

Application of Aluminium Mould, Climbing Frame and Assembly Integrated Construction Technology

Li Chungang^{1, 2}, Cheok Mui Yee^{1*} and Zheng Zhuolin^{1,3}

¹Tun Razak Graduate School

Universiti Tun Abdul Razak, Malaysia

²Zhuhai Construction Engineering Holding Group Co., Ltd., Zhuhai, Guangdong, China

³Guangzhou City Construction College, Guangdong, China

*cheokmy@unirazak.edu.my

ABSTRACT

In order to achieve the modularity of aluminium mould, crawler frame and PC assembly construction, and the standardization of secondary structure one-time forming, this paper takes the application of aluminium mould+crawler frame+assembly integrated construction technology in a residential project as an example, and sums up and analyzes from the process of deepening design, the key points of deepening design and the key points of construction, so as to provide guidance and reference for the deepening design and construction of the similar projects in the future.

Keywords: PC assembly, Aluminium Mould Climbing Frame, Deepening Design

1. Introduction

During the ‘14th Five-Year Plan’ period, China's guaranteed rental housing construction demand is large, and at the same time, in the context of China's development trend of building industrialisation, aluminium mould + climbing frame + PC assembly construction technology has gradually developed into the ‘standard’ for residential projects, and the standard floor of residential projects can improve the verticality of concrete structure, improve the level of concrete structure, improve energy efficiency, safety and environmental protection, and combine with ALC wall panel construction technology can achieve plaster-free effect. The standard floor of residential project adopts aluminium mould + scaffolding + PC assembly construction technology, which can improve the verticality and flatness of the concrete structure, save energy efficiently, be safe and environmentally friendly, and combine with ALC wall panel construction technology to achieve the effect of no plastering, which can greatly save the investment of the project.

At present, the residential project for aluminium mould + climbing frame + part of the assembly of the integration requirements are very high, and thus need to deepen the design of aluminium mould + climbing frame + assembly as a whole, the application of the technology in the process of possible problems front to solve, and give full play to the advantages of the technology to improve quality and efficiency.

2. Engineering overview

Jinwan District Public Rental Housing and Talent Apartment Project is located in Jinwan District, Zhuhai City, Guangdong Province, with a total investment of 1.187 billion yuan, a total land area of 62,800 m², a total construction area of 237,800 m², including a 1-storey basement, 13 high-rise residential buildings, three 2-storey supporting services, a 4-storey kindergarten, which will provide 2,605 sets of guaranteed housing after completion, and further improve the full coverage and multi-level housing security system in Jinwan District. It will further improve the full coverage and multi-level housing security system of Jinwan District. The standard floor of this project adopts the integrated construction technology of aluminium mould + climbing frame + assembly.

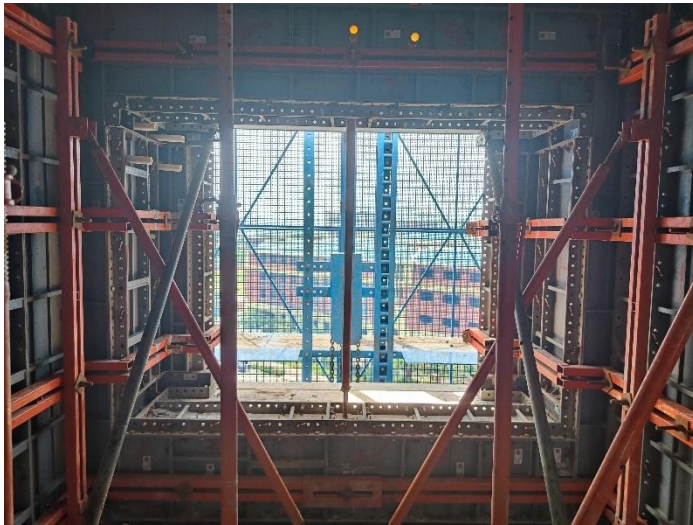


Fig. 1 Integrated construction of PC+aluminium moulding+climbing frame

3. Aluminium mould + climbing frame + assembly integrated deepening design

3.1 Deepening preparations

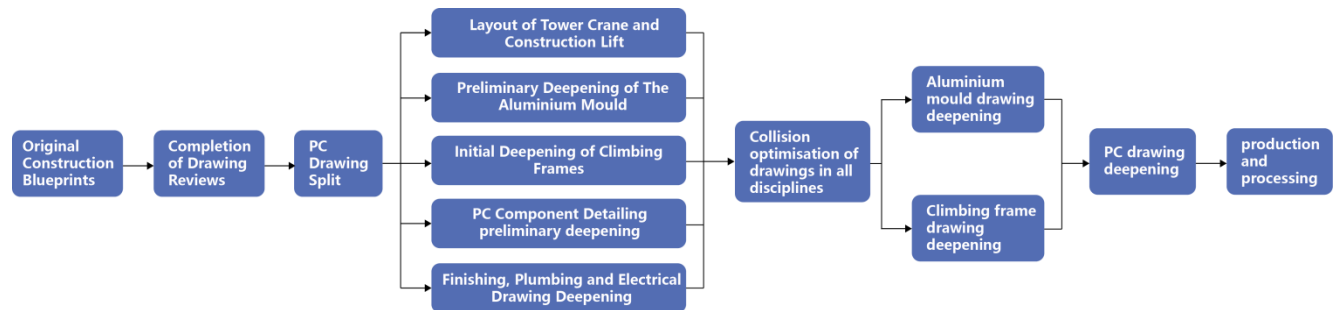
Determine in advance climbing frame, aluminium mould, prefabricated components, aluminium alloy doors and windows, finishing, electromechanical and other relevant professional subcontracting units, set up aluminium mould, climbing frame, PC assembly and other professional deepening working group, according to the design unit to provide the construction blueprints after the review of the drawings, organization of drawings after the review, to deepen the unit of aluminium mould as the main unit, and the other units cooperate with the provision of accurate reserved embedded point drawings, in order to provide favourable conditions for the deepening of aluminium mould design.

3.2 Deepening the design process

Aluminium mould climbing frame deepening production cycle is long, aluminium mould deepening completed production period of at least 25 days, PC deepening completed to the components into the field period of at least 30 days, so deepening the design of the work need to leave enough time for manoeuvring.

All kinds of water and electricity pipeline deepening design location must be determined before the aluminium mould design deepening work starts.

The deepening design position of all kinds of plumbing and electrical pipelines should be guaranteed to be accurate, and should not be changed at a later stage. Aluminium mould and PC design and production cycle is long, otherwise it will cause serious delay in progress and economic loss.



3.3 Aluminium mould deepening design key points

For the height of not more than 300mm under the hanging beams, structural columns, bathroom countercane, not more than 300mm wall stacks and other secondary structures through the deepening of the design and the main structure of the integrated pouring and shaping to reduce the secondary structure construction of reinforcement and other processes, greatly improving the efficiency of the high, and at the same time a pouring and shaping of the second construction quality is better than the bathroom countercane is suitable for pouring together with the lower level of the wall columns, can be added with the back of the flute fixation, and better than with the same level of the beams and plates. Pouring accuracy and construction quality is better;

The lift shaft is optimised as a full shear wall structure by communicating with the design unit, with horizontal and vertical structural tie plates set up in the structural wall and tie bars configured at the joints;

Aluminium mould deepening, cast-in-place main components and ALC partition wall at the junction of aluminium mould deepening 100mm × 10mm plaster pressure groove, ALC wall panels and the main structure of the wall (beams) joint position riding seam hanging glass fibre mesh wiping crack-resistant mortar, finish surface and wall (beams) surface flush, to avoid cracks at the joint position at the same time as to provide favourable conditions for the free of plastering; precast window and cast-in-place structure of the smooth connection position to consider the pressure groove, the pressure groove of cast-in-place parts 4mm*70mm, another 4mm*50mm into the prefabricated window, i.e., the width of the pressure groove is 120mm; stacked plate cast-in position, the bottom of the plate needs to be considered for the practice of pressure groove, the width of the pressure groove = the width of the cast-in strip +60mm, each side of the stacked plate is 30mm deep, depth of the pressure groove is 10mm, when one side of the stacked plate side for the cast-in place, the width of the pressure groove is 130mm, deep into the stacked plate is 30mm, aluminium moulds The 10*50mm plastering pressure groove is set along the periphery of the feeding opening, the discharge opening and the reserved opening for the pump pipe, so that the joints of the successive poured slabs can be plastered by riding the joints and the finish layer can be constructed on a large area, which avoids cracks at the joints and realises the indoor plastering-free;

Window eaves, balconies, corridors, fire eaves and other components should be set up drip line, aluminium alloy template needs to be set up on the 20 * 10mm trapezoidal drip line compression groove, 20mm from the edge, 20mm from the wall edge to disconnect, to prevent the rain along the drip line edge flow to the wall;

According to the deepening of water and electricity reserved buried deepening drawings, the use of 50 (width) * 40 (depth) mm trapezoidal water pipe pressure groove, reduce the water and electricity pipelines in the concrete grooving, improve construction efficiency while ensuring the quality of reinforcing steel;

Balcony position according to the balustrade deepening drawings set the reserved cup mouth (upper mouth 200 * 140mm, lower mouth 180 * 120mm tapered cup mouth, depth of 20mm, stereotypical processing of the balustrade to achieve rapid installation of the construction of the later stage, sill position in order to ensure the aesthetics of the four sides of the usual flat window with the use of the internal increase in the cement enterprise mouth, the internal increase in the stacks of 20mm thick, the long side of the 70mm, the short side of the 60mm;

Floating window under the floating board and the upper floating board are made cover and set up an anti-floating back flute, staircase cover set up observation port, the size of 150mm × 200mm, every three steps to set up a, put the line holes, pumping pipe port side needs to be ≥ 300mm from the cast-in-place walls, beams edge line and in line with the 50mm module, otherwise it is difficult to match the mould.

3.4 Aluminium mould + climbing frame + assembly integration deepening points

Aluminium mould + scaffolding + assembly integrated construction technology will affect the construction of the factors front to deepen the design stage, the general contracting unit to coordinate the civil construction, finishing, installation of the relevant professional subcontracting to form a joint deepening the design of the working group, through the preliminary deepening of the professional deepening the design of their respective needs, through the BIM technology of aluminium moulds, scaffolding, assembly of professional deepening the integration of the drawings and integration of the depth of the various aspects of the construction of the assembly building. Through BIM technology, the deepening drawings of aluminium mould, scaffolding, assembly and other professions are integrated and combined, and the collision problems between aluminium mould, scaffolding, tower crane attachment and other professions are solved in advance, so as to realize the integration of aluminium mould, scaffolding, assembly and other professional construction.

The combination of three high-precision processes of aluminium mould, climbing frame and prefabricated components puts forward extremely high requirements on the precision of installation. Once the pre-installed bolts and reserved holes of prefabricated components are deviated, it may lead to the poor joints of the aluminium moulds, and the aluminium moulds can not be fixed and lead to the dismantling of the alteration, which affects the construction efficiency and the verticality, smoothness, and elevation of the aluminium moulds and the quality of structural shaping, so it is necessary to control the bolt holes of the prefabricated components, the reserved holes, and ensure that the deviation is within $\pm 3\text{mm}$. Therefore, it is necessary to strictly control the positional deviation of bolt holes and reserved holes of prefabricated components and ensure that the deviation is within $\pm 3\text{mm}$.

The deepening design of PC components needs to consider the position and size of aluminium mould feeding port, discharge hole, water and electricity cable box, and climbing frame machine hole;

deepening of climbing frame machine hole according to the size of machine screw, and pre-embedded casing on the laminated plate (usually A40mm), the casing needs to avoid the truss reinforcement of the laminated plate.

Prefabricated convex window fixed diagonal brace position usually needs to be more than 300mm from the inner edge of the convex window, to prevent the aluminium model can not be installed, prefabricated convex window according to the aluminium model deepening drawings calculated tensile bolt holes (usually A30mm), at the same time need to check the air conditioning reserved holes, window lightning protection flat iron embedded or not, aluminium model feeding port needs to be fixed diagonal brace on the convex window, the ceiling light fixtures for the optimization of the avoidance of the PC components on the crawler frame machine holes as far as possible optimization. The holes for climbing frames on PC components should be optimised as much as possible to be shared with the bolt holes of aluminium mould, so as to reduce the amount of bolt hole blocking works in the later stage;

Crane deepening need to consider the tower crane attachment wall, the tower crane attachment wall should be set in the cast-in-place concrete column position, at the same time avoid prefabricated components, climbing frame machine position need to avoid the tower crane attachment wall, the tower crane attachment wall is usually installed in the crawler, crawler need to reserve a sufficient width of the drawbridge-type aisle plate in the position of the attachment wall to ensure that the climbing frame lifting machine position, columns, perforated plate protection and the tower crane attached to the wall does not conflict with the crane, the crane attached to the wall in the crawler before the first spell for accurate positioning and review the relationship with the climbing frame to ensure subsequent safety. Accurately locate and review the relationship with the climbing frame before the first assembly of the climbing frame to ensure the safety of the subsequent construction.

Prefabricated convex window according to the aluminium alloy window deepening drawings for integrated casting deepening design, prefabricated convex window and window frame integrated casting molding, greatly improving the leakage prevention effect of the external window, shorten the construction period, and improve the effect of typhoon prevention. Residential projects usually have difficulties in the construction of aluminum formwork for double-layer air-conditioning panels, so steel bars can be reserved in the aluminum formwork for air-conditioning panels in the middle layer, and this layer can be poured twice after climbing frame lifting.

	
Window frames fixed in precast projecting window moulds for integrated casting	Window frame fixing and prefabricated projecting window integrated casting effect

4. Aluminium mould + climbing frame + assembly integrated technology construction points

According to the current development trend of the industry, most of the residential projects adopt the construction technology combining PC assembly type, aluminium mould and climbing frame construction technology, which can achieve the effect of plaster-free indoor and outdoor of the standard floor, meanwhile, the climbing frame can provide a safer and more convenient construction platform for the operators, and this technology can make the various construction processes closely connected, and establish a stepwise and efficient flow construction between the main structure of the building, the secondary structure, the rough installation, the electrical and mechanical, and the fine decoration. This technology can make the construction processes closely connected, establish the step type efficient flow construction among various professions, and the aluminium mould + assembly type has the characteristics of high precision and good visual effect, which can improve the overall construction quality of the project.

In the construction of assembled buildings, prefabricated convex windows are usually lifted first, and then wall column and beam reinforcement is tied, the position of aluminium film is installed and corrected, and finally the lifting of laminated panels is completed. In order to reduce problems such as slurry leakage and errors at the joints between prefabricated components and cast-in-place structures during construction, it is necessary to use double-sided adhesive compression joints on the laminating surface of prefabricated components and aluminium moulds during construction, so as to achieve the purpose of avoiding slurry leakage and improving the quality of concrete.

The dismantled aluminium formwork must be thoroughly cleaned up before applying the release agent, applying the release agent requires uniformity and comprehensiveness, and the release agent should be stirred evenly before applying, and the aluminium formwork that has been applied with the release agent should be poured with concrete as early as possible, otherwise, prolonged placing

will greatly reduce the isolation effect of the release agent, which will lead to poor quality of the concrete after the dismantling of the formwork.

Due to the production of aluminium moulds there are some minor deviations, and most of the aluminium moulds are standard components, in order to prevent the prefabricated convex window inside aluminium moulds can not be reinforced and chiseled prefabricated convex window, prefabricated convex window production window hole size in accordance with the +5mm processing, to ensure that the aluminium moulds are normally installed.

The position of the laminated strip is cast-in-situ concrete, and there is a risk of subsidence. A row of vertical poles should be set directly below this position to prevent leakage caused by local deflection of the concrete pouring aluminum formwork keel, which will affect the concrete forming quality.

Aluminium mould and precast convex window junction position aluminium mould need to pay attention to the reinforcement measures, the traditional practice for the precast convex window inner side is not in contact with the cast-in-place concrete only extends a side of aluminium formwork, and the aluminium formwork without tie fixing measures, the junction of the risk of seepage is very great, optimization of the convex window in contact with the cast-in-place concrete to the outside of the extension of the two sides of the aluminium formwork, and aluminium formwork side reinforcement need to be used to aluminium formwork flute back to embrace the convex window type of reinforcement, the most outward extension of the aluminium formwork after adding pressure groove material sealing. The outermost extension of the aluminium formwork is blocked with additional compression groove material, and the top compression groove is set to fit with the compression groove of the prefabricated components, so that there is no gap at the junction position of the prefabricated convex window and the aluminium formwork, which greatly reduces the risk of slurry leakage and improves the quality of concrete moulding.

Traditional Practice	 Lack of fixing measures on the side	 Lack of Rachel measures on the side
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Optimized Practice	
Explain	The traditional aluminium mould deepening design reinforcement is only done at ① position shown in the picture; after optimization, the aluminium mould is extended to ② and ③ positions, and the back flute is used for reinforcement and tie.

Quality inspection is an important link to ensure the quality of the building, so the construction unit should pay enough attention to the quality inspection; during the production of prefabricated components, the general contracting unit, together with the supervisory unit, will arrange the quality management personnel to supervise and manage the supervision and acceptance in the prefabricated components manufacturer, so as to control the quality of prefabricated components from the source; after the production of aluminium alloy template is completed, the aluminium mould unit should complete the preassembly within the manufacturer and the general contracting unit will organise the owner to participate in the preassembly acceptance. After the production of aluminium alloy template is completed, the aluminium mould unit should complete the pre-assembly in the manufacturer; and the owner, design and supervision unit should participate in the pre-assembly acceptance; before the materials are delivered to the site, the structure and quality of aluminium mould and PC components should be carefully checked and accepted to ensure that they meet the building requirements before they are delivered to the site.

In the main structure of the construction stage, prefabricated components transport vehicles are usually longer and heavier, the construction site road design needs to be coordinated with the requirements of its width and radius of gyration, before the construction of the basement roof to check whether to meet the full load of transport vehicles, in the case of not meeting the requirements of the load bearing capacity needs to be considered to increase the reinforcing bars, at the same time in the basement roof to draw out the traffic routes, strict control of the vehicle walking, to prevent the seepage due to the traffic caused by the emergence of the seepage.

5. Conclusion

Aluminium mould + crawler + assembly integrated construction technology compared with traditional technology has obvious advantages, perfectly fits the trend of China's building industrialization development, in the realization of the whole construction link green energy saving basis, so that the overall quality of building construction has been significantly improved, while optimizing the traditional construction mode of the long-existing technical problems, this paper on the public rental housing and talent flat project in Jinwan District, Aluminium Mould + crawler +

assembly integrated construction technology application experience is summarized, focusing on the analysis of the technology to deepen the design and construction should pay attention to the problem to provide experience for the subsequent similar projects. This paper summarises the experience of applying the integrated construction technology of aluminium mould + crawler + assembly, and focuses on the problems that should be paid attention to in the deepening design and construction of this technology, so as to provide experience for the subsequent similar projects.

REFERENCES

- [1] ZHOU Ningfei,LI Linlin. Deepening design of assembly building based on aluminium mould climbing frame integrated construction[J]. Jiangsu Construction,2021,(S2):41-44.
- [2] LI Wenjun, ZHONG Qiang, ZHANG Kai. Integrated construction technology of aluminium mould climbing frame for assembled building[J]. Construction Technology,2019,48(S1):895-899.
- [3]Bi Yongkui. Integrated construction technology of aluminium mould climbing frame for assembled building[J]. Smart City,2020,6(14):163-164.DOI:10.19301/j.cnki.zncs.2020.14.093.
- [4] WANG Yunlei,LI Mengcai,LI Regime. Integrated construction technology of aluminium mould climbing frame for assembled buildings[J]. Construction Technology Development,2021,48(22):32-33.
- [5]Zhang Wenxiong. Application of integrated construction technology of aluminium mould climbing frame in assembled building project[J]. Foshan Ceramics,2024,34(04):159-161.
- [6] LIU Taiqian, LIU Chuangye, YANG Tengfei, et al. Application of integrated construction technology of aluminium mould climbing frame in assembled building project[J]. Xinjiang Nonferrous Metals,2023,46(06):109-110.DOI:10.16206/j.cnki.65-1136/tg.2023.06.047.
- [7] JANG Jiangchun,GAO Yan,WANG Zhibin. Analysis of integrated construction technology of aluminium mould PC crawler for assembled building[J]. Bulk cement,2022,(06):116-118.
- [8] LI Jiangyan,CHEN Wei. Research on integrated construction technology of aluminium mould climbing frame for assembled buildings[J]. Engineering Construction and Design,2022,(14):111-113.DOI:10.13616/j.cnki.gcjsysj.2022.07.236.
- [9] Zhen Liang,Satellite Wen,Tao Zhang. Integrated construction technology of aluminium mould PC crawler for assembled buildings[J]. Smart City,2021,7(14):46-47.DOI:10.19301/j.cnki.zncs.2021.14.023.
- [10] Jiang LL. Integrated construction technology of detachable aluminium mould climbing frame for assembled buildings[J]. China Building Metal Structure,2024,23(01):43-45.DOI:10.20080/j.cnki.ISSN1671-3362.2024.01.014.
- [11] Jiang P. Analysis of construction technology for integration of aluminium mould and assembly building[J]. Residence industry,2024,(01):34-36.

- [12] SONG Nan, HE Botao, YE Meng, et al. Research on integrated construction technology of aluminium mould climbing frame for assembled buildings[J]. *Ceramics*,2023,(09):106-108+189.DOI:10.19397/j.cnki.ceramics.2023.09.068.
- [13] Chen Yanyu. Research on construction technology of aluminium mould and assembly building integration[J]. *Sichuan Building Materials*,2023,49(07):97-98+101.
- [14] ZHANG Jiangchun, GAO Yan, WANG Zhibin. Analysis of integrated construction technology of aluminium mould PC crawler for assembled building[J]. *Bulk cement*,2022,(06):116-118.
- [15] WANG Yuhao. Discussion on integrated construction technology of aluminium mould climbing frame for assembled buildings[J]. *Engineering Technology Research*,2022,7(17):57-59.DOI:10.19537/j.cnki.2096-2789.2022.17.019.
- [16] Zhao G-A. Analysis of integrated construction technology of aluminium mould climbing frame for assembled buildings[J]. *Brick and tile*,2022,(06):148-150.DOI:10.16001/j.cnki.1001-6945.2022.06.029.
- [17] SONG Hui-Peng,XIE Jing,LI Yong-Jun. Integrated construction technology of aluminium mould climbing frame for assembled buildings[J]. *China Building Decoration*,2022,(04):182-183.