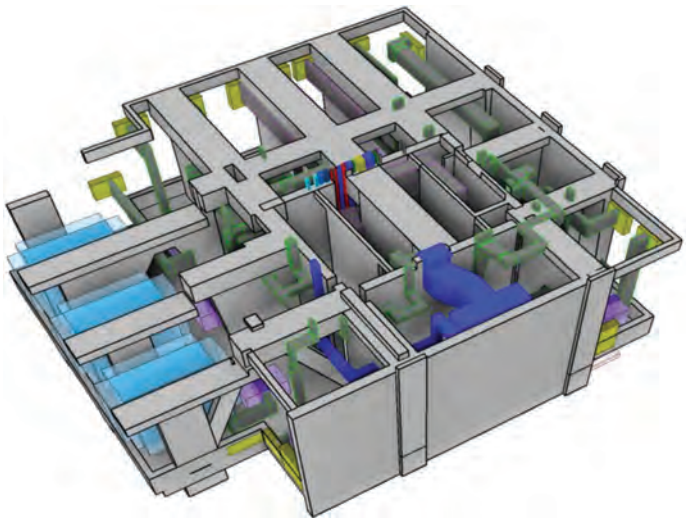

Figure 5. Podium transfer and technical level (Source: PACE)
图5. 过渡墩座墙及技术水平（来源：PACE）

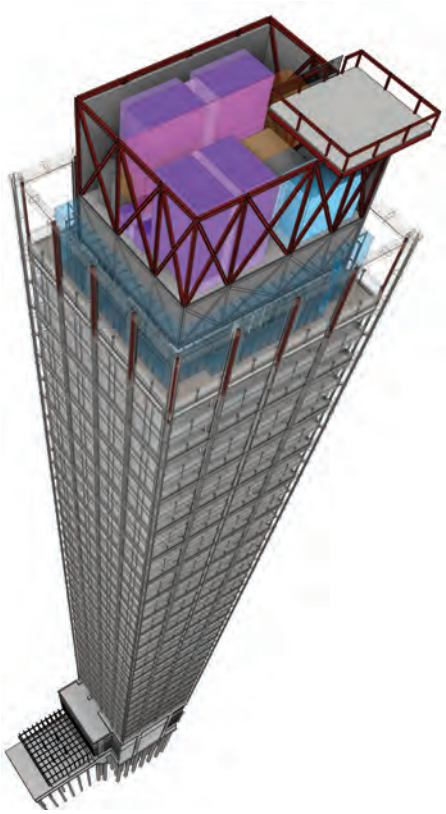

Figure 6. Nimit Langsuan roof crown (Source: PACE)
图6. 尼米朗双（Nimit Langsuan）顶层（来源：PACE）

system can be used to increase damping and reduce the building response of the wind and seismic loads (Figure 6).

Envelope

High performance high-rise buildings have a keen focus on the performance of the envelope, which controls the amount of natural light and climate inside the space. The envelope also serves as an important opportunity to define the character of the building and become a way-finding element for the cityscape.

As stated previously, the façade is the key architectural statement for Nimit Langsuan and is characterized by the 3D transparent façade treatment made of curved and double curved glass profiles. The curved elements are arranged in a repeating grid for the full height of the residential portion of the tower which covers over 40 stories of the 52-story tower. This creates a unique treatment that reveals itself and changes in detail and relief as the viewer approaches the tower (Figure 7).

Façade Systems

While the design team went to great lengths to create a unique façade treatment with the OMEGA elements, an equal amount of effort was given to the other façade elements to produce the high performance system.

The proposed design offers repetition and economy of scale, and the proposal is to adopt a unitized curtain walling system where possible for the east and west elevations. The unitized system will be produced offsite and provide a high quality and cost effective solution to almost 50% of the glazed areas.

The balcony areas on the north and south elevations are developed as a stick system to facilitate the installation of the sliding glass doors.

Glare mitigation and solar control

The façade was designed to control glare and manage solar gain inside the units. External shading devices are not suitable with the current architectural philosophy for the project; therefore, high performance (selective) coatings are necessary on the double glazing units to avoid overheating of the internal environment and reach the required solar performance.

Thermal Comfort

Temperatures in Bangkok are in the range of Tmin=15°C (in winter) to Tmax=38.5°C (in summer). Again, double glazed units with high performance coating and filled with air were selected to provide the thermal insulation and support thermal comfort for the internal environment.

3D Curved Glass

Nimit Langsuan is characterized by its use of three-dimensional curved glass. Three-dimensional curved glass is a building material which while new to the Thai market has been utilized with success on other projects around the world. To realize the design for this project the team conducted a detailed precedent study of other buildings that have successfully utilized curved glass. The following projects were considered as precedents for study to realize and engineer the architectural intent.

40 Bond Street

As suggested by its name, the building is located at 40 Bond Street in the North of Houston district in New York, United States, and it is the first luxury residential project by Herzog & de Meuron and Handel Architects. The curved glass of varying thicknesses is used to crown the decorative steel plate that covers the support frame, giving off a reflective finish.

Casa da Musica

Casa da Musica, also known as the "shoe box" concert hall, is located in Porto, Portugal,

于增加阻尼和减少建筑对于风和地震载荷的响应（图6）。

围护结构

高性能的高层建筑物通常十分注重其围护结构，这能控制自然光及室内的气候。 围护结构也常成为建筑的特色，有机会成为城市景观的地标所在。

如前所述，Nimit Langsuan的幕墙是其主要建筑特征，由曲面和双曲面玻璃元素制成的3D透明幕墙展现了其特征 。塔楼共52层，其中超过40层为住宅， 曲面元件以重复栅格的形式排列覆盖在这40层的外立面。 这为观赏者走近塔楼的过程创造了独特的并随之而变的观感和景致（图7）。

幕墙系统

虽然设计团队为了创建具有OMEGA元素的独特外观付出了极大的努力，他们也并没有因此而忽视其它有助于高性能系统的外观元素。

设计蓝图通过重复来实现规模经济，其建议是在东向和西向视图上可行之处采用单元化的幕墙系统。 单元化系统将由异地生产，这为几乎50%的玻璃区域提供了高质量的和具有成本效益的解决方案。

在北部和南部视图的阳台区使用的是立框式系统，方便滑动玻璃门的安装。

减轻眩光和太阳能控制

幕墙设计需考虑控制眩光和管理单元内太阳能的增益。 以目前的建筑设计理念，外部遮阳设备不适合使用该项目；因此，在双层玻璃原件上使用高性能的（选择性的）的涂层是必须的，这能避免内部环境过热并符合关于太阳能的使用规定。

热舒适度

曼谷气温大都在最低温度15° C （冬季），以及最高温度38.5℃（夏季）的范围之间。 使用高性能涂层的双层玻璃元件并在其间填充空气可以为内部环境提供热绝缘和保持热舒适度。

Figure 7. Nimit Langsuan façade (Source: PACE)
图7. 尼米朗双（Nimit Langsuan）幕墙（来源：PACE）

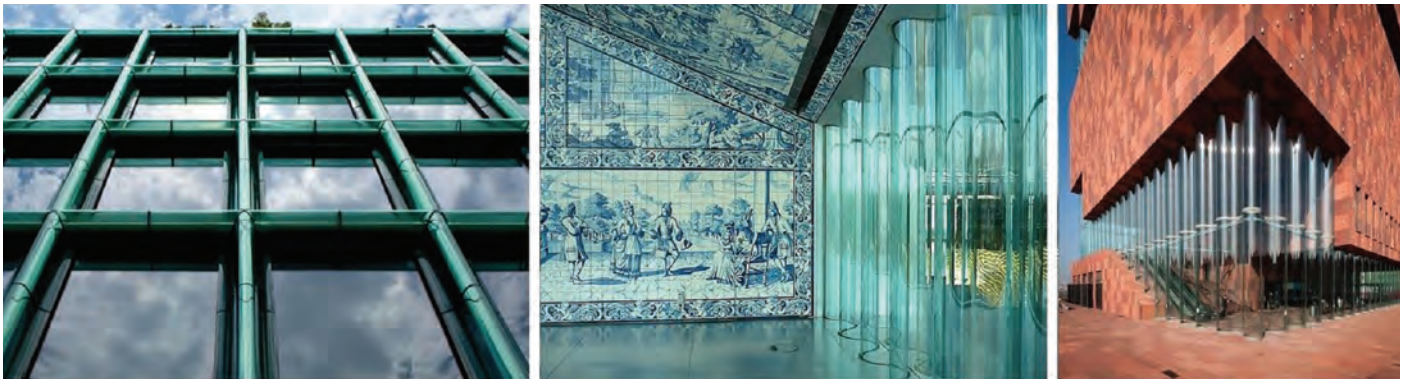

Figure 8. 3D Glass Precedents – 40 Bond Street (Source: Dirk Verwoerd Architectuur fotografie) Casa da Musica (Source: Zahner) MAS Antwerp (Source: Glass Effects)
图8. 3D玻璃先例 – 40邦德街（来源：Dirk Verwoerd Architectuur fotografie）卡萨穆西卡（来源：Zahner）安特卫普MAS（来源：Glass Effects）

designed by OMA and Rem Koolhaas. Here, the façade is made out of curved glass which was designed as a key part of the acoustic strategy.

The Museum Aan De Stroom (MAS) Antwerp

The Museum Aan De Stroom is a museum located in the Eilandje district of Antwerp, Belgium, shaped as stacked boxes designed by Neutelings Riedijk Architects. The curved glass creates slices through the stacked boxes and texture and reliefs to the views inside and outside the museum (Figure 8).

OMEGA Elements

The shapes of the curved elements resemble the Greek letter omega and have been appropriately named the OMEGA profiles by the architect.

The OMEGA elements are composed of curved glass. Alternative elements are being considered for the horizontal elements which include stainless steel with a bespoke finish to match the clear amber color of the glass elements.

The OMEGA elements are double curved with a depth of 700mm and overall width of 1100mm. The glass elements are curved using the heat bending process and will include a polyvinyl butyral (PVB) interlayer, and are chemically tempered to increase the toughness and improve safety.

The team has conducted a detailed prototyping process with several suppliers to develop the design and ensure the feasibility of the OMEGA façade elements (Figure 9).

Building Services

Modern high-rise buildings include a complex network of mechanical and electrical systems to service the inhabitants. To achieve high performance these systems must also be designed in an integrated way to improve the

3D曲面玻璃

Nimit Langsuan的特征在于其使用的三维曲面玻璃。 三维曲面玻璃虽然在泰国是新型建材，但已成功用于世界各地的其他项目。 为了实现这个项目，团队对以往的曲面玻璃建筑的成功案例进行了详细的研究，以下所列举的为曲面设计的成功先例：

邦德街40号

恰如其名，大楼位于美国纽约休斯顿大街的北部，邦德街40号。它是赫尔佐格&德梅隆工作室（Herzog & de Meuron）与亨德尔建筑师（Handel Architects）合作的第一个豪宅项目。 不同厚度的曲面玻璃用于装饰钢板覆盖的承重框架，发出反射光面。

卡萨穆西卡（Casa da Musica）

卡萨穆西卡，也被称为“鞋盒”音乐厅，位于葡萄牙的波尔图，由OMA和库哈斯（Rem Koolhaas）共同设计。 在这个项目，外墙是由曲面玻璃构成并成为声学设计的关键部分。

安特卫普的Aan De Stroom博物馆（MAS）

Aan De Stroom博物馆位于比利时安特卫普的Eilandje区，形如Neutelings Riedijk建筑师设计堆放的长方体。 曲面的玻璃通过堆叠的长方体和其自身纹理来展现博物馆的内部和外部的景致（图8）。

OMEGA元素

曲面元件的形状类似于希腊字母Ω，所以被建筑师恰当地命名为项目的OMEGA特色。

OMEGA元素由曲面玻璃构成。 在横向元件方面，可以考虑使用替代品，包括订制的且与透明琥珀色的玻璃匹配的彩色不锈钢。

OMEGA元素有着深度70米和共计宽度110米的双曲设计。 玻璃元件使用的是热弯曲加工过程，这包括聚乙烯醇缩丁醛（PVB）中间层，同时被化学回火增加韧性以提高安全性。

团队已经实现了详细的成型过程，并与几家供应商共同研发，从而保证了OMEGA外观元素的可行性（图9）。

建筑服务

现代高层建筑为其居民提供机械和电气系统的复杂网络。 为了实现建筑的高性能，

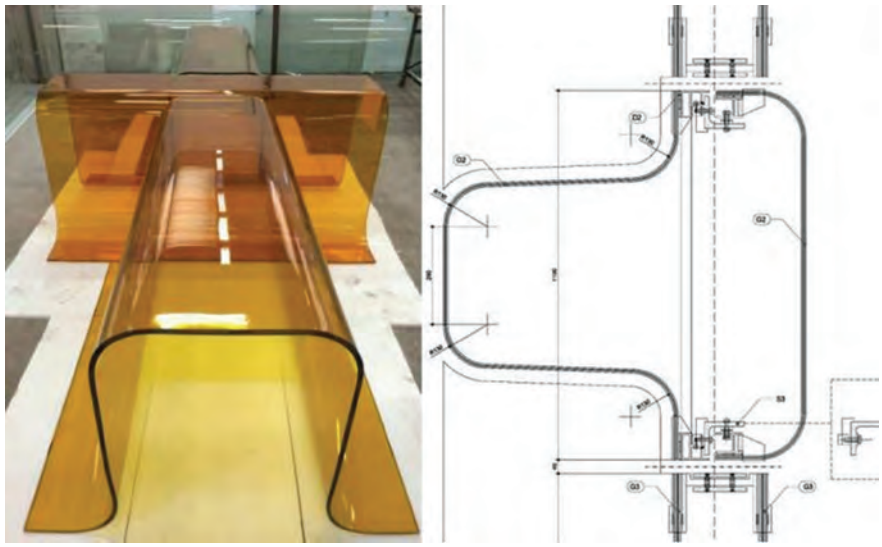

Figure 9. OMEGA element prototype (Source: PACE)
图9. OMEGA元素原型（来源：PACE）

internal environment for the inhabitants. For Nimit Langsuan, integration of the building services and building systems into the architecture and structure was one of the key points of success in the design strategy.

Self-Contained Apartment

One of the high performance design strategies employed at Nimit Langsuan is the concept of self-contained apartment. This concept means that each apartment is designed so that all elements of the apartment including mechanical, electrical and drainage services are distributed between the floor and roof slabs.

The common practice in Thailand is to drop drainage elements through the apartment floor slab into the ceiling zone of the apartment below. While this creates obvious potential problems of leaks and maintenance it also adds to the complexity for coordination of the services which leads to an increased services distribution zone. For Nimit Langsuan, the team implemented a strategy which is common in some European markets where the drainage distribution is above the structural slab and contained in the floor finishes build-up. Several floor finish build-ups were considered with the recommended proposal being a dual layer concrete screed composed of aerated concrete and normal structural screed (Figure 10).

Horizontal Distribution

This self-contained apartment strategy enabled the optimization and simplification of the horizontal distribution in the ceiling zone.

From the main vertical service risers, mechanical and electrical services are distributed horizontally to each apartment. The proposed strategy includes the conventional approach of routing services within the ceiling void of the core area to each apartment. Upon entering the apartments, we propose a zoned approach for distribution and location of the services which limits the services void to 250mm in the living areas while providing 600mm in back of house areas such as bathrooms and corridors. Using this zoned approach, the main distribution will be limited to a maximum 150mm duct/pipe size with service crossovers being limited to the back of house zones.

This zoned approach enabled the design team to achieve the client's requirement of a 3000mm clear floor to ceiling height in the main living areas which have been coordinated with the architectural floor plans and sections (Figure 11).

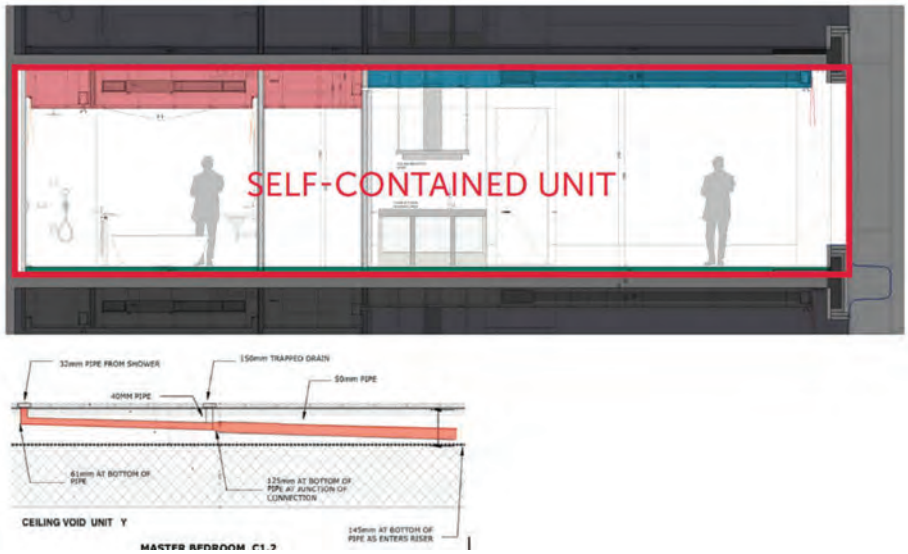

Figure 10. Self-contained apartment (Source: PACE)
图10. 独立公寓（来源：PACE）

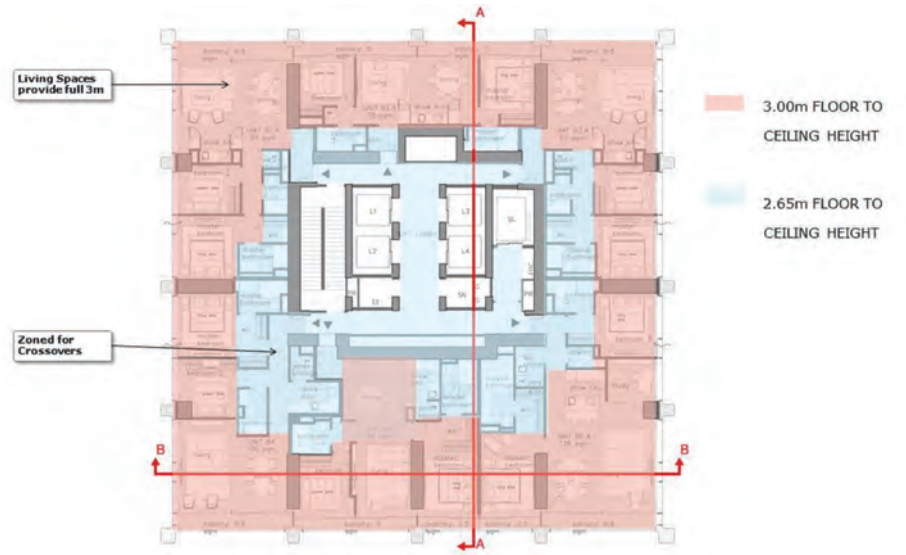

Figure 11. Building services horizontal distribution zoning (Source: PACE)
图11. 建筑服务设施水平分布分区（来源：PACE）

这些系统也必须以集成式综合设计来改善居民的内部生活环境 。 集成的建筑服务以及建筑结构一体化是Nimit Langsuan项目成功的关键点之一。

自助式公寓

Nimit Langsuan采用的高性能设计策略之一是自助式公寓的概念。这个概念意味着每间公寓的设计保证机械、电气和排水等所有元素在地板和楼板之间合理分配。

在泰国普遍的做法是，把整个房间的排水引流通过公寓楼板降排到下一层的公寓的天花板 。 这明显会带来泄漏和维护的潜在问题，还增加了服务区分配的复杂性。对于Nimit Langsuan，团队引入了在一些欧洲市场常见的解决策略，其排水引流分布在结构板的上方和集成地板内。在结合了多种地板集成设计之后，被推举的做法是双层混凝土砂浆层组成的透气混凝土和普通的平板结构（图10）。

水平布局

这种自助式公寓有助于天花板区域水平布局的优化和简化 。

主垂直服务立管和机电服务都会水平分布到每个公寓。 提案是采用在核心区的每间公寓天花板空隙内铺设管线服务的传统做法。 在公寓内，我们使用了服务区域的概念用以分配和定位，在客厅区域把无效服务限制在0.25米，同时在背面，如卫生间和走廊提供了0.6米。 使用这种划分方法，主要管线分布将被限制在最大为0.15米的导管/管道，并且服务交叉被限于住宅区域的后面。

这种划方法使设计团队成功实现客户的要求，即在主要生活区域，地板到天花板的净层高为3米，这也与建筑平面图和剖面图相照应（图11）。

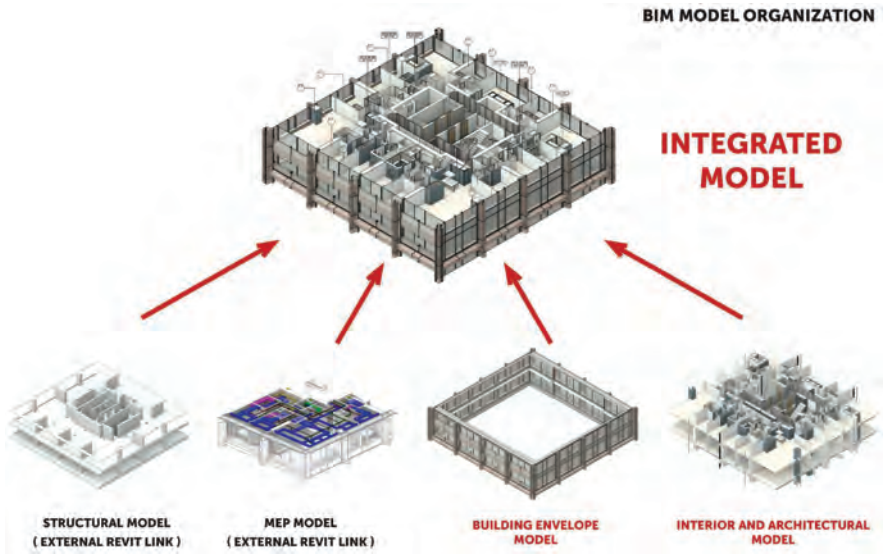

Figure 12. Nimit Langsuan BIM (Source: PACE)
图12. 尼米朗双(Nimit Langsuan)建筑信息模型（来源：PACE）

Environmental System

Bangkok is a vibrant city but its climate during certain months of the year and level of traffic can lead to high temperatures with high levels of air pollution. This is a common challenge in large Asian cities and was a key influence in development the environmental systems strategy for Nimit Langsuan. High performance for the environment systems means control of the temperature and improvement of the air quality for the internal environment.

For Nimit Langsuan the building services design is based on a centralized approach which places the majority of the plant in dedicated technical zones in the building. This approach limits the amount of equipment required inside the apartments and also provides benefits related to maintenance and energy usage.

The cooling system strategy is new for the Thai residential market, where a centralized Water Cooled Variable Refrigerant Volume (VRV – W) system was selected. The system uses a closed loop cooling water distribution system providing cool water to remove the heat (via roof top cooling towers) from each of the indoor condenser units in the apartment. The indoor condenser units in each apartment provide individual control and operation for each apartment unit which is important in the Thai market. The main benefits of the cooling system is not only limited to the efficiency but the closed loop design with centralized cooling towers eliminating the need for external units, which is a common feature on residential balconies in Asia. This design strategy integrates the cooling strategy with the envelope to provide unobstructed views of the façade.

BIM

Nimit Langsuan is a success story in design integration with one of the primary enablers being the use of the building information model (BIM) environment. For Nimit, the level of detailing is set to minimize on-site coordination and allow optimization of the building floor plate. Over 50 models have been created and represent all the main building systems including architecture, structure, building services, envelope and interiors. This comprehensive BIM approach is a requirement to achieve the level of design optimization for the project (Figure 12).

环境系统

曼谷是一座充满活力的城市，但在一年的某些月份的气候以及交通状况会导致高温并伴随着重空气污染。 这是亚洲大城市共同面临的挑战，也是影响Nimit Langsuan环保系统战略的重要因素。 对环境系统的高性能要求使得需要对内部环境的温度和空气质量进行控制和改善。

Nimit Langsuan的建筑服务设计是基于在特定的技术区域设置大多数服务站的集中方式。 该方法减少了公寓内的所需设备的数量，并且还有利于相关的维护和节能。

冷却系统是泰国住宅市场的一个新现象，该项目选用的是一个集中的水冷式变制冷剂流量多联式空调系统（VRV – W）。该系统采用闭环冷却水系统来提供冷却水以去除来自每个公寓的室内冷凝器的热量（通过楼顶冷却塔） 。 公寓的室内冷凝器为每间公寓提供个人控制和操作，这在泰国市场是非常重要。 冷却系统的主要优点不仅限于效率，闭环设计的集中冷却塔消除了外部放置设备的现象，而这在亚洲住宅市场还颇为常见。 这种集成式冷却系统的设计策略使得围护结构可以提供一览无遗的幕墙。

BIM

Nimit Langsuan是集成化设计的一个成功案例，其主要推动力是建筑信息模型（BIM）环境的使用。 Nimit Langsuan项目的详细信息能够最小化现场协调，并能够进行楼板的最优化选择。该项目的主要建筑系统模型已经超过了50个，包括外观，结构，建筑服务，围护结构和内饰。这种全面的BIM方法是实现项目设计优化的必然要求（图12）。

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