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The Design Strategy for Functional, Efficient, Curved Super High-Rise Buildings | 超高层建筑功能经济的曲面形体设计策略

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Abstract | 摘要

This paper explores the corresponding design strategies of skyscrapers curved figures. It discusses the stacked functions in a single building and presents the methods of how curved figures can adapt functions by battering shapes and changing plan outlines. It also address the technical problems of curtain walls and how an iterative algorithm can be used in the optimization of the curved figure form-findings. By taking Zhuhai Hengqin International Finance Center and Guangxi Nanning ASEAN Tower as two on-going project examples, the paper concludes curved figure strategies can benefit super high-rise building design.

Keywords: Curved Figure, Iterative Algorithm, Spatial Efficiency, Stacked Multi-Function, Super High-Rise

本文探索了超高层建筑曲面形体设计策略，探讨了单体建筑的叠加功能。阐述了曲面形体设计如何通过造型设计和改变平面轮廓适应功能需求的方法；解决了幕墙的技术问题以及如何在曲线造型优化过程中采用迭代算法。以珠海横琴国际金融中心、广西南宁东盟大厦两个在建项目为例，本文总结出曲面造型设计策略有益于超高层建筑设计。

关键词：曲面形体、迭代算法、空间经济性、多功能叠加、超高层

The Shape Development of Skyscrapers

The shape of the skyscraper has continued to evolve for many decades, from the typical box or cubic style, to a variety of forms in recent years, with a rising percentage of curved-figured towers. The abundant choices of shapes not only cater to architectural aesthetics, but have other significances as well. The shape of the façade is not curved merely for design purposes, but rather, the curvature can have two purposes: on the one hand, it reflects the inner multi-function and maximization of usable space; on the other, it broadens technique and catalyzes construction methods with the use of parametrical tools. This paper will discuss these two aspects, and present and share some of the author's experiences in designing skyscrapers with examples of real projects the author has worked on.

Stack of Functions

Proper Plan Functions

The modern high-rise often comprises a mixed-use office building. If in western history we can see a transformation of a pure office tower to one of multi-functional usage, the pursuit of Chinese high-rise building, beginning in the 1980s, was at its start oriented on multi-functionality. Such a case can be seen in the Baiyun Hotel in

超高层建筑的形体发展

超高层建筑在几十年的发展后，由典型的方形或者筒形，演变成最近几年出现的多种多样的形式，其中圆弧形塔楼的比例一直在增加。丰富的选择不光提供了建筑学美观的外形，同时具有其他重要性意义。采用圆弧型的幕墙不光是为了追求设计效果，同时具有其他两方面的意义，一是在建筑空间上对应着内部的不同功能，达到空间的合理性。二是技术上不论是设计上的参数化、还是生产中的工艺，都扩展了相应的建筑技艺。下面就这两点，结合一些笔者参与过的项目案例，来展示和分享一些作者在高层摩天大楼设计中的经验。

建筑功能的叠加

适宜的平面功能

现代建筑超高层往往是一个综合性的办公场所，如果说国外的超高层还有一个从纯办公到多功能的发展过度，那么中国的追赶脚步自80年代开始起就已然沿着多功能的方向。这样的案例可以从广州白云宾馆看出来，其主要功能是接待外宾。同样，中国北部北京的京广中心，作为第一个超过200m的多功能高楼，底层是办公楼，顶部是酒店。现如今中国是最大的高层建筑的地域，因为巨大人口技术和人口密集度，并且经济的快速发展需要城市里采用多种形式。

Guangzhou, which was the first super high-rise in China, built up mainly for international guests. In the north, we also have Jinguang Center in Beijing – the first mixed-use building above 200 meters in height, with office on the lower floors and hotel functions on the upper levels. Until today, China has been the largest epicenter of the construction of skyscrapers, primarily because of its large population, dense cities, and economy. Normally, functions of towers would include several facilities, such as commercial or retail podiums, lobbies, offices, hotels and apartments, sky lobbies and penthouses. Though stacked together, with a vertical core to provide accessibility to each floor, each function does not require the same plan layout and shape, so we cannot treat them in the same way, in the aspects of height, depth, and width.

Take the most common functions of office, apartment, and retail in comparison; they differ in every parameter. Usually in neat height, offices needs 2.7 meters, apartments can have 2.4 meters, and retail requires at least four meter, with the ground floor often much higher, reaching around six meters. If we add on the structure height, which is around 0.9 meters, and MEP heights which are around 0.6 meters (according to the author's project experience), then we get floor height with offices at 4.2 meters, apartments at 3.9 meters, and retail at 4.5 to five meters.

Also, there are depth differences as natural lighting weakens if a plan is too deep. The proper depth would be offices at 12 to 14 meters, apartments at 10.5 meters, small retail no larger than 15 meters though larger retail spaces can be quite deep. There are also differences in the corridor's width, which adds on to the total plan depth. A typical retail corridor could have more than six meters in width if the shops are allocated on both sides, and offices would have a 1.8- to 2.5-meter corridor, while apartments can have a 1.5- to 1.8-meter path. As the core is often larger in lower levels and smaller in upper levels – mainly due to the elevator numbers required to be higher at the bottom of a tower and less so on the upper floors, the proper plan size could differ quite a bit.

Figure Types

It is not efficient enough to maintain a same-plan layout throughout a multi-functional building. Super high-rises also have different sections, dictated by elevator capacity and fire regulations; so, on the question of handling shapes, there would often be the following strategy options: some buildings take setbacks and create terraces, like the Willis

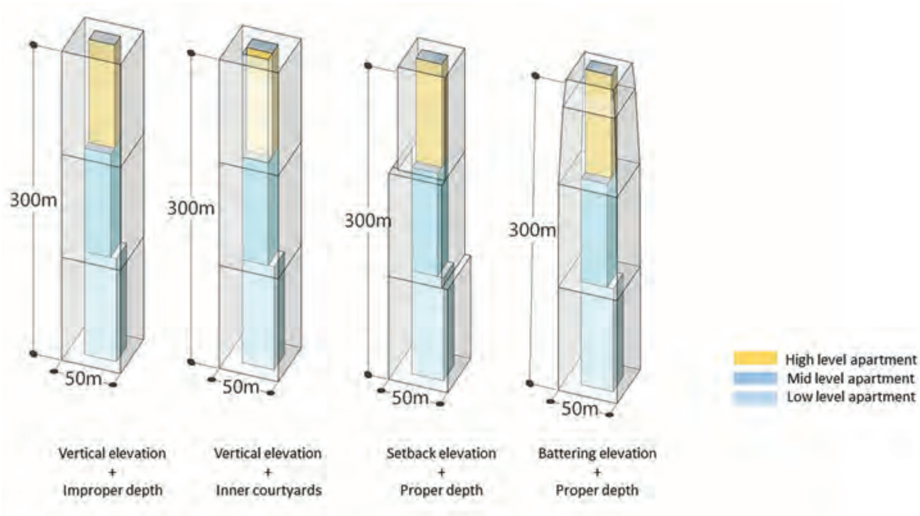

Figure 1. Different massing methods (Source: Yu Wang)
图1. 不同的形体处理方法（来源：王禹）

Tower in Chicago, which uses bundled-tube structuring where each cube stretches into a different height; and some maintain the outlined figure, but create internal courtyards and voids, such as the Jinmao Tower in Shanghai or the Jinji100 Tower in Shenzhen, as the upper hotel part does not need as many elevators so that a large part of the buildings core would be left empty on the hotel level to create a void. Some can utilize a gradient changing curved figure – a battering shape, for instance – to fit functional needs. This kind of strategy makes the building holistic on the outside, and leaves a richer chance of different building layouts (Figure 1).

In the case of Guangxi Naning Tower, the vertical control line of the building is a tilted curve battering towards the central plan, with the curve growing larger at the bottom and smaller on the top, to adapt to function changes. In the end, we created a cube box with the bottom plan layout of about 2,650 square meters, the top plan layout at about 2,370 square meters, and the largest plan layout about 3,600 square meters, which is at one third of the building's height. Vertically, the shape adapts the building's function of office at bottom and hotel at the top, and the plan layout is pushed in the middle of the edge and pulled at the corner to create a fillet square shape with concave edges, which allows for a larger view angle at the corner. Compared with a typical square plan on a same standard level layout with the same core and the same area (in this case 2,600 square meters), the new plan's edge has a better depth of 10.5 meters and leaves only a smaller area of 111 square meters, which goes beyond the proper depth, as compared to having less of a corner view area and an average of 11.6 meters in depth, wasting 140 square meters, which goes beyond the proper depth. Note that different shapes with certain advantages often come with a balance of disadvantage,

超高层是所谓的“城市综合体”的概念，里面的功能包络万千，包括底层的商业，高层的办公、公寓及酒店，首层的大堂，包括顶层的云端餐饮等。在这些功能在超高层建筑内通过垂直交通组织一起的同时，不同功能需求的平面布置和形状不同，所需要的平面、层高、进深都不同。

就拿最常有的公寓、办公、商业三项功能来类比，在每个参数上都有不同：比如公寓的经济形适宜净高是2.4米左右，而办公层净高是2.7米左右，商业的净高则要求在至少4米，还不说首层高度经常更高甚至达到6米。如果加上结构厚度大概0.9m，设备需求约0.6米（根据作者的工程经验）则层高是公寓3.9米，办公的层高是4.2米，商业层高可在4.5–5米。（不同功能）进深度方面要求也不一样，因为平面进深越大自然光采光性能越差，合理的进深基本可以，办公楼12–14米，公寓楼10.5米，小型商业不超过15米，大型商业可以很深，比如商业两面铺需要6米的走道，而办公需要1.8–2.5米，公寓仅需要1.5–1.8米走道. 另外核心筒在底层的比较大，在高层比较小，主要是因为电梯数量要求不同，合理的平面尺寸会先查很大。

立面的轮廓方式

综上，所有楼层保持相同的平面布置并不是有效的。电梯运载能力和防火分区也注定摩天大楼也具有不同的剖面。因此在确定建筑外形的问题上，通常有以下的策略：一些大楼采用退步阶梯式，例如芝加哥西尔斯大厦，就采用束管式结构，每个矩形筒拉伸到不一样的高度；一些大楼外边沿形状保持一样，但是在内部设置中庭或休闲区，例如上海金茂大厦或者深圳京基100大厦，在酒店层不需要大量的电梯时，把核心筒内剩余的空间留下成为休闲区域。但是建筑同样可以采用倾斜的弧形外形，以便实现渐变的符合功能要求的形状。这种策略使得建筑物的外表更加整体，并同时提供了更加丰富的平面布置的可能性（图1）。

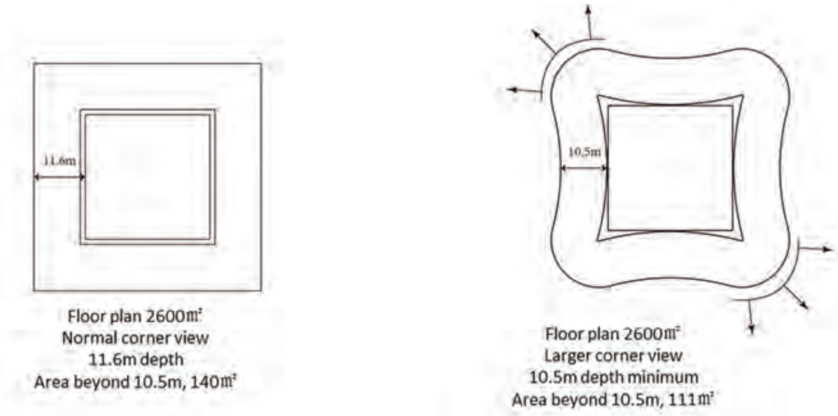

Figure 2. Comparison of plan layouts of Nanning Tower (Source: Yu Wang)
图2. 南宁塔的平面比较（来源：王禹）

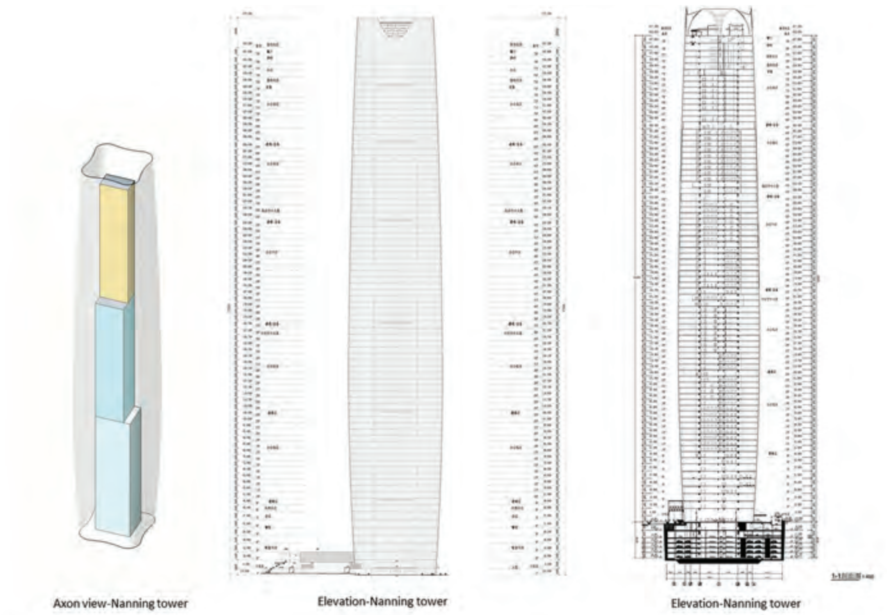

Figure 3. Nanning Tower elevation and section plans (Source: Yu Wang, THAD)
图3. 南宁塔的剖立面（来源：王禹，THAD）

as a concave shape holds more wind pressure and does not perform better than a cubic plan or convex-shaped plan (Figures 2 & 3).

Also curved shapes could be a combined shape, for example in the design of Hengqing Tower, where the upper apartment of the building adapts a fan shape – a four pinwheel shape with four legs stretching out. The advantage of the shape is it allows for more natural lighting in the condos, where typically the condos in a skyscraper, often divided into several on each floor, will have a minimum view vista of only one side, making the corner rooms much more valuable as they offer views in two directions. The pinwheel shape, however, creates a unit with front and backside natural lighting conditions, so comparably, it brings more value across more units. Take the similar 2,600-square-meter plan for example, where a typical depth would be around 11.5 meters, and the perimeter, which means view vista, is only 206 meters long. In the case of Hengqin Tower, the depth of the condos was significantly shortened into 9.5 meters due to double-façade natural light and because of its zigzag form, which made the perimeter 288 meters long. As the shape transforms to the bottom of regular square office plans, the design tries to morph the shape of a pinwheel with a square, creating some interesting effects of curved façades and fadeouts (Figure 4).

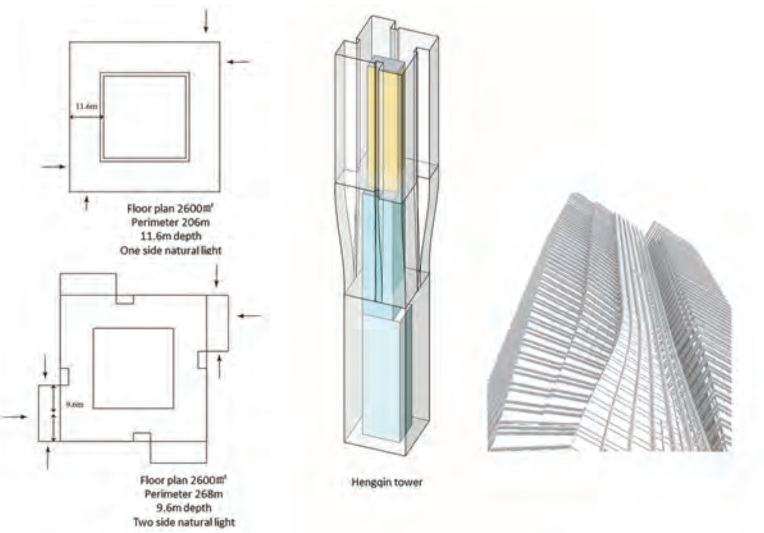

Figure 4. Comparison of plan layouts of Hengqin Tower (Source: Yu Wang, Aedas)
图4. 横琴塔的平面比较（来源：王禹，Aedas）

比如在广西南宁东盟大厦、珠海横琴国际金融中心这两个案例中。广西南宁东盟大厦采用的是逐级收分的形体，以应对这种功能变化。我们最终的形体有三个主要控制平面，其中底面面积2650平方米左右，顶面面积2370平方米左右，而最大层面积约3600平方米，大约在建筑高度的三分之一处。形体整体的好处还有作为风荷载受力的连续性优势，同时建筑平面上将四边内凹，将四角倒圆，拿传统四方形平面对比，在满足2600平方米面积和同样核心筒情况下，这样在转角的视野更加开阔且有更多面积,同时短进深满足10.5m，超出部分面积仅有四角的111平方米，而矩形平面则普遍进深11.6m，超出部分面积也增多至140平方米。当然相对于边内凹的平面，立方体的平面或者凸曲线的平面在风荷载上的条件更好一些，采用不同的形式会有不同的优劣（图2、3）。

同时，弧形也可以是结合而成的形状，比如在珠海横琴国际金融中心的案例中，则采用更有意思的风车形平面作为上部公寓住宅的平面，如四瓣纸风车的形状，四个腿伸出去，因为这样住宅的采光面能够做到最大，进深也不会那么深，同时渐变到底部的办公楼也能保持完整且好用的矩形。比如同样是2600平方米的平面，一个方形的平面拥有将近11.5m的进深，同时边长只有206m，边长则意味着景观朝向面，而越长的边长意味能看景的房间越多，在处理成风车后，景观面增加到了288m长。同时在从风车平面转变为方形平面过程中，也出现了许多有趣的面的形体转折（图4）。

相应的技术问题

整体的形体控制

几十年前，在没有电脑技术的帮助下，想做到每层不同，并符合类似等差数列一样的渐变类型是很困难的。现如今，随着量化建模工具的发展，实现弧形外形更简

The Related Technical Problems

Volume Control

Several decades ago, without the help of computer technology, it would have been difficult to make each floor different and follow a gradually changing pattern, such as an arithmetic progression. Now with the development of model parametrical tools, it is easy to rationalize a curved figure, as one needs to only provide the logic of form finding, oftentimes the needed control line or point is reduced to several, and the computer could fill the rest. For example, Nanning Tower only uses one plan outline curve and two symmetrical vertical control curves to form its holistic shape, and computer cuts out floors according to preset floor heights, and then the optimization of each floor's outline. Hengqin Tower is more complex and needs more control lines. The control line varies as designs and logics are different, but the progress is still similar.

It is also important to rationalize the shape as the design as it is carried from the concept phase into the development or construction phases. One thing to consider would be the transformation of the concept outline curves into segments of arches in order to be capable for standard production, as arches can be exactly defined by the radius and the center. In the case of Nanning Tower, the outline was rationalized into a symmetrical eight segments of arches – four edged ones that concave and four corner ones that convex with a certain central point. Each arch can then be equally divided into proper glass panel-lengthed scales, so the type of the glass can be minimized. Also, vertically on each floor the gradually changing figure can be resembled by a stepping battering shape with each level purely vertical, which allows us to use plane glass to make construction easy. Of course, with the development of the construction technology, one can make any conceived shape into reality, but these strategies are important, especially for budget-limited projects (Figures 5 & 6).

Glass Curtain Wall Types

Basically there are three types of glass to apply on a curved figure or surface: plane glass, hot-bend glass, and cold-bend glass – most of these are prefabricated into the unitized curtain wall. Plane glass is to used as a zigzag segment of lines to mimic curves. It is economical and easy to construct, but doesn't have clean curve effect. It also has a balance between the curvature and the divide length, as dense length provides a more precise mimic of the curve, but too much vertical frame would make the building look un-transparent.

Hot-bend glass can be twisted into many shapes and fit on not only 2-D surfaces, but also 3-D surfaces; 2-D surfaces meaning that the surface has curvature only along one direction, such as a pipe, and 3-D surfaces meaning that the surface has curvature along two directions, such as a saddle shape. At the production phase, the glass is heated and transformed when it is soft, according to the modules with which it is the same design shape; however, it also has certain production limits, like when applying with typical types of glass, such as insulated glass or low-e glass, as it is not capable to provide with any shape where the insulate layer means that there would be a slight difference in size between the inner and outer layers of the glass, making the changes too subtle to control. On the other hand, with the pursuit of green building certifications, such as LEED in the US or BREEAM in the UK, becoming more desirable, skyscrapers' tend to use low-e glass, which has become more standardized. It is not possible to use hot-bend glass if the shape is too complicated, and it is better to be applied on 2-D surfaces.

Cold-bend glass is the newest method and has a limited cost, as it is originally a plane glass, only bent by force, according to the design, without the need to heat and soften it. Yet with a three to five percent degree of

单，只需要提供整体模型的成型逻辑，并加载少数几个控制线或点，电脑将自动完成其余的成型工作。例如南宁塔只使用了平面曲线和两条镜像的竖向控制弧线就完成了整体的造型。电脑根据预设的层高切出楼板外边线，之后对每层的外边先进行了细微的优化。横琴塔案例比较复杂，需要更多的控制线。控制线随着设计和逻辑的不同而变化，但整体的流程是类似的。

当然优化外形是很重要的，因为设计过程是要从概念设计转化为深化施工设计或者是施工阶段的。需要考虑怎么把概念设计中的样条曲线拟合成为整段的圆弧线，以便能够便准化生产，因为圆弧能够精准确定半径和圆心。在这里例举广西南宁东盟大厦，连续的曲线被规整成对称的8条圆弧，每个圆弧确定圆心，便于确定模数。这样再均分每段圆弧达到适宜的玻璃划分尺寸，使得玻璃的不同种类减少。同时在纵向上，也将渐变的外轮廓做成阶梯状收分，这样简化玻璃划分，便于安装。虽然目前技术能够使任何扭曲的造型得到实现，但在一些限额设计项目中，这样的优化措施就十分有必要（图5、6）。

曲面幕墙玻璃种类

在玻璃幕墙实现上，有三种玻璃的相应技术:平板玻璃、热弯玻璃、冷弯玻璃。其中平板玻璃是考虑以折线代替曲线做，具有价格低廉，施工便捷的优点，但是设计折线的效果不如弧线来得连续。同时对于弧

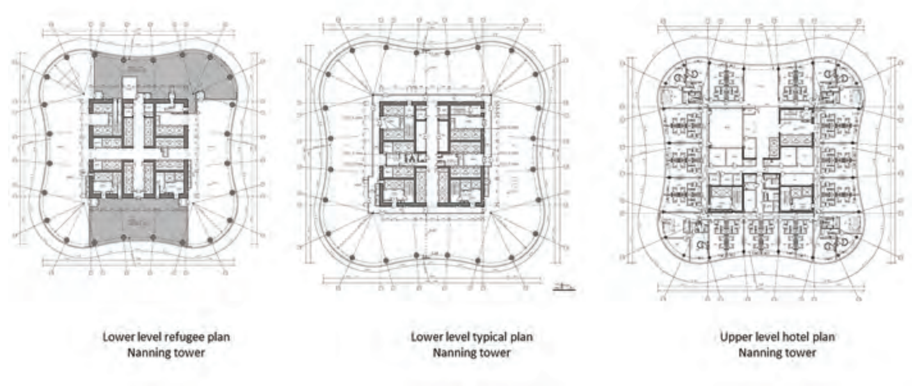

Figure 5. Nanning Tower plan (Source: Yu Wang, THAD)
图5. 南宁塔不同层平面（来源：王禹，THAD）

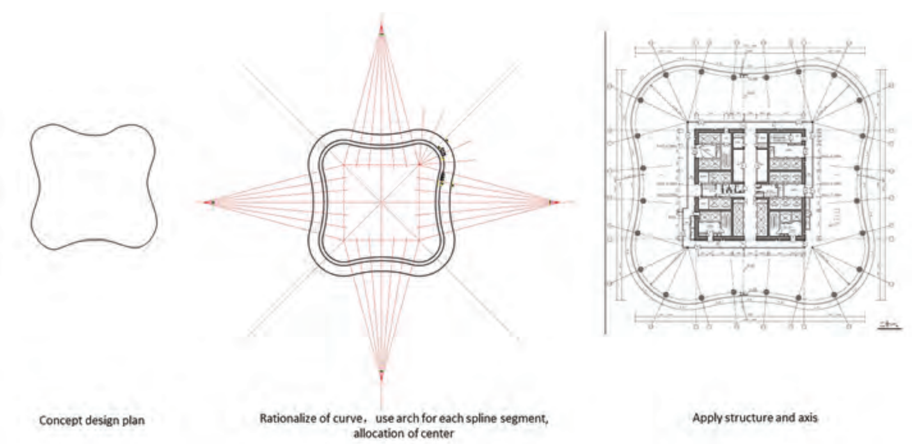

Figure 6. Rationalization of Nanning Tower plan outline (Source: Yu Wang)
图6. 南宁塔平面轮廓规整化（来源：王禹）

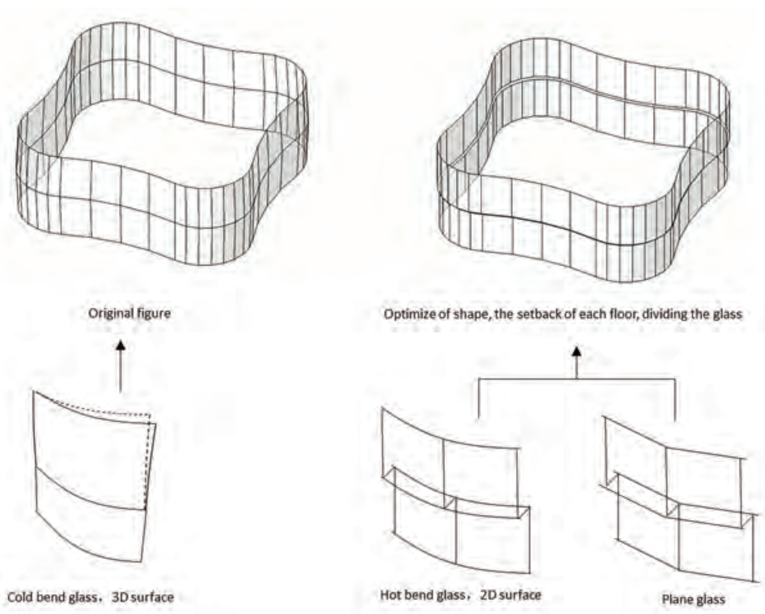

Figure 7. Optimization of façade and curtain wall types (Source: Yu Wang)
图7. 立面与幕墙的优化（来源：王禹）

bending as its limit, over bending will cause the glass to break, as it is equal that the system is pre-stressed, so it is hard to apply on surface with great curvature (Figure 7).

In real projects, these three kinds of methods often co-exist and are used on different parts of the surface. In the Naning tower for example, we mostly used the plane glass, as the project is budget limited, and we tried to make the arch segments even and not steep, so that the glass width can take on a normal module and the building would not look overly dense in some areas; eventually the glass panel width came to be around 1.8 to 2.1 meters. On Hengqin Tower, a different part of the façade was used with different glasses – with normal surface plane glass and twisted surface cold-bent glass. Also at some fillet corner, hot-bend 2-D glass is introduced. Finally, at some complicated 3-D surface, only planar triangular glass could be used to mimic the fluent surface curvature (Figure 7).

The Paneling of the Curtain Wall

During the concept design, we would often think of the conjunction point as just a point, while in reality, it is not. For example, if you use a grid-unit glass system, then each point would actually meet the four points of the adjacent panels. While in planar figure this four-point system might really be one point in space, in curved figures, this issue would mean the displacement of each glass panel; in other words, the four points do not overlap each other in space. Improper design would have had a bad visual effect, or more severe consequences, such as causing a leak. Of course, there would be curtain wall consultants helping to solve the problem, but it would be better if the architect could take it into consideration and control the quality of design. For example, on the typical office floor of Hengqin Tower, with the plane glass system, the displacement is often dissected by horizontal or vertical fins or frames that stick out between the glasses. When dealing with displacements, you could also set the reference point to be either at the midpoint of the glass edge, or at the corner point, which will result in different calculation outcomes.

Such a problem would not exist when using triangular panels, as three points will always be on one surface, so it is able to set the conjunction overlapping each other in space; however, this again could raise the issue of how to divide and optimize the surface so that the division is even and rational in stress taking, and still within the design effect's control. This optimization process could be done using computer parametrical tools. For example, a simple rectangular panel would better be applied on a surface according to the surface's UV direction, which is the orthogonal grid-like coordinating structure of a surface advantageous to the buildings mechanical system. A triangular panel can be realized by simply adding on a diagonal line to the system and dividing the rectangles, or it can be done in an equilateral triangular way; but glass has its proper size, so on a 3-D surface with extremely unparalleled edges, following the UV direction completely would mean some piece of glass would get too large while other pieces would become too small. More often on a 3-D surface, the most reasonable stressed division is achieved by an iterative calculation. In the case of Hengqin Tower, we first decided on the panel material and its proper size, which is around 1.5- to 2.5-meter triangular lengths, and we set off an original paneling pattern on the surface, which is a diagonally divided rectangular

度和通透度，也有一个平衡，比如在折线越密的情况下，弧度拟合越好，而由于立柱龙骨增多通透度越小。热弯玻璃能够扭拧成很多形状，不仅能够满足二维面，并且能够满足三维面。二维面意思是沿着单一方向弯弧，例如圆管；三维面意思是沿着两个方向拉完，例如马鞍型. 热弯玻璃是考虑完全将玻璃加热加工，以达到完全拟合设计上的圆弧的效果，但是在增加造价的同时，对玻璃的种类也有所限制，比如对中空low−e玻璃等，就不方便任意的热弯加工。因为双层玻璃两侧如果是曲面的话，会有难以加工的精细的误差，所以使用起来会有限制。另一方面，由于追求绿色建筑评级认证越来越热门，两大评级机构LEEDUS和BREEAM UK，更是倾向于LowE玻璃。如果造型太过复杂，就不可能应用热弯的中空玻璃，最好还是采用二维面。第三种材料是冷弯加工，冷弯是一种较新的技术，并不太贵，因为板块本身是平板玻璃，只是根据设计的力去弯曲，并不需要加热或者软化。然而3%~5%度数是冷弯的极限，过度冷弯会造成玻璃的破损，等同于系统是预张拉的，因此在弧度太大的表面，冷弯并不适用（图7）。

实际工程中，面对复杂形体时这几种玻璃常常共同存在并且根据立面的曲率不同而使用。比如在南宁大厦案例中，由于限额设计，基本所有的玻璃都采用平板玻璃，而平面的曲线划分也考虑到尽量均匀的情况，将玻璃分隔控制在1.8−2.1米。而在横琴项目中三种情况的玻璃均有使用，因为项目更复杂而被分成更多面， 基本上在标准办公层，还是使用平板玻璃和部分冷弯玻璃，而在倒角处采用些2维的热弯玻璃，而对于更复杂的3d曲面部分，则使用了平板的三角划分玻璃来拟合光滑的曲面（图7）。

幕墙的分隔

曲面幕墙往往需要注意其中位移差的分部，即以小面矩形玻璃拼接大曲面时，接缝处的玻璃交接不在一个点上的问题,在节点交接上产生诸如对不上或者漏水的问题，在大造型效果上也影响项目的设计。现在多数幕墙都是单元式幕墙，如果采用平板玻璃，则曲面的与玻璃间位移差全靠框来解决，框就需要比玻璃突出，以保证玻璃错缝的拼接。虽然这部分工作通常有幕墙顾问配合，但建筑师能了解就能更好的控制设计。比如在横琴项目中，标准办公层采用的就是带有位移差的平板玻璃，而四块平板间同一脚点的微差则由玻璃间的框和出挑来隔开。同时，计算位移差时采用中点还是脚点作为参考点，也会导致计算结果的不同。

当采用三角形的玻璃划分时，由于三点共面，不会产生分隔的位移差问题，但会产生三相如何分隔的问题，这里也可以利用参数化的调整达到最佳效果。举例来说，对于矩形平面玻璃分隔的线是由UV方向决定，但在三角划分时，划分是按照连接矩

system; note that the original pattern is in symmetrical order, but not efficient in force, and also the boundaries do not match to the shape we needed to apply on. We set the string force to the pattern so each edge would try to get onto the surface, but it was unable to become too short because we set the proper length of each piece. We let the pattern iterate on the surface until finally the division was stress economical. We then trimmed off the rest of the part outside of the surface to get the more rational outcome we wanted (Figure 8).

Conclusion

This paper discusses the curved-figure design of skyscrapers in both functional and technical aspects. In the functional aspect, as the building has stacked to be multi-functional, it requires differing plan layouts which a curved figure can more easily adapt to. In the technical aspect, the realization of such shapes and the optimization of the construction part can be down by newly emerged techniques. Such points are discussed accompanied by two real projects, both curved in figure, yet rational. The author hopes that when dealing with other real cases, the questions discussed above will have some common traits and that these experiences can be shared with others. Hopefully with the discussion of such questions, the possibility and feasibility of future city's super high-rise compounds can be expanded.

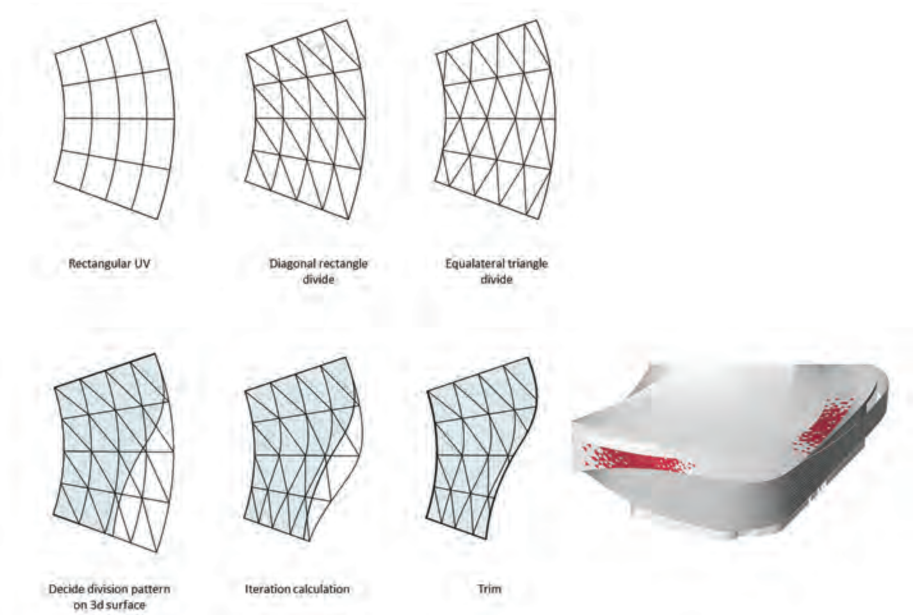

Figure 8. Iterative façade paneling division (Source: Yu Wang)
图8. 幕墙面板分隔的迭代计算（来源：王禹）

形对角点来做，还是按照60°角均分的设计考虑，也很有讲究。有些时候在二维曲面上，受力最均匀合理的划分并不是按照某个固定角度来做的，而是通过迭代算法产生曲面均分。因为在面对边缘很不平行的3d曲面时候，完全根据UV向划分会导致有的玻璃划分面特别小，而有的划分面特别大。而玻璃是有固定尺寸的，太小无法加工，太大费用昂贵。所以非常需要以一种合理方式划分。举例横琴中心的一片曲面来说，我们先根据玻璃（或者金属）幕墙的材料和效果考虑好每块板的大小，控制在1.5-2.5米边长的三角形，接着通过将事先设置好的分隔在曲面上迭代计算，让交点位于曲面上的同时，不至于小于最小的边长，这样最后切掉多余的部分，就得到曲面上相对稳定的状态下的划分。找到更加合理的分割点（图8）。

总结

文章就超高层建筑曲面的功能和技术两方面作为切入点，功能上多功能叠加的趋势使得各层平面需求不同，技术上新的设计和建造技术能够合理经济的完成造型任务。结合具体的设计案例，分析了超高层建筑的曲面造型设计，在实际运用中，不同项目可能情况各异，解决手段也各有不同，本文所举的案例只是个例而已，但对功能空间的使用、对相应幕墙技术的运用，则有一定的通用性质，希望因小见大，最终是扩宽超高层综合体的合理性、可实现性、以及未来城市更多合理经济的垂直综合体的可能性。

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