

Detailed Design Analysis of Curved Glass Curtain Wall—Taking the Design of a Headquarters Building in Wuxi as an Example

Dongyan Chen¹

¹ Shanghai Urban Architectural Design Co., Ltd., Shanghai 200235, China

Correspondence: Dongyan Chen, Shanghai Urban Architectural Design Co., Ltd., Shanghai 200235, China.

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Abstract

Taking the design of a headquarters building in Wuxi as an example, from the perspective of architecture, this paper extracts many key points of the detailed design of curved glass curtain wall, combines actual cases and work experience, specifically analyzes the challenges and problems faced by glass curtain wall in the practice of detailed design, and expounds the basic ideas and technical strategies of this case in the selection of curtain wall system scheme and the related structural design of curtain wall.

Keywords: curved glass curtain wall, refined design

1. Introduction

The pursuit of refinement and permeability is the goal of modern glass curtain wall design, behind the efficient achievement of the goal is a systematic design system and a scientific control system.

A headquarters building project is located in Wuxi City, Jiangsu Province, China. It is a functional complex headquarters park integrating office, meeting, supporting facilities. There are 15 floors above ground and 2 floors underground, with a building height of 67.9m. The total construction area is about 150,000 square meters, of which the above-ground construction area is about 88,000 square meters. As shown in Figure 1, The façade mainly includes glass curtain wall, aluminum alloy

hanging panel, decorative louvers, etc.



Figure 1. Project renderings

2. Design Ideas

The detailed design of the curtain wall follows foresight, step-by-step and hierarchical.

Anticipate risks before deepening the design. First of all, predictability is the control of cost and effect consistency. Within the controllable cost range, make reasonable selection of the curtain wall system; The second is to predict the problems in construction in advance, so as to solve it in the design stage and ensure the implementation of the project.

The step-by-step nature is reflected in the design process. Unlike the regular design process, at the beginning of the scheme development, we worked with the curtain wall designer and floodlight consultant to design typical node details of 1:10 and 1:30. Then return to the scheme model placement. After many times of scrutiny by architects, curtain wall and lighting designers, identify the main materials and construction, and form a budget estimate to communicate with the owner. After determining the cost, further deepen the 1:100 stage drawings. Finally, guide the comparison of curtain wall samples to ensure the accuracy of façade appearance control.

Hierarchical is to ensure that the design work is carried out in a focused and orderly manner. According to the different material structure, the curtain wall system is disassembled layer by layer, and the curtain wall system is disassembled through the color separation diagram of the façade system. As shown in Figure 2, the headquarters building is divided into four main types, of which the T1 system and the T2 system are the most important standard façade systems. It accounts for about 70% of the entire curtain wall system, which has the greatest impact on the effect and cost control of the entire project.

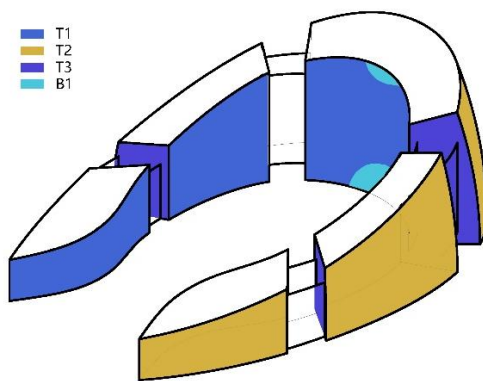


Figure 2. Color separation diagram

3. Technical Strategy

First, the system category is determined. Considering the convenience of construction and saving time, this project adopts a unit-type curtain wall. The T1 façade effect is horizontal and vertical, and the T2 façade effect is vertical and horizontal.

3.1 Scheme Selection

There are three used curtain wall schemes for curved curtain wall implementation: polyline fitting method, hot bending method and cold bending method. Folded line fitting, that is, flat glass is used to fit the curved glass curtain wall, and the curved surface is formed by folding. The appearance effect is not smooth, but the cost is low. In the hot bending method, the profile and panel need to be bent. The adjacent curtain wall panels transition naturally, and the appearance is smooth and beautiful. The glass is formed by hot bending through a custom mold at high temperatures, and the bending material is easy to rebound. The cold bending method, that is, the micro-warping forming method, is to twist the flat glass plate into the effect of a curved curtain wall by manual bending when installed on site. It can realize the appearance effect of smooth transition of the glass surface, but the warpage range between curtain wall plates should not be too large.

Since the T1 system of this project is a ribbon single-curved glass curtain wall, the height direction is only one unit high. The angle of the folded line is 175-182 degrees, and the range varies greatly, so the folded line of the glass curtain wall of the folded line unit is used. Drawing on Beijing Galaxy SOHO single-layer ribbon polyline unit is the practice of adopting a new plug-in structure. As shown in Figure 3, with the intersection of the glass surface as the center, the angle of the glass surface is adjusted by the insertion angle of the male and female frames of the unit, so as to meet the changing angle requirements and appearance quality requirements of the glass surface. This front end adopts the form of rack, combined with the method of inserting and breaking the angle of the male and female frames of the unit, to ensure that the back of the horizontal frame is flush with the back of the mullion. The width of the outdoor side seam of the unit is 10mm, and the indoor is 10~11mm (Figure 4).

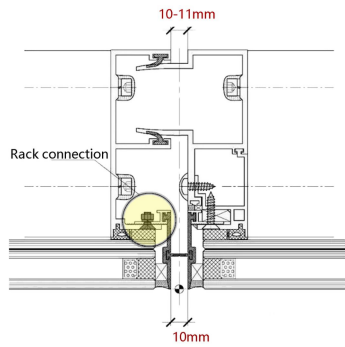


Figure 3. Cross-sectional element nodes

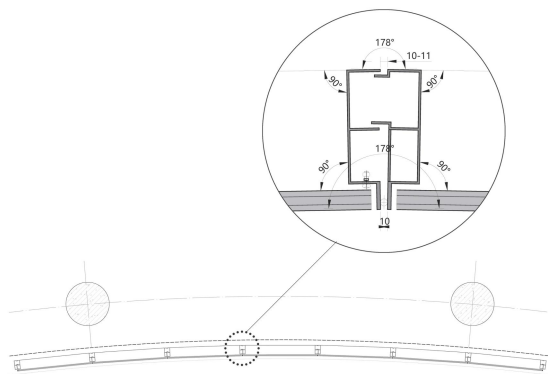


Figure 4. Concave polyline element

The optimization method of hyperboloid building skin model, under the premise of following the unchanged architectural effect, can be modified and analyzed layer by layer to simplify into a single curved surface. It is then processed into a regular polyline shape in a folded and curved manner. Three ways to implement curved curtain walls were mentioned earlier, due to the large variety of bending radii in this case, it is not suitable for the hot bending method. Although the cold bending method can achieve the appearance effect of hyperbolic building skin. However, in this case, the warpage range between the curtain wall plates is too large to be used. Considering the construction effect, economic benefits and quality safety, the legal derivative scheme of the broken line was adopted in this case.

The profiles and panels of the curtain wall of the curved staggered unit do not need to be bent, but are realized by special structural design. However, there are splits in the upper and lower plates or staggered seams in the left and right plates. Since the upper and lower floors of the original T2 system in this case were irregular

split-level, the upper and lower adjacent curtain wall unit plates could not be installed in docking. Split sink technology is required. The top cross member of the unit plate is split into the top cross material and the tank material, which are bolted together. The top cross material adapts to this layer, and the sink material adapts to the edge of the curtain wall of the next layer, and the position between them can be continuously adjusted. Due to the gradual upward adduction of the body in this case, the vertical epidermis mutation is large. Therefore, the epidermis is further corrected and simplified to a concentric surface, and the upper and lower layers are regularly misaligned. Which is achieved by adjusting the top and bottom beam shapes of the unit curtain wall (Figure 5). At the same time, an adjustable gradient compensation profile is designed in the column to solve the problem of left and right staggering. As shown in Figure 6, the groove between the layers is added vertically to divide the upper and lower body blocks to reduce the discontinuous effect of vertical staggering.

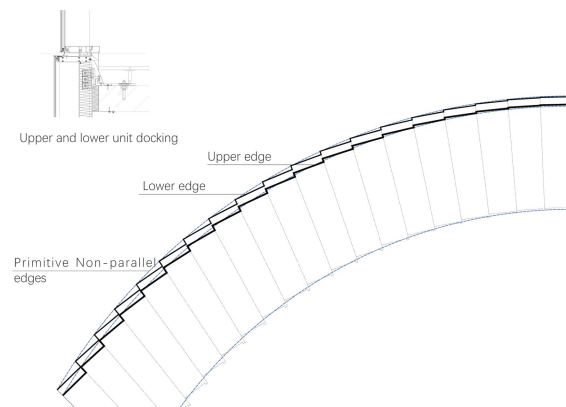


Figure 5. Edge correction

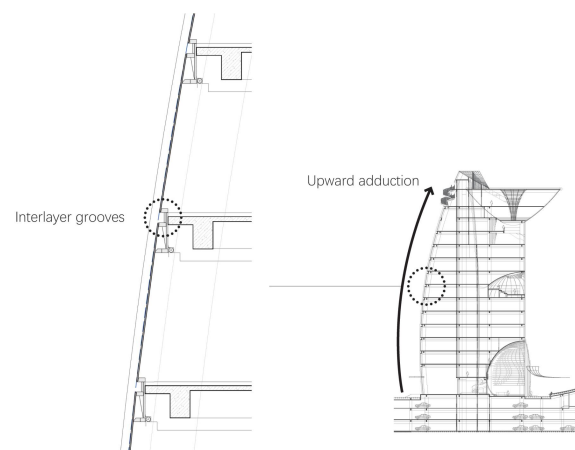


Figure 6. Vertical section

3.2 Refined Design

3.2.1 Material Selection

At present, the specification requirements for the size of domestic glass panels are 8 thick tempered glass, not more than 4.0 m², and 10 thick tempered glass is not more than 5.0 m². In order to save costs, try to use economical glass thickness. In this case, the glass control is 4 m², the thickness is 8 thick tempered laminated hollow double silver low-e glass, the parameter is 6+1.52PVB+6LOW-E (double silver) +12A+8. The span of the column network is 6.6~9.9m, and the floor height is 4.2m. The width of the curtain wall unit is considered to be consistent with the column network. The area of the glass plate is adjusted by adjusting the upper and lower positions of the spandrel and the skirting board.

In order to avoid the chimney effect of buildings that set up curtain walls in the event of a fire. When the automatic sprinkler system is set up indoors, the height of the solid wall or fireproof glass wall between the openings of the upper and lower floors should not be less than 0.8m, and each layer should be blocked with fireproof rock wool. The transverse keel of the T2 system is adjusted to a hidden type, and the end is clamped with a small member and pressed against the glass. As shown in Figure 7, such a flexible connection achieves a concealed fire protection effect. When glass is used between floors, in order to cover the structure inside the floor, a back plate is usually lined behind the glass. Because the calcium silicate board is low in cost, it needs to be colored in advance at the factory, and it is fragile and requires the installation process. In comprehensive comparison, the effect of fluorocarbon sprayed aluminum plate on the back of insulating glass is better than that of galvanized steel sheet on the back of single glass. The interlayer material of the T2 system in this case adopts a combination of tempered laminated hollow double silver low-e glass and fluorocarbon sprayed aluminum plate backing plate. The upper part of the backing plate is tilted out at a certain angle to form a three-dimensional shadow box, and the relationship between light and shadow is used to generate depth, so that the interlayer glass effect is close to the unity with the upper and lower units.

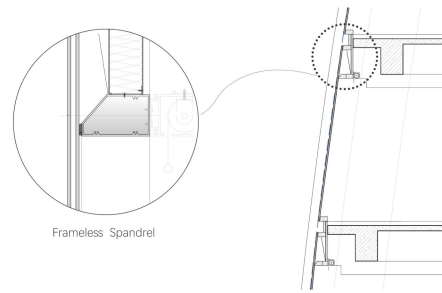


Figure 7. Flexible sealing spandrel

3.2.2 Ventilation Window Hidden

In the post-epidemic era, the natural ventilation of buildings has received more attention. Architects have adopted metal ventilators in order to pursue the visual effect and minimalist design style of the building's façade. It has little impact on indoor space and appearance, but the cost is high. In this case, the T1 system strengthens the sense of horizontal lines. An electric upper hanging outer window is set in the groove between the floors. The sun visor is located under the ventilation window, which can shield the ventilation window to a certain extent. Through indoor angle simulation, neither ventilation nor shading affect the indoor view (Figure 8). The T2 system adopts the grooved window on the side of the façade bay window. As shown in Figure 9, the opening fan is designed as an aluminum plate fan with a width of 300mm and rock wool insulation. The method of opening and inverting is adopted to reduce the impact on indoor use. Fresh air enters from the side walls of the profile with recessed openings, creating an effective ventilation path.

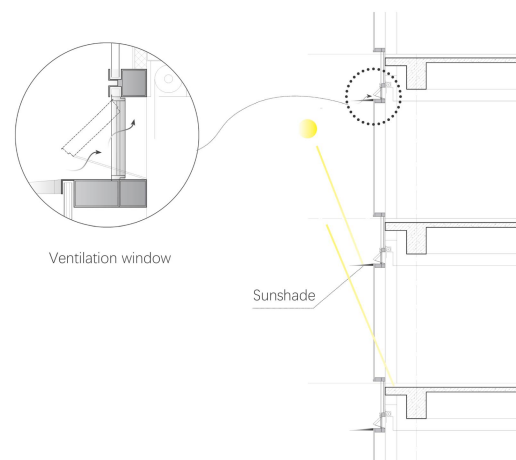


Figure 8. T1 system window section

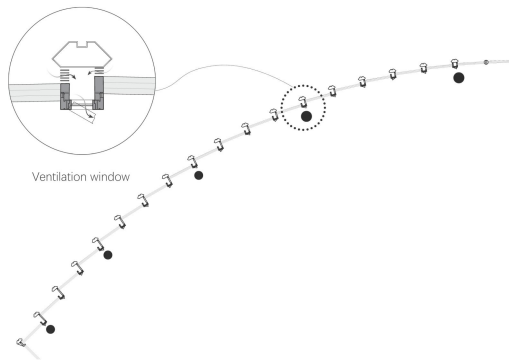


Figure 9. T2 system window detail

3.2.3 Corner Curtain Wall Detailing

Instead of using two 45° miter cut members, the corner shaft uses a small square shaft as a unit module. Although the transportation cost is high, the on-site installation error is small, and the look and feel is more upright. The window frame above the glass is completely embedded in the interior of the metal plate, revealing only part of the glass. The lower window frame is not hidden inside, otherwise the surface water is easy to flow in through the gap between the glass and the window frame, resulting in aging and leakage of glass glue. This achieves a semi-hidden box effect.

3.3 All-In-One Design

3.3.1 Integrated Design of Curtain Wall and Night Scene Lighting

The goal of night lighting emphasizes the intention of the building façade. The need to focus on the relationship between light and curtain wall, installation method, how to repair and hide, lighting uniformity and indoor glare.

The façade of the T1 system is characterized by enhanced horizontal lines. As shown in Figure 10, the lighting design is combined with the sun visor, which is washed from the inside to the outside. The grooves between the floors are washed to present a soft architectural night effect. Easy access by opening the top plate.

The façade of the T2 system features enhanced vertical line texture. The floodlighting scheme was to highlight the chiaroscuro of the building façade by installing light strips at the notches of the vertical profiles of the curtain wall and the grooves between the floors (Figure 11).

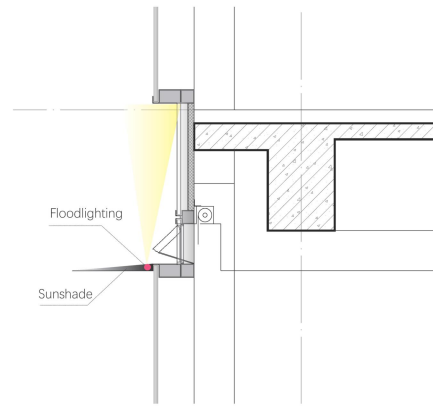


Figure 10. T1 system light position

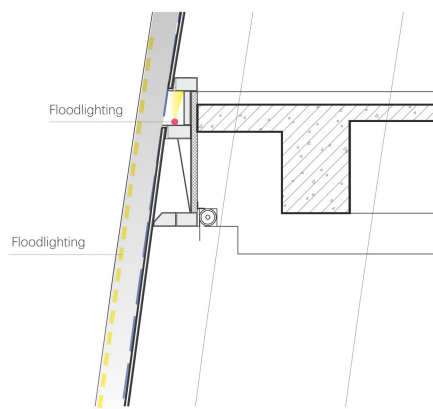


Figure 11. T2 system light position

3.3.2 Integrated Design of Curtain Wall and Landscape

In addition to considering the integration of the color and modulus of the paving and façade curtain wall, the handover of the façade and the landscape of the first floor also needs to deal with the handover of the keel of the curtain wall and the landscape. If hard paving is used, the bottom height of 150mm façade is retreated inward, forming grooves to weaken the sense of grounding and present a suspension effect. The bottom is made of metal for a more refined look. There will be conspicuous kicks indoors, which can be combined with the integrated design of the air conditioning outlet; Or the aluminum plate wrapped in the ground keel is concave to reserve space. Then cover the metal edge of the curtain wall through the hard paving of the landscape. Avoid handover construction defects caused by exposed metal edges. In this case, the outdoor design of mirrored pool and façade handover is adopted. As shown in Figure 12, 15mm drop plate space is reserved on the inside

and outside of the glass curtain wall to pave the pebbles to connect with the pool. The window frame under the curtain wall is completely embedded in the cobblestones, exposing only the glass part. The treatment of the bottom closure realizes the level inside and outside, extending the indoor and outdoor landscape experience.

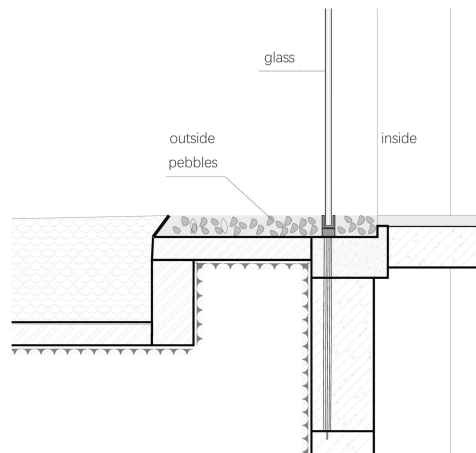


Figure 12. The first floor detailed

4. Conclusion

The fine design of curved glass curtain wall involves all specialties, and the problems faced are detailed and complex. The appearance of the pure and clean glass curtain wall is inseparable from the designer's detailed and detailed design. The most important thing is to have a systematic idea from the design selection, cost control and construction details.

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