

Research on Seismic Performance Evaluation of Prefabricated Reinforced Concrete Structures in High-Rise Buildings

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Abstract: *With the continuous growth of urban population, people have put forward more residential requirements for construction projects. With the continuous improvement of socio-economic level and the continuous development of the construction industry, China has gradually strengthened its seismic design of reinforced concrete, aiming to improve the stability, reliability, and safety of high-rise buildings, thereby providing people with a comfortable and safe living environment. To improve the seismic, fire, and stability performance of high-rise buildings in the construction of high-rise buildings, and meet the living needs of urban residents. In the construction process of high-rise buildings, emphasizing the effective application of prefabricated concrete (PC) construction technology can greatly improve the construction efficiency and quality of high-rise buildings. At present, there are still some problems in the construction process of PC structures. Based on understanding the advantages of the application of PC structures, it is necessary to grasp the defects in the construction process, analyze the technical points of PC structure construction, and strengthen construction quality control work. This article analyzes the seismic performance of PC structures based on a certain prefabricated high-rise building project.*

Keywords: *High-rise buildings, Prefabricated reinforced concrete structures, Seismic performance*

1. Introduction

With the continuous development of China's economy and the need for urban and rural construction, new types of civil buildings are constantly emerging. The introduction and promotion of high-strength concrete and steel have gradually increased the height of buildings. The acceleration of urbanization has led to a continuous increase in urban land prices, and the proportion of the real estate economy in the national economy has also continued to rise [1]. The contribution rate of high-rise buildings has reached about 30%, gradually becoming the main body of construction projects [2]. As one of the most severely damaged countries, destructive earthquakes in China have caused a large number of casualties and property losses. Therefore, the use of new high-strength concrete and steel to construct high-rise civil buildings must undergo sufficient seismic performance test analysis and theoretical verification.

In recent years, the development speed of China's construction industry is getting faster and faster, especially the construction technology of prefabricated building is getting more and more mature. The PC structure construction technology used during the construction of high-rise buildings is to improve the construction efficiency and enhance the stability of high-rise buildings in the pre-production of construction materials [3]. The seismic damage of building structures poses a threat to human life, production, life, and property. With the understanding of the seismic damage mechanism of building structures, seismic technology continues to develop and improve, and the seismic performance of building structures has been improved. From traditional seismic technology based on structural stiffness, ductility, and bearing capacity, it has developed into a comprehensive seismic technology that utilizes isolation, energy dissipation, and seismic reduction technologies [4]. With the continuous development and popularization of seismic resistance technology in buildings, prefabricated components have emerged. This component, with its high accuracy and strong flexibility, is widely used in the seismic design of reinforced concrete high-rise buildings. It plays an important role in ensuring the reliability, safety, and economy of the seismic design of high-rise buildings [5]. Due to the continuous acceleration of urbanization construction, the scale of construction projects is also increasing, and construction technology is constantly being reformed and updated. PC structures have

also developed rapidly in China. In high-rise buildings, PC construction can meet the requirements of energy conservation and environmental protection, and has advantages such as high construction efficiency and excellent quality. It is currently a key promoted building structural system, which can not only achieve good economic benefits and promote green construction, but also improve the accuracy and safety of some prefabricated components, optimize traditional building technology, and achieve the goal of industrial development in the construction industry [6].

Prefabricated building is a new trend of future construction, which meets the requirements of energy conservation and environmental protection, and defines the future development direction for the construction field. In order to ensure that high-rise buildings have high seismic performance in earthquakes, it is a problem that designers must consider and solve how to scientifically design reinforced concrete high-rise buildings in the context of the application of prefabricated components.

2. Technical Advantages and Disadvantages of PC Structures

2.1 Technical Advantages of PC Structures

PC structure refers to the assembly, node connection, and cast-in-place of prefabricated components on the construction site. In the construction of high-rise buildings, the use of PC structure construction technology can improve the construction efficiency and enhance the stability of high-rise buildings in technical practice [7]. The application forms of PC in high-rise buildings are shown in Table 1. In specific applications, the standardization and construction accuracy of prefabricated components are higher. Walls, columns, slabs, and beams are all manufactured and processed in the factory, with unified specifications, ensuring the standardization and production accuracy of prefabricated components.

Table 1: Application of PC in high-rise buildings

PC structural components	Prefabricated wall panels	Prefabricated columns	Precast beam
PC non-structural components	Precast facade	Prefabricated staircase slabs	Prefabricated laminated boards
Composite structures	Composite walls	Laminated slabs	Laminated beams

Compared to traditional frame and brick concrete buildings, high-rise buildings based on PC construction technology have strong freedom in spatial layout. And while ensuring the reliability of the building structure, modular concrete prefabricated components are used, making it more convenient for construction personnel to carry out the layout of building components. The components such as walls, columns, and slabs in PC structures are all manufactured in the factory with consistent design specifications, which to some extent ensures the standardization and standardization of prefabricated component production and significantly improves production accuracy. The building components used in the construction technology of PC structures are all PC components. It helps to maintain on-site construction safety and improve construction efficiency. The construction technology of PC structures in high-rise buildings will utilize BIM technology in practice to ensure the reliability and accuracy of high-rise building design. Prefabricated components are all produced through factory hydration production, so there is particularly little construction waste on the construction site, which improves resource utilization and reduces the harm to the surrounding environment of the construction factory [8].

2.2 Shortcomings of PC Structures

The inability to fully grasp the specific situation of high-rise buildings in the construction design of concrete structures has led to some problems in the sequence of construction design and construction. Especially before formal construction, it is relatively difficult to arrange and handle a large number of components, which will to some extent affect the efficiency and quality of subsequent construction. The inability to fully grasp the actual situation of high-rise buildings before construction leads to problems in construction design and sequence. Especially before the start of construction, it is difficult to handle a large number of components, which can easily affect the efficiency and quality of subsequent construction. In specific construction, there are many types of components, and it is necessary to choose lifting equipment reasonably based on the specific data of component installation and actual needs to ensure the safe and stable operation of lifting operations and improve the construction efficiency of PC structures. In the actual construction process, due to the large amount of work and the variety of component types. The connection and sequence of construction processes are a

prerequisite for ensuring the stability of the construction of PC structures in high-rise buildings. In the actual construction process, due to the large workload and diverse types of components, it is easy to encounter problems of improper sequence in different construction stages, which can affect the overall progress [9].

3. Seismic Design and Analysis of High-Rise Building Structures

3.1 Seismic Design of High-Rise Building Structures

In the specific construction of a high-rise building project, prefabricated components are mainly used, using reinforced concrete construction methods. The outer enclosure structure is also set as a curtain wall structure. When the building has more than 7 floors, prefabricated components can be used. The overall ETABS three-dimensional model of the high-rise building structure is shown in Figure 1. In order to improve the seismic design level of the project, designers need to reduce the seismic effect of the upper structure in the context of the application of prefabricated components, while also improving the seismic performance of high-rise building structures to ensure the reliability and safety of people's living. In order to minimize the torsion of high-rise building structures as much as possible, designers need to arrange seismic bearings containing lead cores around the high-rise building structure.

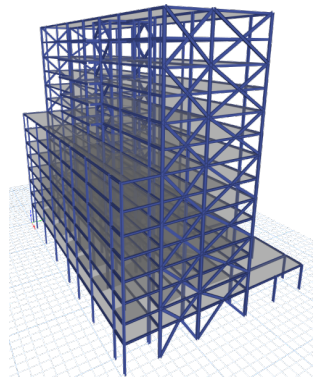


Figure 1: Overall structure ETABS 3D model

3.2 Seismic Analysis of High-Rise Building Structures

Safety, applicability, and durability can be said to be the most basic design requirements for the PC structure design. In addition, sufficient attention and attention should be paid to many details. By using ETABS software, partition assumptions are made for each floor of high-rise buildings based on the characteristics of seismic structures. At the same time, in the context of the application of prefabricated components, reinforced concrete, frame columns, and shear walls should be effectively combined to form a unified whole, thereby achieving the accuracy of ETABS model construction. In the process of seismic design of high-rise building structures, designers should pay attention to the control of floor shear force to ensure that the seismic crack resistance strength of the structure reaches seven degrees. Then, while reducing the seismic fortification amplitude, starting from both non seismic and seismic structures, the degree of earthquake impact should be minimized as much as possible, laying a solid foundation for further improving the seismic performance of high-rise building structures. In order to ensure the seismic design level of high-rise building structures and ensure the safety of high-rise buildings, designers should pay attention to the verification of the tensile stress of seismic bearings in the context of the application of prefabricated components, and ensure that the tensile stress of seismic bearings meets the relevant standards and requirements of seismic design. In the context of the application of prefabricated components, in order to further improve the seismic performance of high-rise building structures, designers should pay attention to the construction and application of seismic analysis models in the process of seismic design, ensuring that seismic design work has evidence and rules to follow [10].

The new construction technologies and methods represented by PC structures are increasingly being accepted and used, enhancing the understanding of the construction industry and academia, continuously highlighting the importance of construction mode selection, and continuously reflecting the economic, environmental, and social benefits of the PC construction industry in this process. In the

whole life cycle of a building, the construction link, use and demolition process will inevitably have an impact on the surrounding environment, especially in the construction link, there will be a large consumption of resources and energy, resulting in light pollution, noise pollution, dust pollution, etc., and a large number of construction waste, which are exactly the problems existing in the construction of traditional cast-in-place buildings. The environmental benefits of prefabricated building mainly focus on the energy conservation and emission reduction in the construction process, that is, to comprehensively determine the environmental benefits of prefabricated building in the construction phase from four aspects: saving resources, saving energy, reducing construction waste emissions, and reducing carbon emissions.

4. Conclusions

With the gradual increase of policy support in recent years, PC buildings are thriving, which is also an important path for the transformation and upgrading of the construction industry. The full application of PC structure construction technology can improve the overall construction efficiency of high-rise buildings, and has positive significance for improving the level of high-rise buildings. In urbanization construction, the use of PC structure construction technology in high-rise building projects can leverage the flexible characteristics of this technology to improve the construction level of high-rise buildings in the construction industry and achieve sustainable development of the construction industry. In the construction process of high-rise buildings, the full application of PC structures can ensure the construction efficiency of high-rise buildings and have positive significance in improving the overall construction level of high-rise buildings. As for the construction technology of PC structure, it also needs technicians to optimize, reform, update and improve it constantly, and strengthen the innovation and practical application of this technology, so as to further promote the development of prefabricated building engineering in a more scientific and standardized direction. Simultaneously utilizing information technology in the new era to promote the innovative development of PC structure construction technology. Furthermore, in the internal construction of the construction industry, leverage the practical advantages of PC structure construction technology to promote standardized construction of high-rise building projects. To truly leverage the technical advantages of PC structure construction, we should comprehensively grasp the problems and key points in the construction process. At the same time, it is of great significance to continuously improve quality control work from the perspective of process links, in order to enhance the standardized construction of high-rise buildings.

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