

EFFICIENT CONSTRUCTION TECHNOLOGY AND APPLICATION OF INWARD-TILTING INCLINED CURTAIN WALLS

Bo Li^{1,2}, XiaoXia Zhao^{1,2*}, DaJian Xiong^{1,2}, XiaoXiao Jiang^{1,2}, LuLu Chen^{1,2}

¹China Construction Fourth Engineering Bureau Co., Ltd., Guangzhou 510000, Guangdong, China.

²China Construction Fourth Bureau Construction Investment Co., Ltd., Shanghai 200000, China.

*Corresponding Author: XiaoXia Zhao

Abstract: With the continuous evolution of glass curtain wall forms, architects' aesthetic standards and imagination have undergone a qualitative leap, leading to the design of numerous new shapes—such as twisted-surface curtain walls, spherical curtain walls, and inclined curtain walls—that differ from traditional vertical glass curtain walls, thereby enriching the visual diversity of curtain walls in urban construction. Among these, inward-tilting inclined curtain walls have become a relatively common novel curtain wall form. However, when conventional suspended access platforms (suspended cradles) are used for the construction of inward-tilting inclined curtain walls, several problems arise: the platform must be erected and dismantled at every floor level, resulting in low construction efficiency; and upon completion of daily work, the platform cannot be lowered to the ground, posing significant safety hazards. To address these issues, this paper proposes an efficient construction method using a specialized suspended platform designed for inward-tilting inclined curtain walls. The technical principle and process flow of this method, along with its application effects in a renovation project in Zhejiang Province, are described. The research results indicate that the proposed method significantly improves the installation efficiency of inward-tilting inclined curtain walls, reduces construction safety risks, and effectively solves the problem of the suspended platform being unable to land after work, demonstrating promising application prospects and dissemination value.

Keywords: Inward-tilting inclined curtain wall; Specialized suspended platform; Efficient construction

1 INTRODUCTION

Driven by the upgrading of architectural aesthetics and policies promoting prefabricated buildings, free-form curved surfaces and inward-inclining setback buildings have become the mainstream design forms for urban landmark structures. An inward-tilting inclined curtain wall refers to an enclosing structure in which the curtain wall façade forms an inward-inclining angle with the vertical plane; the common inclination angle ranges from 5° to 65°. Such curtain walls are mainly applied in scenarios such as inward-inclining lighting surfaces in building atriums, storey-by-storey setback exterior façades of high-rise buildings, sunken public venues, and earth-sheltered buildings [1-2].

Compared with traditional vertical curtain walls, the inward-set architectural form shaped by inward-tilting curtain walls can greatly enhance the three-dimensional perception and modern sense of the building as a whole. However, the special inclined structure makes its construction process more complex [3-5]. Conventional construction methods—such as outdoor hoisting of curtain wall components and the use of full-scope scaffolding—are restricted by factors including limited indoor space due to the inward-inclining structure, absence of external working platforms, and inward sliding of panels. These constraints readily lead to quality problems such as installation accuracy deviations, glass breakage, rainwater leakage, and structural stress deformation; moreover, they result in long construction periods, high labor costs, and prominent safety hazards [6-9].

To solve the above engineering pain points, the industry is gradually phasing out traditional extensive construction methods and promoting efficient construction technologies such as standardized construction and inclined suspended platforms, which largely adapt to the special construction conditions of inward-tilting inclined curtain walls. Therefore, conducting research on the efficient construction technology for inward-tilting inclined curtain walls holds significant engineering practical value.

2 PROJECT OVERVIEW

The curtain wall engineering of a renovation project in Zhejiang Province has a total area of approximately 30000 m². The curtain wall system comprises vertical-exposed-and-horizontal-hidden glass curtain walls, aluminum panel curtain walls, and aluminum canopies. The glass curtain walls adopt ultra-clear Low-E tempered insulating/laminated glass panels, coupled with HJY series transoms and HJM series mullions (some mullions are internally lined with hot-dip galvanized steel tubes), thereby balancing daylighting, energy efficiency, and safety performance. Both the aluminum panel curtain walls and canopy panels utilize 2.5 mm thick single-layer aluminum sheets, while the supporting members employ hot-dip galvanized angle steels and steel tubes/square tubes to ensure structural strength and corrosion resistance. Inward-tilting inclined curtain walls are present in Buildings 1-1# and 1-2#. The inclination angle is 81° for

Building 1-1# and 83° for Building 1-2#, with the maximum glass panel size being 1500×2550 mm and a weight of 101 kg (Figure 1).



Figure 1 Rendering of the Renovation Project

3 TECHNICAL PRINCIPLE

This paper proposes a construction method using a specialized suspended platform for inward-tilting inclined curtain walls. The method improves the conventional suspended platform through modified design: the wall thickness of the front bracket is increased to extend its outward extension length, thereby enabling construction of 2-3 floors before dismantling and repositioning are required. Simultaneously, a support platform is installed on the structural beam at the platform parking position to ensure the suspended platform can be parked safely and stably after work. In addition, floor edge protection and a dedicated access passage to the specialized suspended platform are provided at the parking position to ensure safe entry and exit for operators.

By modifying the conventional suspended platform and increasing the outward extension length of the front bracket, the proposed method achieves the purpose of covering 2-3 working floors, thus realizing efficient construction. At the same time, the installation of the platform parking platform and personnel access passage reduces the safety hazards in the construction of inclined curtain walls.

4 CONSTRUCTION PROCESS

4.1 Modified Design and Assembly of the Suspended Platform

The conventional suspended platform is improved by increasing the wall thickness of the square tube of the front bracket. Specifically, the wall thickness of the square tube of the conventional front bracket is changed from 70 mm to 80 mm, and its outward extension length can be increased from ≤ 1700 mm to ≤ 2800 mm. The platform is then installed following the standard installation procedure for conventional suspended platforms.

4.2 Fabrication and Installation of the Suspended Platform Support Platform

At the structural beam on the floor where the platform is parked, M12 expansion bolts are used to fix vertical 50×50 equal-leg angles. The 50×50 equal-leg horizontal angles and diagonal bracing angles are then welded and fixed. The horizontal spacing of the angles is 1.5-2.0 m. During the fixation of expansion bolts, a horizontal reference line is set on the structural beam to control the elevation. When welding the horizontal angles, a surveyor's level is used to control the elevation, ensuring that the installation elevation difference does not exceed 25 mm (Figures 2-3).

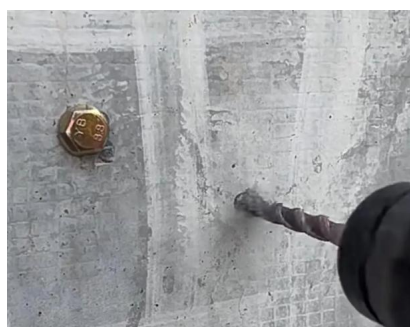


Figure 2 Installation of Expansion Bolts on the Structural Beam**Figure 3** Completed Effect of the Suspended Platform Support Platform

4.3 Floor Edge Protection and Access Passage Setup for Platform Operators

At each access position of the slope suspended platform on the floor edge protection, an openable device is installed. This facilitates the entry and exit of operators while maintaining the protective effect of the floor edge protection.

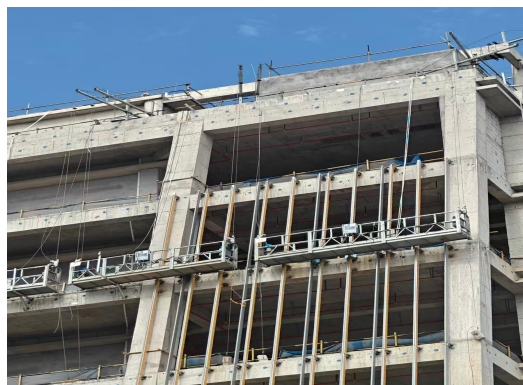
4.4 Platform Inspection and Curtain Wall Construction Using the Slope Suspended Platform

Upon completion of platform assembly and support platform construction, a pre-use inspection of the suspended platform is carried out, and a qualified inspection report is issued by a certified inspection unit. Since the slope specialized suspended platform is a non-standard platform, a re-inspection and a new qualified inspection report are required every time the platform is moved downward to a new position. After passing the inspection, the construction, supervision, and subcontracting units conduct a joint acceptance check, and the platform is tagged for use. The construction and installation of the inward-tilting inclined curtain wall then proceed according to the normal curtain wall construction process.

5 APPLICATION AND EFFECTIVENESS

The construction method using the specialized suspended platform for inward-tilting inclined curtain walls allows a greater number of floors to be constructed in a single setup. Its installation method and efficiency are comparable to those of a conventional suspended platform, yet the installation efficiency is increased by two times (i.e., tripled). Meanwhile, the support platform ensures safe parking of the platform, and the access platform guarantees operator safety.

The field application results of the efficient construction method using the specialized suspended platform for the inward-tilting inclined curtain walls discussed in this paper demonstrate that the construction is efficient and stable. Although remarkable results have been achieved, some issues remain during construction. The main problem is that when the slope suspended platform operates at different floors, the distance between the platform and the floor varies, which may require local temporary measures to assist construction. Therefore, further research is needed to determine whether auxiliary construction measures should be taken to address the varying operating distances at different floors, so as to further improve installation efficiency and lay a foundation for the wider dissemination of this method (Figures 4-5).

**Figure 4** Construction of Curtain Wall Mullions and Profiles Using the Slope Suspended Platform

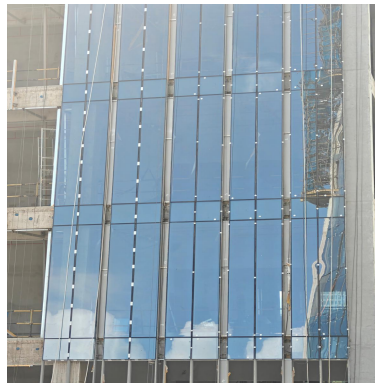


Figure 5 Completed Effect of the Slope Curtain Wall

6 CONCLUSIONS

This paper proposes an innovative efficient construction method for inward-tilting inclined curtain walls using a specialized suspended platform. The method solves the problems associated with traditional inclined curtain wall installation methods, such as the need for repeated erection and dismantling of the platform, the inability to lower and park the platform upon daily completion of work, and the difficulty for operators in accessing the platform. By modifying the conventional suspended platform and adding a support platform and access passage, it is better adapted to the construction process of inclined curtain walls, thereby significantly improving the construction efficiency of inward-tilting inclined curtain walls. The method has been successfully applied in a renovation project in Zhejiang Province.

The research shows that this method not only enhances the installation quality and construction efficiency of inward-tilting inclined curtain walls, but also reduces the construction safety risks caused by the inability to park the platform after work and the difficulty of operators in entering and exiting. However, further research is still needed to determine whether auxiliary construction measures are required to address the varying operating distances of the inward-tilting suspended platform at different floors, so as to expand the application scenarios of the method and promote its widespread adoption.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

- [1] Zhang L, Chen J. Key construction technology of inverted installation method for inward-inclining special-shaped glass curtain walls. *Construction Technology*, 2022, 51(18): 78-82.
- [2] Li J, Zhou K. Measurement and installation technology of variable-inclination inward-set curtain walls based on BIM. *Building Technology*, 2023, 54(5): 590-593.
- [3] Wang H. Joint optimization and construction of step-by-step inward-inclining curtain walls for high-rise buildings. *Sichuan Building Science*, 2022, 48(S1): 135-138.
- [4] Schmidt R. Prefabricated inward-tilt unitized curtain wall construction technology. *Journal of Building Facade Engineering*, 2021, 11(2): 45-58.
- [5] Muller F. Anti-slip connection design for inward inclined facade panels. Germany: Schüco Technical Research Report, 2022.
- [6] Kim S H. Construction optimization of inward sloped curtain wall in tropical climate. *Journal of Architectural Engineering Korea*, 2023, 30(4): 112-119.
- [7] Wang X, Ren N, Zhao X, et al. Research on suspended platform construction technology for special-shaped building exterior curtain walls. *Building Technique Development*, 2024, 51(11): 55-57.
- [8] Li Y. Application of non-standard suspended platforms in curtain wall construction. *Building Technology*, 2025, 56(5): 578-580.
- [9] Wang X, Liu T, Chen X, et al. Construction technology of inward-inclining large-span spatial special-shaped curved glass curtain walls. *Shanxi Architecture*, 2025, 51(7): 80-85.