

The Review of Problems in Precast Construction Activities

Yin Rui*

Faculty of Built Environment, Universiti Teknologi, Malaysia

Zhao Sen

Architectural and Civil Engineering, Wuhan Institute of Technology, China

Abstract

The precast building are popular in construction industry because of shortening time, reducing site work, and less wastage, and the others. As the development of precast technology, module buildings were built in many countries in the world. But some of the precast construction are short of integrity and systematized management, then work issues are appeared for whole precast project. Despite these advantages, the precast building project management try to avoid possible risks also. It is necessary to clarify the reasons and optimize the precast management. It is not only the problem of assembling precast components, but also involves many factors such as module design, production, transportation, installation and the others. This article is to research series issues of precast construction management. The content focus on precast components design, producing process, construction problems.

Keywords: Precast building; Precast construction issues; Precast components; Module building; Precast manufacturer; Prefabricate products.



CC BY: [Creative Commons Attribution License 4.0](https://creativecommons.org/licenses/by/4.0/)

1. Introduction

From the traditional "casting in-situ" construction to "module" house, the precast building leads to more concern form the development of modern green industry. How can you imagine one building was built as easy as Lego bricks. Such as the walls, staircases, slabs, balconies, beams, columns, house shelter, and the others. It achieved like factory "assembly line" processes. This construction assembly - style advantages is not only less energy, saving labor, but also reduce the site noise pollution. The precast technology is an effective method to promote Industrialization Building System (IBS). [Chang et al. \(2018\)](#) thought that is an important road for green building development.

There are some problems in the prefabricated components, such as unclear component identification, poor rough surface quality, and non-standard start bar, an the others. [Yu et al. \(2017\)](#) presented the precast components need the suitable management system for controlling these construction project process. Through many kinds of problems about precast building, the participants of the project management try to take advantage of precast components and avoid relevant disadvantages. But some of the analyses are separations, so the participants need integral information and promote the precast building project management. This article aims to analyze relevant papers systematically and summarize relative information for the stakeholders.

2. Methodology

This article research method is using literature review papers through google scholar searching. The main keywords including precast construction problems, precast component issues, precast project management, and the others. There is a analysis of the precast problems survey in the construction activities as flowing:

The Precast Problems Summary

NO	The main precast problems in the study topic.	The number of study topic.	Percentage
1	Precast components separation design issues	5 Tims	10%
2	The connection and joint problems for precast components	8 Tims	16%
3	The precast building leakage problems	5 Tims	10%
4	Precast components conflict and clash issues	6 Tims	12%
5	The precast products quality problems	4 Tims	8%
6	The precast yard and manufacturer management	12 Tims	24%
7	The precast products transportation and logistics management	2 Tims	4%
8	The cast-in-situ problems	3 Tims	6%
9	Precast components installation issues	3 Tims	6%
10	The precast building cost issues	2 Tims	4%
SUB-Total		50 Tims	100%

The above survey is according to more than 50 research article content. Some of the study focus on the several problems. From above table data, the most of problem is precast yard and manufacturer management and the percentage is 24%. The second main issue is precast component connection and joint technology problem.

3. Precast Design Issues

3.1. Precast Components Separation Design Issues

The precast component shop-drawing design including: (1) combine all the requirements into each production detail drawing. (2) check and calculate the load capacity under the load action of producing, transporting, hoisting and installing. (3) consider the lifting point, supporting points for store, then design the embedded parts in the components. In order to be convenient for producing workers, require the designer make shop-drawing and display various information for the component, such as the architecture, structure, water, electricity, and the others. It includes the shape size, start bar, embedded pipes, holes, etc. [Chandrasekaran \(2018\)](#) presented an example of the most difficult design work is to solve the component assembling joint problem.

Sometimes, the preliminary design does not take account the installation production of precast components in the future, then designers often personalize and customize through the separation design. There is a additional design work to make shop-drawing for each precast component. Finally, the precast manufacturers need make mould and rebar schedule for every production. This processes requires accurate and integrated work. In fact, the coordination mechanism of architectural design, precast design and production design is not smooth. It needs the participants have ability to coordinate architect, main-contractor, precast designer, precast manufacturer.

3.2. Precast Components Connection Issues

The vertical steel connection method of precast components is widely used joint technology in earthquake-prone countries, such as the United States and Japan. The technology safety and reliability is proved by the scientific theory and test analysis. The start bar with sleeve grouting connection technology is to connect the upper and lower steel by filling the special materials in gap. For example, [Feng et al. \(2018\)](#) research result demonstrated precast beam-to-column connection needs an effective tool for the seismic performance analysis.

Precast structure joints between different components are the key to ensure the building integrity and continuous to transfer both shear and flexural load. [Bu et al. \(2018\)](#) presented the joint design of precast components is the most important and difficult work for module building. This type of link is easy to emerge quality problem after construction projects completion. Therefore, the designer should not only guarantee the structural safety of the precast component connection, but also ensure joint functional requirements, such as waterproof, fire prevention and thermal insulation.

3.3. The Leakage Problem of Precast Building

Through the professional architectural view: the important design work includes external thermal insulation and waterproof. The waterproof is reflected at the joint of external facade in module building. Some of the external facade was designed with water rubber strip production, and the other external have not water rubber strip and. So some of outer joints are treated with weather resistant rubber. In fact, there are still the possibility of leakage. Water leakage enter into building through various paths, such as roofs, basements retaining wall, facade, toilet, and the other areas.

Sometimes, the precast buildings have the potential quality risks, such as internal toilet leakage and the external facade leakage. There are a lot of joints appeared between various precast component connections in the module building then the site engineers adopt the cast-in-situ process. Unfortunately, some of the leakage led to higher maintenance costs in the future. Furthermore, the problem joints affect the building structure performance. [Ali et al. \(2018\)](#) presented that the precast jointing work needs to be done correctly to avoid the leakage risk.

3.4. The Collision Issue of Precast Design

Usually, the start rebar is too large at the precast component junction and is easy to cause clash issues. Sometimes, the site worker have to bend the rebar or adjust the steel location, but it is unable to accurately realize the design requirements of the steel position. This behavior cannot meet the standard requirement, including the cover thickness of steel, the space of rebar, the length of start bar. Finally, this problem brings risk to affect building structural property seriously. [Sharafi et al. \(2018\)](#) emphasized that the precast buildings need high structural integrity is to prevent constructional issues, including clash problem between precast modules.

The whole building contains complex mechanical and electrical (M&E) system, such as air-condition, ventilation, electric, sanitary, etc. The intricate pipe rote brings the clash problems also. Furthermore, the pipe or cable box should be embedded in the precast component accurately before producing. Otherwise, the different professional pipes are appeared at the same location and lead to the obstacles for M&E works.

4. The Issues of Precast Manufacturer

4.1. The Precast Component Quality Problems

The precast component producing process in an important work for module building. The site engineer should strengthen the quality check before the precast components enter into the construction site. According to the specifications, the inspection content includes the precast component appearance quality defects, dimensional

deviation, embedded box or pipe location, and the others. Some of the precast components have the dimension deviation. Such as the gap between slabs is too large, uneven or not uniform. Because the manufacturer worker has factitious error during precast yard process.

The precast component quality in the producing stage determines the whole building safety performance. Before the component producing work, the manufacturer should ensure the material quality first, including steel, cement, sand, stone and other. Then adopt the suitable mould with enough strength, stiffness, stability. In the case study, there is setback of IBS application because of insufficient IBS factories, unfamiliarity and resistance to change, enormous capital cost (Zakari *et al.*, 2017).

4.2. The Output of Precast Components

According to the investigation and survey, the precast factory is hard to supply enough components for module building project. Sometimes, the residence project have many blocks and start construction work at the same time. So, many precast manufacturer production capacity can not meet the market demand. Because one module building has various types of precast components with different size, including slab, balcony, facade, staircase, lift wall, and the others. It is difficult to control the production line according to the various precast component schedule. The precast products are highly dependent on the effectiveness of manufacturer production planning for the component amount. Wang *et al.* (2017) presented that precast production planning work needs synchronize the products schedule to achieve the delivery on-time, minimum delay time.

Many reasons lead to the lower application in the production process line for precast components. Some of the manufacturer adopt semi-automatic method to produce relevant components. They use traditional method to fixing formwork, binding steel, embedding pipe, casting concrete and the others. It needs require a lot of labor. But the producing work efficiency is stay at lower level also. At present, the Industrialized Building System (IBS) precast components faced serious issues, including delays and poor quality of the productions (Othman *et al.*, 2017).

5. Precast Components Construction Issues

5.1. Casting In-Situ Issues

Some of the casting work will be execute at the construction site, such as casting slab top layer, casting for the connection joint. Because the connection between two precast components needs formwork to cast concrete, this location is easy to leak slurry. It is difficult to guarantee the size of the junction. In fact, the other more defects are easy to be emerged, such as honeycomb, uneven level surface. Furthermore, because of many start bars at the junction, the vibrator can not do work as usual. So, the casting in-situ concrete is difficult to be compacting, then it will reduce the stiffness and strength at the junction. In addition, there are several pipe need to be grouting at the site. Some of grouting is not dense enough according to the standard requirements.

It needs to adopt prevention and control measures ensure the connection quality of site grouting. Furthermore, the embedded pipe and box in the precast products for M&E need some protective measures to reduce the site damage. Because some of the casting concrete flowed into the embedded pipe and box. Zhang *et al.* (2018) case study showed that the concrete wastage of casting-in-situ is higher than off-site casting in the precast yard also.

5.2. Precast Components Installation Issues

The installation work efficiency is an important work for the precast building management. Some of the components perpendicularity and levelness problems were emerged. The contractor should make the installation method statement according to each component weight, dimension, shape, location information. Before the precast components loading at site, the site engineer should make the installation schedule according each component, shape, size, wight, height data. After the precast components loading to its position, the site worker should check the vertical and horizon level, adjust the location to ensure the accuracy of the components installation.

To avoid the cumulative installation deviation exceed standard requirements, the components accurate position must be double checked by site worker before and after installation. However, there is short of a review with the design, construction, and performance of precast buildings under different loading conditions (Lacey *et al.*, 2018). In addition, the site workers need strengthen the protection work after installation finished, it is strictly prohibited to hack or cut on precast components.

6. Discussion and Conclusion

The precast construction is an effective way to promote housing industrialization, construction industrialization, and is a inevitable choice for green development (Wu *et al.*, 2018). Presented that precast construction system has some management problems, because many participants come from diferent copmany. There is a lack of comprehensive management standard for the precast building construction participants. Because of the precast construction project owner, designer, contractor, consultant, supplier are fragmentation units. Such as the leakage defect emerged, it needs check and monitor which link is responsibility for this problem, maybe this issue is come from design, producing process, or casting work at the site. it is an important work for participants to select a suitable construction method.

It is difficult to guarantee the the whole module building quality. The precast technology needs systematization and integrity. This is not only a problem of assembling precast components but also involves many factors, such as M&E embedded technology, transportation, loading & fixing work, grouting technology, and the others. With development of modern building, these precast building needs more integration and matching of these technologies.

Due to the low degree of standardization, the standardization of parts and accessories and the integration of supporting technologies are affected, which hinders the improvement of quality. In the precast building project, it is imperative to evaluate the sustainability of different construction methods.

References

- Ali, M. M., Abas, N. H., Affandi, H. M. and Abas, N. A. (2018). Factors impeding the industrialized building system (IBS) implementation of building construction in Malaysia. *International Journal of Engineering & Technology*, 7(4): 2209-12.
- Bu, Z. Y., Zhang, X., Ye, H., H. X., K. and Wu, W. Y. (2018). Interface shear transfer of precast concrete dry joints in segmental columns. *Engineering Structures*, 175(15): 257-72.
- Chandrasekaran, V. (2018). Special Design Joints for Precast Structural Members and Applications. *International Journal of Advanced Research in Civil & Structural Engineering*, 1(1&2).
- Chang, W. Y., Peng, S. L. and Wei, J. Z. (2018). Research and development status of grouted splice sleeve in precast concrete structure. *E3S Web of Conferences*, 38(2018): 4.
- Feng, D. C., Wu, G. and Lu, Y. (2018). Finite element modelling approach for precast reinforced concrete beam-to-column connections under cyclic loading. *Engineering Structures*, 174(2018): 49-66.
- Lacey, A. W., Chen, W., Hao, H. and Bi, K. (2018). Structural response of modular buildings – An overview. *Journal of Building Engineering*, 6: 45-56.
- Othman, M. K. F., Muhammad, W. M. N. W., Hadi, N. A. and Azman, M. A. (2017). The Significance of Coordination for Industrialised Building System (IBS) Precast Concrete in Construction Industry. *International Symposium on Civil and Environmental Engineering 2016*, 103:
- Sharafi, P., Mortazavi, M., Samali, B. and Ronagh, H. (2018). Interlocking system for enhancing the integrity of multi-storey modular buildings. *Automation in Construction*, 85: 263-72.
- Wang, D., Liu, X., Wang, S. and Cao, X., 2017. "Research on Anchorage Performance of Grouting Anchor Connection of Precast Concrete Structure. 2017 International Symposium on Application of Materials Science and Energy Materials (SAMSE 2017) 28–29 December 2017, Shanghai, China." In *IOP Conference Series: Materials Science and Engineering*.
- Wu, Y. C., Sheng, L. P. and Zhao, W. J., 2018. "Research and Development Status of Grouted Splice Sleeve in Precast Concrete Structure." In *International Conference on Energy Materials and Environment Engineering (ICEMEE 2018)*. p. 38.
- Yu, Z. H., Wei, Y. B. and Zhi, S. D., 2017. "The design and application of information management system for precast concretes based on IOT." In *International Conference on Future Networks and Distributed Systems. Cambridge, United Kingdom*. pp. 19 - 20.
- Zakari, I., Awal, A. S. M. A., Zakaria, R., Abdullah, A. H. and Hossain, M. Z. (2017). Application of industrialized building system: A case study in kano state, Nigeria. *International Journal of Geomate*, 13(39): 80-86.
- Zhang, W., Lee, M. W., Jaillon, L. and Poon, C. H. (2018). The hindrance to using prefabrication in Hong Kong's building industry. *Journal of Cleaner Production*, 204 70-81.