

# The influence of the application of glass curtain walls on architectural style and architectural facade design techniques

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**Abstract.** In recent years, with the increasingly rapid development of the glass curtain wall and its gradually mature use in architecture, many designers choose to use glass curtain walls when designing buildings in order to get the desired building facade effect. As a result, there are many new architectural styles and building facade effects. Against this background, this paper discusses how glass curtain wall is applied in architecture and how it helps and influences architectural design styles and techniques. To conclude, the glass curtain wall has been widely used in the design of high-rise buildings and public buildings at this stage, and it also helps designers to more conveniently adjust the virtual-real relationship of building facades and the overall architectural style. The use of large-area glass curtain walls in the design of facades can achieve special effects that cannot be replaced by other materials. At the same time, the application of glass facades also promotes the process of architectural design modernization.

**Keywords:** Glass curtain wall, Building facade, Virtual-real relationship, Architectural design.

## 1. Introduction

Glass curtain walls were born at the end of the 19th century and have been more widely developed and applied in modern times. The use of glass curtain walls has a certain influence on architectural design techniques. Designers often use many techniques to enrich the effect of building facades when designing buildings. In order to get the desired effect, the designer can adjust the visual virtual-real relationship of the building by changing the structure of the building, opening windows, or using new materials, and the glass curtain wall, as one of the most commonly used materials in modern times, also brings more choices for designers when designing buildings. This article introduces the birth, application history, and advantages of glass curtain walls and explores their influence on modern architectural design styles and techniques, so as to explain the role of glass curtain walls in modern architecture. Glass curtain walls provide designers with great help in modern architectural design. At the same time, their application in modern architecture also gives birth to a lot of new buildings. By explaining the role of glass curtain walls in detail, this paper aims to help designers better use glass curtain walls in architectural design.

## 2. The birth, application, and advantages of glass curtain walls

A glass curtain wall usually refers to the main body of mirror glass, the frame of aluminum alloy material or other materials of the enclosure wall, usually set outside of high-rise or super high-rise buildings. Glass curtain walls can be divided into single glass walls and double glass walls according to the number

of layers. Due to the addition of iron, nickel, or other elements in the glass, the glass curtain wall can absorb infrared or ultraviolet light, so that the temperature and radiation value inside the building are reduced [1].

Born in the firmament of the Industrial Revolution and as the offspring of Paxton's shimmering glass sheath, the curtain wall is one of the best examples of modern architecture's quests for the incredible lightness of buildings. Over architecture's long history, buildings have become progressively less earth-bound, and their enclosures are more sheer and ethereal [2].

The application of building curtain walls began at the end of the 19th century, and they were only used on a small scale in the early days. In 1851, the "Crystal Palace" built for the Industrial Exhibition in London was the earliest primary building curtain wall. By the 1950s, with the development of building technology, glass curtain walls began to be applied to the building envelope on a large scale, announcing the arrival of the era of building curtain walls; In the 1980s, with the development of construction technology and the progress of glass production technology and processing technology, glass curtain walls have been more widely used [3].

Similar to the application of the curtain, the so-called "curtain wall" is the packaging and protection of the external wall of the building, and the materials used by curtain walls are lightweight and convenient. By utilizing the great light transmission of glass, glass curtain walls can reduce the building's indoor lighting energy consumption; in winter, by utilizing solar radiation, the building can obtain heat energy, so as to reduce heating energy consumption [4]. In the process of designing a building, the use of curtain walls is not only energy-saving and environmentally friendly but also plays a beautifying role. Specifically, glass curtain walls are light and pressure-resistant. They are especially useful in the construction of high-rise buildings, replacing the material that is too heavy to use. This fully reflects the importance of glass curtain walls since they provide good conditions for the construction of high-rise buildings.

For safety, the curtain wall has the advantage of insulating the building from wind, rain, pressure, lightning, heat, and noise. It has a high level of thermal insulation which can effectively slow down heat loss, while in summer, it can also reduce sunlight radiation as well as the temperature of the house, making people more comfortable in the physical sense.

In summary, glass curtain walls not only have the benefit of environmental protection but also carry the effect of beautification, which meets the requirements of people for beauty and makes the city more modern and stylish from the overall effect with a more rapid development pace [5].

### **3. The influence of glass curtain walls on modern architectural design styles**

Glass curtain walls have been widely used in building envelopes due to their aesthetic and utility, especially in high-rise buildings. In order to meet the aesthetic needs and functional requirements of daylighting, a single glass panel with an area exceeding the safety size limit of 8 m is used more and more widely in modern high-rise building construction, such as Hong Kong Taikoo Place and the Beijing Taikang Center [6].

The influence of glass curtain walls on modern architecture is mainly reflected in high-rise buildings and public buildings, the most intuitive manifestation of which is the change in the design style of these buildings. Different from private houses, public buildings tend to display internal functions rather than protecting internal privacy. Therefore, under the premise of satisfying structural safety, most designers of public buildings hope to show the building to the outside world, so public buildings are more inclined to use glass curtain walls at present.

As mentioned before, the most obvious part of the influence of glass curtain walls on the architectural style is reflected in high-rise buildings and public buildings. Glass is a material with strong permeability, and glass curtain walls have a higher degree of performance to the outside world compared with ordinary glass. Due to the strong permeability brought by large areas of glass, the protection of privacy of buildings is delicate, and people will feel exposed to the outside world when they are in the building. In other words, buildings with a large area of glass curtain walls are not suitable for residential use. However, public buildings have no such concerns, and they carry the purpose of showing themselves to

the outside world. At the same time, the architectural style of facade design is formed by the interactive arrangement of geometric blocks and large-scale glass curtain walls. Since the design of facades with glass curtain walls can achieve a simple style, which is in line with the design style of modern buildings, the application of glass curtain walls in modern public buildings is very common.

Besides, the new characteristic glass is a new type of glass curtain wall material, and this type of curtain wall structural material is mainly suitable for the curtain wall installation project of high-rise buildings [7], because the self-weight and the overall structure of the glass curtain wall is smaller and lighter, it is helpful in the construction of high-rise buildings, enabling the building to be built taller. Moreover, high-rise buildings are generally built on the key nodes of traffic, such as intersections and commercial centers. Since the wall belongs to the physical part in the virtual-real relationship, and a large volume of objects near a place with a large flow of people will give people a feeling of depression, too many high-rise buildings can increase the psychological pressure of people passing by. However, a large area of glass curtain walls can greatly weaken this feeling of oppression by enhancing the permeability of the building. At the same time, the reflection of glass curtain walls between various buildings in the city can make the facade landscape of the building more integrated with the surroundings and enhance the unity of the building and the city. Usually, it is a must for architects to consider the surrounding buildings when designing a building. Due to the glass curtain wall's helpful role in architectural design as summarized above, buildings using glass curtain walls appear continuously in the city.

#### **4. The influence of glass curtain walls on architectural design techniques**

The appearance of glass curtain walls as a building material has a great influence on the style and design techniques of buildings. In architectural design, sometimes, the facade of a building is too plain and lacks a sense of design. At this time, architects usually use some design techniques to make the facade have a richer effect. Most of the design techniques are essentially to adjust the relationship between the virtual and real facade of the building, and designers often use some combination of virtual and real techniques to enrich the facade effect. What is more, the virtual and real relationship of the building facade can be adjusted by using some special materials, and the glass curtain wall is such a material.

Compared with the design of traditional glass on the building facade, the most intuitive difference of a glass curtain wall lies in the volume of glass. As the coverage area of ordinary glass surfaces is limited, the use of traditional glass will definitely cut the whole wall. Therefore, when an architect intends to make the facade more integrated, she or he can only sacrifice certain facade effects due to the limitation of the traditional glass design. However, it is not that ordinary glass can not achieve good facade effects, it is because of the single building materials in the past and similarities in building needs. As a result, most of the facade effects of the building are the same, but the appearance of the glass curtain walls enables the whole facade to be unified and coordinated into a plane so that the facade of the building cannot be divided. Meanwhile, the building can create different visual effects while meeting its basic use needs, providing a new choice for the facade design and also giving designers more space to play. Because of this choice, the design of the building facade becomes more flexible.

Compared with traditional glass, the clever design of glass curtain walls not only lies in the modern sense of its material and more convenient application but also in the difference between the formation modes of the facade composed of glass curtain walls and that of traditional glass. The facade of the building composed of traditional glass is formed by the shape of the outside of the building and the shape of the opening window itself. In such a design, there is a large separation between the exterior facade and the interior of the building, and the effect of the exterior facade has no great relationship with the interior. At the same time, in order to achieve the expected effect, the exterior sometimes uses many decorative components to cover the exterior facade. However, on the other hand, modern architecture often pursues a simple style, and the way of using redundant components is inconsistent with modern design concepts. At the same time, in order to protect the environment, the use of building materials should be minimized to avoid waste and pollution of the environment. When the glass curtain wall is used to design the facade, one can feel the advantages of the all-glass curtain wall facade. Because of its

good permeability, the glass curtain wall increases the connection between the inside and the outside so that the internal space of the building becomes a part of the facade of the building, especially in the design of shopping malls, gyms, libraries, and other public buildings, through the use of large-area glass curtain wall. While achieving the effect of a traditional glass facade, the functions inside the building can be shown to the outside world. When people look at the building from the outside, they can observe the interior design through the space cut by the glass curtain wall, so that the interior and exterior design of the building together form the facade of the building, which enriches the effect of the facade of the building. By showing the internal space to the outside world in public buildings, people can complete the interpretation of the internal space, so that they have a deeper impression of the building. Meanwhile, such a facade can narrow the distance between people and the building, reducing the cold feeling and the feeling of isolation brought by the glass material, because the glass curtain wall has a good permeability. When the interior design is conveyed to the outside world through the glass curtain wall, people's inner rejection can be reduced. At the same time, such a facade at night, when the lights inside the building are turned on, will bring different facade effects and even provide lighting effects for the surrounding area. Through such visual permeability design, it can bring a new facade effect.

Visual transparent design is divided into transparent design, translucent design, and hollow design. Transparent design adopts glass curtain walls, floor-to-ceiling windows, and other design schemes to enhance the transparency of the building and make users feel the derivative of the space visually. Translucent design mainly uses translucent glass, drapery curtains, etc. This kind of design not only carries the visual sense of invisibility, but also the sense of architectural space layer and haziness. The design can realize the space separation through different colors, styles, and materials, but the separation is not complete since the mobility of the space is maintained while keeping the isolation space, so that the space penetrates and communicates with each other, further enhancing the sense of hierarchy and permeability of the space. Hollow design is a decorative art technique, which mainly uses different types of hollow carving texture, so that the space produces light, flexible, transparent visual effect and space effect. It is mainly used in corridors, doors, windows, and other buildings to further enhance the sense of spatial hierarchy and cultural connotation of architectural design [8]. Because the glass itself has strong permeability, the layout of the architectural structure inside the building should be paid special attention to in the design, so as not to destroy the integrity of the building due to the chaotic structure of the regular glass facade.

## 5. Conclusion

As one of the most commonly used materials in modern architecture, glass curtain walls have exerted a great influence on architectural design since its birth, and buildings dominated by glass curtain walls, such as the Crystal Palace in London, have been successively constructed. Until today, glass curtain walls have been widely used in modern architectural design. They can help architects more conveniently change the relationship between virtual and real in the building facade, and thus give birth to new architectural styles and techniques. The glass curtain wall itself has good permeability and the feature of modern materials. The use of glass curtain walls can bring good results when designing public buildings or open and non-private spaces of buildings, solving the problem of a lack of connection between the internal space of traditional windows and wall buildings and the outside world. At the same time, the designer can also get the ideal facade effect more easily through the combination of window walls and glass curtain walls. Glass curtain walls can help designers carry out better transparent designs. Through the permeability effect of glass curtain walls, the interior of the building is taken as a part of the facade of the building, which can better show the interior of the building to the outside world. Meanwhile, designers can also design the facade with glass curtain walls to make the building more modern and reduce the energy consumption of the building. This meets the requirements of modern design in both appearance and use. In short, a reasonable use of glass curtain walls can provide great help to the design of building facades.

## References

- [1] Lei, J. (2023). Key points and precautions of glass curtain wall construction technology. *Engineering Technology Research*, 8(09), 56-58 (in Chinese). doi:10.19537/j.cnki.2096-2789.2023.09.018.
- [2] (2005). The art and craft of Cesar Pelli's curtain walls. In *Curtain Walls: Recent Developments by Cesar Pelli & Associates* (pp. 18-27). Berlin, Boston: Birkhäuser. doi:10.1515/9783764376543.18
- [3] Huang, X. K., Zhao, X. A., Liu, J. J. and Liu, G. (2013). Thirty years' of development of China's building curtain walls. *Building Science*, 29(11), 80-88 (in Chinese). doi:10.13614/j.cnki.11-1962/tu.2013.11.011.
- [4] Zhang, G. S., Cai, Z. L., Chen, Z. R., Bai, Z. K. and Kang, J. S. (2022). Optimization of Energy Saving Measures for Glass Curtain Wall of Super High Rise Buildings in Guangdong. *Science Discovery*, 10(4), 232-241. doi:10.11648/j.sd.20221004.15.
- [5] Kang, L. (2023). A study on the design and construction technology of glass curtain walls of high-rise building. *Journal of Ceramics*, (08), 19-21 (in Chinese). doi:10.19397/j.cnki.ceramics.2023.08.005.
- [6] Chen, B., Jiang, L., Zhang, L., Yue, W., Yang, H. and Yu, H. (2023). Wind Resistance Performance of Large-Scale Glass Curtain Walls Supported by a High-Rise Building. *Buildings*, 13, 636. doi:10.3390/buildings13030636.
- [7] Lu, D. Q. (2022). Building green energy-saving curtain wall and dynamic energy-saving curtain wall technology. *Geshe*, (35), 44-46 (in Chinese).
- [8] Zhang, Y. F. (2023). The Application of Transparent Design in Architectural Design. *Housing and Real Estate*, (23), 74-76 (in Chinese).