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Research on the Influence of Design Parameters on the Seismic Capacity of High Rise Prefabricated Structure Buildings

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Abstract: *Building industrialization and resilience are the goals and trends of structural engineering development. Prestressed assembly design and construction is an effective way to achieve this goal. The birth of prefabricated buildings has met people's demand for diversified buildings from many angles. At the same time, prefabricated buildings have also broken the limitations of long construction time and low efficiency of traditional buildings, and gained broader development prospects in construction work. Compared with cast-in-place concrete structure, prestressed prefabricated concrete structure has the advantages of good performance, small residual deformation after earthquake, full use of high-strength materials to reduce self-weight, industrial production and fast construction speed. Each part of the prefabricated building can be disassembled and assembled. When designing the structure, it is necessary to consider the characteristics of the structural system, and set up the connection mode reasonably during assembly to ensure the stability of the structure. This paper expounds the influence of design parameters on the seismic capacity of high-rise assembled structure buildings, and puts forward the seismic design strategy of high-rise assembled structure buildings.*

Keywords: *Assembled building; Design parameters; Shock resistance*

1. Introduction

Under the background of the new era, with the rapid development of social economy, the development speed of China's construction industry has also become faster and faster, and all sectors of society have put forward stricter requirements for every aspect of architecture, especially the structural form of architecture [1]. At present, the architectural forms are increasingly diversified, and prefabricated buildings are one of them, which is also the main trend of future architectural development. Prestressed prefabricated concrete structure is a new type of structure that organically combines prestressed concrete structure and prefabricated concrete, and prefabricated components are assembled into a whole by prestressed tendons [2]. Compared with cast-in-place concrete structure, prestressed prefabricated concrete structure has the advantages of good performance, small residual deformation after earthquake, full use of high-strength materials to reduce self-weight, industrial production and fast construction speed [3]. Prefabricated buildings are quickly recognized by people for their advantages of modular production, fast installation and less pollution. Assembled steel structure conforms to the national strategy of promoting the use of residential industrialization and steel structure development. Its advantages are superior seismic capacity, integrated design and production, large effective use area, flexible layout of building space and good comprehensive economic benefits, and it has broad market prospects [4]. In terms of energy saving, prefabricated buildings can save the resources consumed in the construction process, so that the development of the construction industry has been in a sustainable development trend, meeting all the conditions needed for the rapid development of the construction industry in China [5]. Architectural structure design means that architectural designers embody their own ideas and creativity in construction buildings. Designers should consider the factors such as the geology of the construction site, earthquake resistance and crack prevention ability in the process of architectural structure design, and integrate these external factors into the final design drawings. The prefabricated building structure meets the requirements of "green building" and the sustainable development needs of the construction industry [6]. Structural design is an important part of building project construction. In the design stage, it is necessary to comprehensively consider the project requirements, surrounding geology, structural performance, etc., and establish corresponding building models and draw drawings to provide a basis for subsequent

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construction [7]. Compared with traditional buildings, prestressed prefabricated buildings have the advantages of simple construction technology, low construction requirements and short construction time, and can reap more economic benefits for the construction industry [8]. Compared with the traditional reinforced concrete structure, each part of the prefabricated building can be disassembled and assembled. In structural design, the structural system characteristics should be considered, and the connection mode during assembly should be reasonably set to ensure the stability of the structure. As a new building type, prestressed prefabricated buildings should have high seismic performance [9]. This paper expounds the influence of design parameters on the seismic capacity of high-rise assembled structure buildings, and puts forward the seismic design strategy of high-rise assembled structure buildings.

2. Basic characteristics of prefabricated buildings

Assembled building means that in the process of building, all the components needed by the building are manufactured in advance, and then these components are transported to the construction site in a unified way, and assembled through the design arrangement, and finally the whole building is completed. For the structure of prefabricated buildings, it is necessary to pay attention to the reasonable division of concrete components in order to improve the effectiveness of concrete components in construction projects. The dimensions of structural members should meet the requirements of modularization and standardization in production, so as to optimize the design. A large number of modularized and standardized components are convenient for production and reduce the cost. In terms of construction, the speed of prefabricated buildings is very fast, the quality of completed buildings is relatively high, and it is also highly environmentally friendly [10]. Combined with the current development status of prefabricated buildings, prefabricated buildings will certainly become the main development direction of construction industry in the future. The bearing capacity, deformation and cracks of precast members should be checked, and the bearing capacity under earthquake conditions should also be calculated, in addition, the checking calculation under short-term design conditions should be paid attention to. The final section and reinforcement of members are different because of the different stress modes of members under various working conditions or the concrete strength of members does not reach the design strength. Figure 1 shows the design concept of high-rise assembled building.

Figure 1: High-rise prefabricated building

In order to better apply the prefabricated building design technology in the construction, the whole construction process should be carried out on the premise that the fundamental conditions are met, so as to ensure that the later construction is consistent with the previous architectural design. Precast member design In the process of designing the whole structure, we should focus on the connection design between precast members to ensure that all nodes are safe and reliable, meet the requirements of codes, and meet the requirements of structural bearing capacity design and seismic design. Assembled building refers to the prefabricated building form that integrates system structure, external wall enclosure system, equipment integrated pipeline and built-in system, etc. It is a systematic project, which is mainly assembled into an integrated building by prefabricating standardized components in advance. The principle of applying prefabricated building technology is to put the overall technical work before construction, so the construction process of prefabricated building in the later stage is very complicated, and the design in the earlier stage will be bound by many conditions, which makes the actual construction in the later stage have many hidden dangers.

3. Influence of design parameters on seismic capacity of prefabricated buildings

When designing a building structure, if the architectural design conditions permit, the structural

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design usually gives priority to increasing the cross section to solve the over-limit phenomenon of frame beams and columns [11]. In recent years, the actual intensity of many earthquakes has exceeded the standard fortification level, and the actual earthquake action suffered by buildings is far greater than the design earthquake action. Therefore, it is of great significance to determine reasonable earthquake action, load coefficient and other parameters to ensure the seismic safety of building structures. Generally speaking, improving the safety of the structure will increase the construction cost of the structure accordingly, and the important index reflecting the construction cost is the amount of materials. Designers should carefully study the industry regulations, not only make the relevant parameters meet the industry standards, but also pay attention to the environmental protection regulations, and help the designed prefabricated buildings fully meet the industry standards set by relevant state departments. In addition, they should also pay attention to cost control so that the design can be the most scientific, reasonable and legal. In the process of using assembled building structure, the assembled frame structure system should be selected scientifically and reasonably in combination with design parameters. This can not only effectively prevent the waste of cost, but also effectively improve the utilization efficiency of prefabricated building structures.

4. Key points of seismic design of high-rise assembled building structure

Prefabricated building design needs to deepen the design link. In the specific design process, we should not only pay attention to the original building structure design content, but also pay attention to all kinds of new design requirements. The design process of prefabricated components must refer to the production level of the production unit, ensure the appropriate size, minimize the errors between building structures, and try to avoid quality problems caused by size. Most units split the components in order to reduce the construction cost and ensure the construction process, which is beneficial to control each construction point in the construction site. During the design of prefabricated buildings, designers should fully grasp the project scale and cost, select effective building structure types according to the corresponding standards and requirements, and control the connection modes and positions of key areas such as columns and shear walls to ensure that the relevant dimensions meet the design standards of prefabricated components. The classification of building data model of high-rise assembly book based on design parameters is shown in Figure 2.

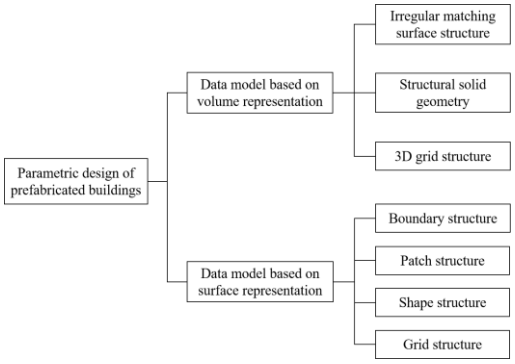

Figure 2: Classification of building data models of high-rise assembly books based on design parameters

The design staff should also consider the work of safety and component transportation, and constantly redesign the prefabricated components, so as to make the total construction more reasonable. During the design of prefabricated components, we should refer to the production process level of the production unit, determine the most reasonable size, minimize the errors between building structures, and strive to avoid quality problems caused by size problems. At the same time, designers should also pay attention to the hoisting work level of the construction unit and reasonably choose the hoisting mode, location and other details. In the elevation design of prefabricated buildings, the horizontal and vertical structures must be combined with each other, and the prefabricated external walls must be divided in the horizontal structure diagram. Mainly to separate the balcony from the window. In the vertical structure drawing, the protruding prefabricated members should be constructed perpendicular to the rules, and the balcony design should be highlighted on the horizontal vertical surface to form a separate main body on the external wall.

For the disassembly of prefabricated components, it is necessary to grasp the stress situation of the main structure of prefabricated buildings. When mastering the scope of cast-in-place and prefabrication,

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it is necessary to clarify the location of component disassembly and the relationship between post-pouring area and prefabricated components. When the structure is split, the types of components should be reduced according to the actual situation to ensure the overall rationality of the building structure. At the stage of scheme design, all project participants must be informed to organize a meeting to clarify their respective terms of reference, discuss and finalize the architectural graphic design scheme, facade design scheme and apartment type, standardize the dimensions of functional space areas such as kitchen and bathroom, and determine the modulus of window opening. For prefabricated components, it is necessary to demonstrate the economy and feasibility scheme to ensure the quality and economic benefits of engineering construction. Designers can use the building information model (BIM technology) to design, so as to effectively enhance the visibility of assembled buildings in the design process, help designers to better optimize and adjust the component design, and improve the quality of structural design. When applying the prefabricated building technology, we should also have a full grasp of the overall layout of the construction, so that the overall layout after the later completion has higher reasonable application performance and the overall structure of the building has strong bearing capacity.

5. Conclusion

Under the background of the new era, with the rapid development of social economy, the development speed of the construction industry has also become faster and faster, which has improved the use efficiency of prefabricated buildings to some extent. The application of this structural form has effectively improved the relatively complicated room division problem on some floors. It effectively reduces the situation that beams have to be set when there are walls, and makes the whole structure more perfect in force transmission. At the same time, this structural form also brings great convenience to the construction of the building, and also reserves more space for residents to arrange themselves. It is of great significance to determine reasonable earthquake action, load coefficient and other parameters to ensure the seismic safety of building structures. Compared with traditional forms, prefabricated buildings have the characteristics of fast construction speed and high construction efficiency. But for now, designers should combine the actual situation, use scientific and effective solutions, and constantly optimize the structural design of prefabricated buildings, which can effectively improve the rationality and scientificity of prefabricated structures. In the design of the weak parts of the irregular structure, through the adjustment of structural layout and the targeted strengthening of component design, the adverse effects caused by irregular shape can be reduced and the effect of improving the seismic performance of the structure can be achieved.

References

[1] Li C Z, Xue F, Li X, et al. An Internet of Things-enabled BIM platform for on-site assembly services in prefabricated construction [J]. Automation in Construction, 2018, 89(5):146-161.
[2] Huq M S, Burgos E A, Lequesne R D, et al. High-Strength Steel Bars in Earthquake-Resistant Reinforced Concrete T-Shaped Walls[J]. ACI Structural Journal, 2021(1):118.
[3] Abey S T, Anand K B. Embodied Energy Comparison of Prefabricated and Conventional Building Construction [J]. Journal of the Institution of Engineers (India), 2019, 100(4):777-790.
[4] Hwang B G, Shan M, Looi K Y. Knowledge-based decision support system for prefabricated prefmished volumetric construction [J]. Automation in Construction, 2018, 94(10):168-178.
[5] Fiorino L, Pali T, Landolfo R. Out-of-plane seismic design by testing of non-structural lightweight steel drywall partition walls [J]. Thin-Walled Structures, 2018, 130(9):213-230.
[6] Vahdat-Nejad H, Asef M. Architecture design of the air pollution mapping system by mobile crowd sensing [J]. Iet Wireless Sensor Systems, 2018, 8(6):268-275.
[7] Harry S, Kumar A. Transformation of the Design Studio in New Learning Spaces: Virtual Design Studio in Architecture Pedagogy [J]. ECS transactions, 2022(1):107.
[8] Poulos A, Miranda E. Proposal of orientation-independent measure of intensity for earthquake - resistant design: [J]. Earthquake Spectra, 2022, 38(1):235-253.
[9] Urea A G, Tremblay R, Rogers C A. Earthquake-resistant design of steel frames with intentionally eccentric braces [J]. Journal of Constructional Steel Research, 2021, 178(8):106483.
[10] Imansyah MD, Imran I, Kamaruddin K S, et al. Behavior of earthquake-resistant structure elements using polypropylene fiber and high strength reinforcing bars [J]. Matec Web of Conferences, 2019, 258(3):05007.
[11] Pradhan R, Pradhan P M. Earthquake Resistant Assessment of Building Construction Technique in the Nayagaun Settlement of Kavre before Gorkha Earthquake [J]. Lowland Technology International, 2020, 22(1):27-34.