

Study on Design and Planning of Modeling Facade of Urban High-rise Buildings

GuiLing Zhu *, XiaoKai Zhao, LinYa Li, JiaNan Wang, ZeLong Cheng

ZhongYeDi Construction Group (Sanhe) Architecture Design Consult Co., Ltd, Hebei Province, China, 065201

* Corresponding Author Email: 15030684559@163.com

Abstract. At present, when the government agencies in many cities approve the application for the construction of high-rise buildings, they must first evaluate the wind comfort and wind safety of high-rise buildings, and only when sufficient comfort and safety are proved will they be approved. The modeling of high-rise buildings is often not a single simple collection, but a complex body or group composed of multiple volumes. Whether its final modeling can become a harmonious and unified organic whole is the basis of forming the modeling order and aesthetic feeling of high-rise buildings. The interface between high-rise buildings and external space is facade, which plays an irreplaceable role in shaping architectural personality and creating environment, and is also closely related to the establishment of city image. Based on this, this paper analyzes the main points of the design and planning of urban high-rise building facade from the design and planning principles of urban high-rise building facade. Then according to the facade detail design, ecological design, facade decoration component design, improve the artistry and functionality of high-rise buildings.

Keywords: High-rise Buildings; facade design; modeling.

1. Introduction

The progress of architectural design technology makes the facade design more complicated and diversified, one of which is to install a large number of decorative components on the facade and roof, such as balconies, sun visors, parapets, handrails and shutters. The facade design of high-rise buildings is to further beautify the architectural space modeling on the basis of meeting the requirements of function and structural structure, and to explore the role of architectural style and composition on the image, materials and technology of the facade of high-rise buildings and its relationship with the aesthetics, form and context of buildings [1]. At present, when the government agencies in many cities approve the application for the construction of high-rise buildings, they must first evaluate the wind comfort and wind safety of high-rise buildings, and only when sufficient comfort and safety are proved will they be approved. Based on the principle of facade design, this paper analyzes the main points of facade design planning of urban high-rise buildings, so as to improve the artistry and functionality of high-rise buildings.

2. The meaning of building facade

Facade means the front or face of a house. The facade of a building refers to the direct contact interface between the building and the external space of the building, its image and composition, or the components at the interface between the internal and external space of the building and their combination (Figure 1). Today, in order to define the facade of a building, people use words such as "skin", "curtain wall" or "exterior wall" to describe it, which are actually a way of expression [2]. Although different words are used, these words are all used to express this architectural term that can be varied in architecture.



Figure 1. Building façade.

As an important part of the building, the facade of the building has its specific functions. It should be the most basic function of the building facade to protect the building from wind and rain. Secondly, ventilation, lighting, sound insulation, thermal insulation and internal and external communication are also important functions of the building facade [3-4]. Because of the high height of high-rise building, the environmental factors it faces are more restrictive, and its facade needs to add more technical elements, which are either exposed on the external surface of the building or hidden behind the transparent glass curtain wall, thus causing the difference between the facade of high-rise building and the latter.

3. Planning and design principles of modeling facade design of urban high-rise buildings

3.1. Principle of consistency

With the development of modern architecture and modern art, architects' theoretical understanding of plastic arts has gradually formed a process based on visual psychology, starting with the analysis of morphological elements, and studying the creation laws and means of abstract forms through the combination of geometric forms of plane and space [5]. Housing occupies a dominant position in the city, and it has been repeatedly emphasized before. It will be extremely sad to imagine that a large number of high-rise houses in the city are unique in style, integrated with each other, or have nothing to do with the surrounding public buildings, or even destroy the landscape of the original city. Therefore, the most important thing in the design of high-rise residential facade is to maintain the principle of unity and consistency with the urban environment and surrounding buildings.

3.2. Humanization principle

Although the technique of symbol collage originates from traditional and historical components and forms, it is not bound by historical and traditional design principles, composition principles and connection methods, but changes and regroups according to specific context, new form composition and aesthetic needs. Humanized architectural design is the architectural design and creation under the principle of "people-oriented" [6-7]. Architects should pay attention to follow the principle of humanization in design and construction, and at the same time, integrate environmental sociology, environmental psychology and social ecology to improve the boring, monotonous, alienated and other

adverse effects in high-rise buildings and their environment, so as to create a space environment that conforms to scientific humanism.

3.3. Aesthetic principle

The modeling of high-rise buildings is often not a single simple collection, but a complex body or group composed of multiple volumes. Whether its final modeling can become a harmonious and unified organic whole is the basis for forming the modeling order and aesthetic feeling of high-rise buildings [8]. High-rise buildings, because of their large size, have a problem of distance between near and far. Express as much meaning as possible with as few architectural elements as possible from the modeling; From the structural logic, the main plane should be simple, regular and symmetrical, the vertical direction should be regular and concise, but not particularly prominent, and the ratio of length, width, height and thickness should meet the requirements of the specification index, and the above factors should be combined to form a complete high-rise modeling.

4. Design and planning of modeling facade of urban high-rise buildings

4.1. Facade detail design

The square shape of high-rise building is an unbiased, stable and static shape, and the square relationship will make the doors, windows, floors and roofs in high-rise buildings easier to apply and build. Choosing a plane square as a geometric shape in the modeling of high-rise buildings has the characteristics of low cost and convenient structural construction, and has a modern, simple and atmospheric image. The architectural polygon has a lot of deformation and development, which can highlight the sense of straightness of the architectural plane, and its display function is stronger than that of the square body, and the polygon body is a kind of dynamic and static architectural body. High-rise building modeling can use the local deformation method to construct a unique image, and the morphological variation is easy to appear an organic form similar to natural formation, which has a simple and simple visual effect and can show a sense of growth.

In addition to considering the functional requirements, the facade composition of high-rise buildings should mainly create a coordinated overall effect, which can be achieved through better proportional relationship, vertical and horizontal division of collocation organization, material, color and decorative elements [9]. At present, the diversity in the design of high-rise buildings reflects that the pursuit of more expressive buildings requires a variety of ways. This feature is not so much that there should be a variety of styles, but rather that the same goal should be achieved through a variety of ways. The composition of facade design must be clear about horizontal and vertical factors. Generally, the proportion of each element should be matched with the overall relationship to achieve a pleasant look and feel effect. The slender factors of high-rise buildings are more conducive to the integration of micro and giant factors, so that large and medium-sized have small, small and medium-sized have large.

Windows are the key part of high-rise building modeling and facade design. In the design, we should first consider the functions of windows in ventilation, lighting, sealing and sound insulation, and then design the color, appearance and size of windows, which need to be coordinated with the structural characteristics of the whole building, and at the same time, consider the surrounding environment, arrange and combine reasonably, and meet the requirements of functionality and aesthetics. The type of entrance and bottom of a building affects the overall shape of a high-rise building. Therefore, attention should be paid to the modeling and elevation detail design of high-rise buildings. Balcony plays a connecting role in the indoor and outdoor environment of buildings. Scientific and reasonable design can effectively promote the natural integration of indoor and outdoor environment, make high-rise buildings no longer a "closed" space, expand the spatial environment, create a harmonious atmosphere, and highlight the ecological characteristics of high-rise building modeling and facade detail design.

4.2. Ecological design

With the continuous acceleration of urbanization, human beings are facing many survival dilemmas: energy shortage and waste of resources, environmental pollution, population expansion and so on. High-rise building is a product of coping with urban economic and social challenges by technical means, and its construction in China will become an inevitable trend.

Building sunshade is a building technical measure to prevent direct sunlight from entering the room, reduce solar thermal radiation, avoid indoor overheating or glare, and protect indoor objects from sunlight. The external walls of contemporary high-rise buildings are usually glass curtain walls. Shading can disperse the reflected light of glass in the glass curtain walls and avoid light pollution caused by large-area glass reflection. Building sunshade is both functional and artistic. Good building sunshade design is not only helpful for energy saving, but also a key composition requirement that affects the building's external standing and modeling. Therefore, in the shading design of the facade of high-rise buildings, we can combine the shading method with architectural modeling to create excellent works that conform to the spirit of the times, reflect functional requirements and demonstrate architectural technology.

High-rise buildings are of great significance for coping with and solving social and urban environmental problems, and the design of environmentally friendly sustainable buildings often depends on the facade of the building. Therefore, architects should pay attention to the ecological design of the facade of high-rise buildings. The hanging garden of high-rise buildings usually refers to the terrace formed by the concession of the building plane, and in most cases it is several floors high. Its working principle is to use the open space of the courtyard and the landscape treatment of the courtyard to realize indoor and outdoor energy exchange, such as improving indoor natural lighting, natural ventilation and shading (Figure 2).

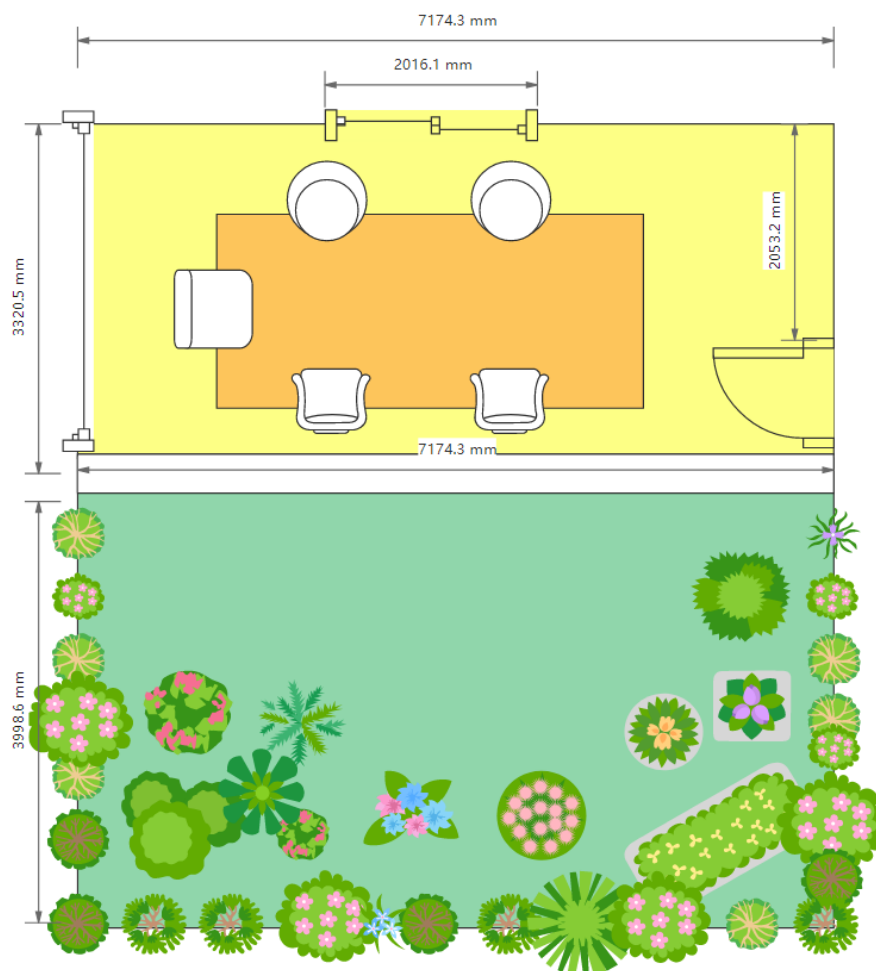


Figure 2. Balcony garden design.

The development of contemporary high-rise buildings presents new trends such as ecologicalization and intellectualization. Because the sustainable design of environment-friendly buildings often depends on the facade of buildings, the ecologicalization and sustainable design of facade of high-rise buildings plays a positive role in reducing building energy consumption, improving indoor space environment and enriching the visual form of facade of buildings.

4.3. Facade decoration component design

At present, the research on high-rise buildings is mostly concentrated in small areas with high wind speed, such as corners near buildings. For a group of buildings, a row of buildings or passages between buildings, most of the research focuses on avoiding high wind speed areas, while ignoring the impact of low wind speed. A far-sighted commercial building can think of the aesthetic needs of urban residents in its design, and can imagine that the building should be used by the public rather than by business people. This foresight belongs to the progressive era. From the point of view of expressing structure, the facade design that can be seen directly at a glance is beneficial for people to understand its structure at first sight, so the exposure of skeleton attracts great interest. On the contrary, the curtain wall completely covers the skeleton from the outside, making it hidden or even completely buried.

Considering that there are a lot of disturbing buildings around commercial buildings, the wind load of small facade components will be more complicated. If the structure of small components is flexible, it may lead to wind-induced vibration and wind-induced noise problems. How to determine the design wind load of small components in building facade is an urgent engineering and technical problem. Because the size of external small components is too small relative to the whole building, and the wind flow fields of small components in different positions are different, it is difficult to directly measure the design wind load of such small components through conventional wind tunnel tests. The wind load near the corner of the building edge is larger, and it is suggested that the wind load of the small facade components in the corresponding area should be approximately estimated based on the local wind pressure coefficients of the corner and non-corner areas of conventional low-rise buildings, and it is emphasized that the maximum negative pressure should be calculated by the reference wind pressure at the top of the building. For the building curtain wall with complex external profiles, louvers and other horizontal or vertical shading systems, it should be determined by segment model test. It should be emphasized that vertical louvers will be affected by the interference of surrounding louvers, but the code does not give the influence of louver interference on louver wind load.

Considering that the determination of wind load of facade decoration components depends on many parameters, namely, building facade and plane form, ground roughness category, surrounding interference buildings, louver shape and support system, louver position on facade, and facade details, etc. [10]. Pressure measuring points are set on the facade of curtain wall, and pressure measuring points and strain gauges are set on both sides of typical sun visor to measure the wind load of the whole sun visor, which is used to guide the wind-resistant design of components between sun visor and curtain wall. In the actual design, the correlation of different positions of the sun visor should be considered, and it is suggested that the diagonal length should be used as the evaluation index of load reduction.

5. Conclusions

The facade design of high-rise building is to further beautify the architectural space modeling on the basis of meeting the requirements of function and structural structure, and to explore the role of architectural style and composition on the image, materials and technology of the facade of high-rise building and its relationship with the aesthetics, form and context of the building. As a material component of the building, the facade of the building has its specific functions. It should be the most basic function of the building facade to protect the building from wind and rain. Secondly, ventilation, lighting, sound insulation, thermal insulation and internal and external communication are also

important functions of the building facade. Residential building facade occupies an important position in architectural culture, and it is also an indispensable element of city image. On the basis that the building meets the basic functions, we must pay more attention to the facade design of the building, so as to promote the overall taste of the building in a real sense.

References

- [1] Luxi, Li Yang, & Chen Lei. (2022). Micro-modeling thinking of high-rise building facade design. *Architectural Science* (002), 038.
- [2] Zhang Zhengwei. (2019). Discussion on design wind load of facade decorative components of high-rise buildings. *Building Structure*, 49(22), 7.
- [3] Yi Cai Xue. (2020). Aesthetic research on the facade design of modern high-rise residential buildings. *Architectural Structure*, 50(9), 2.
- [4] Tang Hua, Wang Songfan. (2012). Wind load research and wind-resistant design of high-rise buildings based on wind tunnel test. *Journal of Building Science and Engineering*, 29(2), 96-101.
- [5] Yang Congwu, Feng Ming, Cao Zhidan, & Tan Yongmei. (2012). Structural design of an irregular high-rise building. *Architectural structure* (012), 042.
- [6] Wang Ming, Tian Sanchuan, Wang Lishang, Xu Hui. (2012). Construction technology of sail-shaped steel structure of super high-rise building in al hikma, United Arab Emirates.
- [7] Jin Wei, Liu Bing. (2022). Key Technology of High-rise Building Design with Inclined Facade with Offset Core Tube. *Building Structure*, 52(01), 23-29.
- [8] Wang Juan (2020). Ecological Design of High-rise Buildings. *Architectural Structure*, 50(17), 1.
- [9] Hu Daohang (2022). Structural design and analysis of a particularly irregular high-rise building. *Architectural Structure*, 52(23), 8.
- [10] Yan Zhiwei, Quan Yong, Tu Nankun, Gu Ming, & Feng Yuan. (2015). Study on the influence of external grid structure on the wind load of high-rise building facade envelope. *Building structure* (2), 5.