A study investigating the integrated application of intelligent construction and assembly building based on BIM technology

Yanxiao Guo*, Jinyi Zhu, Senyu Yang, Xinyuan Feng, Yuxin Zheng

Miami College of Henan University, Henan University, Zhengzhou, China, 450046

* Corresponding Author Email: g20245301416@163.com

Abstract. The construction industry, is facing the inevitable trend of digital transformation in the new wave of technology. The general production and construction build cycle is long and on-site construction activities is associated with a number of environmental issues. Additionally, the construction progress points and management are not clear, which presents a challenge for the industry. Consequently, the objective of this article is to integrate and apply a range of technologies, including BIM (Building Information Modeling), cloud computing, big data, Internet of Things, 5G, RPA (Robotic Process Automation), and others, to on-site operation control by integrating them. This integration will facilitate the analysis of the considerable advantages of intelligent construction and assembly building in its application. The conference center of the Qionglai Talent Service Exchange Center will be used as a case study to demonstrate the potential of these technologies. The paper will also propose new views and ideas for addressing the challenges currently faced by the construction industry. The research findings indicate that the integration of multiple intelligent construction systems and assembly components enhances construction progress, simplifies construction processes, and minimizes construction-related pollution. This evidence supports the viability of efficient, intelligent, and sustainable building design and construction methodologies, and provides a robust foundation for the transformation and advancement of the industry.

Keywords: BIM technology, Internet of Things (IoT) technology, Intelligent construction, Assembly building.

1. Introduction

As a significant contributor to China's economy, the construction industry is poised to benefit from a pivotal opportunity for digital transformation in the context of the current technological revolution. The objective of this paper is to facilitate the digital transformation and innovative development of the construction industry by integrating cutting-edge digital technologies, including BIM, cloud computing, big data, IoT and 5G. This paper will conduct an in-depth study of new Internet of Things technologies for intelligent construction and assembly buildings, integrating BIM technology with information technologies such as the Internet of Things and big data. The aim is to provide solid technological support and impetus for the transformation and upgrading of the industry.

Aish introduced the concept of Building Information Modelling (BIM), which encompasses 3D modelling, schedule simulation, and other related elements, as a pivotal aspect of the BIM concept. Subsequently, Nederveen proposed the term Building Information Model in his paper, and Tolman further elaborated it. Autodesk launched its own BIM software and carried out the publicity and promotion of BIM-related products, thus BIM technology entered the public eye.[1] Borjeghaleh et al. proposed the integrated application[2] in combination with BIM technology, which is able to centralise the management information of a building in the same model. This approach addresses the issue of data and information being unable to be shared across different phases of construction[3], which has been a significant challenge in the past. Prof. Navaratnam highlighted the potential of prefabricated assembled building construction methods as a sustainable solution[4] to reduce labour and material requirements. Chao Huang et al. proposed the use of Internet of Things (IoT) technology to combine real-time dynamic data from Building Information Modelling (BIM) models with equipment in the building, thereby advancing the progress of intelligence and digitalisation in the construction industry. This paper will examine the integration of digital technology into the construction of assembly buildings, with a particular focus on BIM. The utilisation of BIM technology has been demonstrated

to enhance the efficiency of construction management, accelerate the progress of projects, reduce the construction cost, and increase the economic benefits of enterprises[5].

The Qionglai Talent Service Exchange Center, situated within the conference center building construction project, has encountered a number of challenges pertaining to the general production and construction of the aforementioned project. These include a lengthy construction cycle, slow progress, and a high degree of complexity. The project has been put into use with an urgent demand, and the ordinary construction process is more difficult to implement in order to reduce the on-site construction volume, shorten the construction cycle, and reduce manpower. In addition to the aforementioned considerations, the construction industry must also address the issue of power and costs, as well as the need for personalised customisation (e.g., glass curtain wall). Construction site pollution is a significant concern, and construction enterprises tend to prioritise project cost and construction progress, often to the detriment of the surrounding residents and the ecological environment. The environmental issues frequently encountered during construction projects include noise pollution, wastewater contamination, light pollution, waste generation, and dust pollution. These are caused by the use of high-powered equipment and the incorporation of reinforcing steel, gravel, cement, and other materials, which result in carbon emissions and pose a challenge to achieving the carbon peak target[6]. The construction process is not standardised, the construction progress of the traditional building construction is not clear, the construction site is not exact, construction management is not detailed, and other pain points are frequent. Furthermore, there is a lack of integrated operation, standardisation of standards and lack of holistic thinking.

In the context of the rapid evolution of science and technology, cutting-edge technologies such as the Internet of Things (IoT), big data and 5G are gradually permeating all aspects of life. Emerging technologies such as Building Information Modelling (BIM) and IoT technology are playing an increasingly pivotal role in the design of constructed environments[7], and the convergence and integration of these advanced technologies will usher in a profound digital transformation in the construction industry.

The advent of IoT has brought about a paradigm shift in the construction industry, offering unprecedented convenience. By connecting various types of sensors and devices to the Internet, it is now possible to monitor in real time the parameters of a construction site, such as temperature, humidity, pressure, and so on. These data not only help construction personnel to understand the construction process in more detail, but also provide more accurate data support for building design and construction. The monitoring of wind speed, wind direction and other data in the context of high-rise building construction allows relevant personnel to make more accurate predictions of the risk of the construction process, thereby enabling appropriate measures to be taken to ensure the safety and quality of construction. The application of big data technology to the construction industry provides the industry with more intelligent design and construction methods. By meticulous examination and analysis of voluminous data, the underlying principles and prevailing trends in architectural design and construction are further elucidated, thereby furnishing a more scientific foundation for future architectural design and construction.

5G technology furnishes the construction industry with efficient data transmission and processing capabilities, supports the simultaneous connection and data transmission of a multitude of devices, and provides a reliable technical guarantee for construction. It is evident that the digital transformation of the construction industry necessitates the collective endeavours of the government, enterprises and all sectors of society, encompassing the implementation of policies, augmented investment in technology, dissemination and promotion. Digital transformation is not merely a technological advancement, but also a transformation of the industry, encompassing numerous aspects such as production methods, management methods and business models. In conclusion, the integration and application of technologies such as the Internet of Things, big data and 5G, in conjunction with the collective efforts of the entire society, will facilitate the digital transformation of the construction industry.

2. The application of intelligent construction in Qionglai Talent Exchange Service Center

In the construction of the Qionglai Talent Exchange Service Center, intelligent construction technology plays an essential role. The utilization of Internet of Things technology, artificial intelligence, 5G communication technology, and building information modeling (BIM) construction virtual modeling and simulation construction technology has enabled the achievement of a multitude of objectives, including enhanced construction efficiency, reduced costs, and superior quality in the project. This paper utilized the Revit software to model the conference center of the Qionglai Talent Exchange Service Center in three dimensions, then combined this model with the CAD drawings to draw out the details of the building in greater detail, ultimately forming the building as a whole, as illustrated in fig.1.



Fig. 1 Exterior body model of the conference center

The software's rendering function and daylight path function were employed to illustrate the edifice in varying lighting angles, simulating the eventual appearance of the conference center building upon its complete construction. The BIM model of the intelligent construction provides an idealized visualization of the effect, affording engineers and construction personnel access to detailed construction information, thus allowing them to create precise drawings on a two-dimensional plane. The exterior overall model and model details are presented in figs. 2 and 3, respectively.



Fig. 2 Rendered overall model of the exterior



Fig. 3 Details of the rendered model

In intelligent construction and assembly building design, the use of Revit software to create a three-dimensional model of the building, including an internal model, allows for the accurate representation of the building's appearance from multiple angles. This model can then be imported into BIMFILM virtual construction software[8] to produce a construction animation, which assists engineers in the design and construction of more effective planning and coordination of the various components. This process not only improves the efficiency of the design, but also reduces errors and rework in the construction phase[9], to a certain extent.

2.1. IoT technology and 5G applications

The strength of IoT technology and 5G communication technology, such as fast speed, wide range, and timely feedback, has led to the installation of a significant number of video monitoring devices at construction sites. These devices are utilized to monitor environmental changes in real time and supervise construction safety. Additionally, sensors have been installed on each assembled component to monitor temperature status, location status, and other information in real time, providing real-time feedback to the data center.

Comprehensive sensors, such as assembled component position monitoring, assembled component temperature monitoring, and site construction equipment monitoring, are installed to control switches at any time. The open-source IoT data center captures pertinent data and provides timely and efficient feedback. Once the data has been uploaded, the advantages of efficient, convenient, and integrated computer data processing technology and network technology are employed to analyze the data returned by each sensor installed on the assembly components and to continue to monitor the relevant parameters in real time. Concurrently, the platform sets the warning value of these numbers. In the course of transportation, construction and subsequent maintenance, the data center receives early warning information from the computer, and timely monitors the vibration and cracks during transportation, the installation position during construction, and the cracking of the concrete components in the post-maintenance period. This enables the relevant personnel to be promptly informed of any necessary action to be taken when an alarm is received.

2.2. A data-based study of the future of smart construction applications

This paper explores the wide application of IoT technology and AI technology in smart construction, with data as the core. Through the extensive deployment of IoT devices, various types of data from the construction site are collected in real time and aggregated to the data center through high-speed transmission[10]. Moreover, advanced machine learning algorithms are applied to historical data to predict future construction trends. In the practice of smart construction, researchers

connect most of the assembled components to IoT sensor devices to collect various types of data from the construction site, including environmental parameters, equipment status and material consumption. These numbers are transmitted and collected to provide data support for construction decision making. This paper actively explores the application of AI in intelligent construction, using machine learning and other algorithms to study the historical construction data, reveal the potential laws therein, achieve accurate prediction and simulation of future construction trends, and then achieve refined management of the construction process. This not only makes it possible to anticipate potential problems before construction and avoid them in time, but also improves the predictability and controllability of the construction process. In terms of construction progress and quality, the use of advanced technology also enables real-time monitoring of the construction site and accurately adjustment of the work plan.

3. Assembly building construction process

3.1. Transport and installation of assembled floor slabs

The distance between the construction site and the factory where the prefabricated components are manufactured is 50km, which is within the 150km limit set for the transport of prefabricated components. In the prefabricated floor components transport project, the staff analyse the external road traffic conditions and consider the influence of height, width and weight limits.

In the context of construction site and road hardening works, the construction company ensures that the transportation of components meets the loading requirements of vehicles. In the event that there are underground structures on the access road, the roof load should be calibrated. Furthermore, 200-mm-thick precast concrete construction pads were employed in order to achieve recycling, with the objective of reducing material waste.

3.1.1. Lifting of assembled components and precautions

During the construction process, the crane position and cantilever radius are based on the principles of safety, economy, and reasonableness. The final determination of the crane position must be adjusted according to the on-site construction programme. And the lifting of prefabricated floor components is undertaken with the objective of developing construction protection measures designed to prevent components from overturning, falling, and other safety accidents.

3.1.2. Construction and installation engineering of prefabricated floor slabs

The prefabricated wall is constructed using a modified gypsum composite lightweight partition board, which adheres to the specifications outlined in the *Technical specification for lightweight panel partition walls of buildings* (JGJT157-2014) and the national standard atlas *Lightweight Strip Board (I)* (GJBT-1131). Furthermore, it meets the requirements set forth in the *Testing Standard for Lightweight Strip Wall Partitions* (GBT23451-2009). When installing multifunctional lightweight composite partition panels, the strips should be arranged vertically according to the length direction of the partition wall, and the layout also should be in accordance with the standard version. When there is less than one standard board in the partition, the installation height of the partition joint board should not exceed 45m; when installing partition walls with slats within the height limit, it is not advisable to connect the slats more than once.

It is necessary to add the connecting parts and positioning steel clips to the joint of the strip board, and to implement positioning, reinforcement, and crack prevention measures. In order to meet the requirements of sound insulation design and seismic performance of strip partition walls, and to comply with the relevant provisions of the current national standard *Code for Design of Sound Insulation of Civil Buildings* (GB50118), the connection between strip partition walls and top plates, structural beams, main walls, and columns should be made of galvanized steel plate clamps, and fixed with expansion pipe screws and rivets. Furthermore, the installation of steel plate fasteners must adhere to the specifications outlined in the *Technical Specification for Lightweight Panel Partition*

Walls of Buildings (JGJT157-2014) and the National Standard Atlas *Lightweight Panel (I)* (GJBT-1131).

It is inadvisable to design concealed distribution boxes and control cabinets within single-layer strip partition walls and horizontal concealed water pipes. This can be circumvented by utilising exposed installation methods or locally designing double-layer strip walls. It is imperative that partition walls are not penetrated; additionally, thin box bodies should be selected for distribution boxes and control cabinets.

In the event that heavy objects and equipment are to be hung on the partition wall, single point fixation is not permitted. The single point suspension force is less than 1000N, and reinforcement measures are incorporated into the design. Furthermore, the distance between two points should exceed 300mm. Both embedded parts and anchoring components are treated with anti-corrosion and rust prevention measures, and embedded iron parts should be avoided from being exposed. It is of paramount importance that the flatness of the adjacent 200mm width range between prefabricated components and cast-in-place structures is strictly controlled and should not exceed 1mm.

The construction unit is required to develop a detailed construction plan for the storage, lifting, installation positioning, and connection pouring of prefabricated components. And submit it to the engineering supervision and design companies for review. Construction can only be carried out after obtaining written approval documents. It is imperative that operators receive the requisite training and assessment before they are permitted to commence work.

3.2. Construction of prefabricated interior walls

The integration of interior walls through prefabrication ensures the coherence of the overall design, while also guaranteeing that the components are within the permitted range during subsequent installation. It is imperative that the prefabricated components and their cast-in-place nodes are not chiselled in order to avoid any potential structural implications.

3.2.1. Internal wall construction process flow

(1) Upon arrival on the construction site, the prefabricated interior wall panel components are subjected to an initial quality inspection. This inspection primarily concerns the length, thickness, and other related dimensions of the components.

(2) Prior to the installation of the prefabricated wall panel components, it is necessary to make preliminary adjustments to the reserved steel bar positions on the panel surface. When lifting prefabricated interior wall panels, duck-billed buckles are employed to fix the reserved lifting points. It is necessary that the lifting equipment be fixed in place before lifting commences. High-strength lifting chains are utilized in conjunction with tower cranes for lifting purposes.

(3) When installing prefabricated wall panels, workers are positioned on both sides to provide support for the wall panels during preliminary positioning. Once the wall panels have been lifted to the upper part of the reserved steel bars, construction personnel reposition and command the tower crane to slowly lower the wall panels until they are all aligned with the holes and fall onto the floor slab. The fixed gasket is to be installed at the reserved point of the wallboard, and then the slant support is to be installed. Subsequently, the lower right-angle fixing components are installed and the wall panel is preliminarily fixed. Finally, the instrument should be used to calibrate the wall panel. Once the installation of the aluminium mould is complete, the position of the prefabricated wall panel and the length of the reserved bonding steel bars should be reassessed. And perform vertical acceptance of prefabricated wall panels before pouring the floor slab.

(4) The grouting of the prefabricated wall panels begins 24 hours later. Before grouting, the hole is flushed and cleaned, and the grout is poured into the grouting machine after wetting. At the beginning of grouting, injection is carried out from the lower hole for grouting construction; after the mortar flows out of the upper hole, seal the hole and hold the pressure; after the pressure holding is completed, seal the lower hole and complete the grouting.

(5) After the grouting is completed and the formwork is removed, the sloping support of the precast wallboard shall be removed at the same time to complete the construction of the precast wallboard.

3.2.2. Analysis of transportation and construction solutions for prefabricated interior wall components

In response to the problem of component stacking[11], in order to avoid cracking of prefabricated inner wall components due to bumps during transportation, drivers should choose a smooth and less turning route during transportation; the stacking site should be dry, flat, hard and hard; standardize the installation process, improve the installation and construction efficiency, avoid non-standard operations and prohibit violent construction.

Furthermore, this article proposes the integration of intelligent construction[12] as a solution to the shortcomings of traditional building construction, which is characterized by a lack of integrated operation, standardized construction, and overall thinking. The concept of intelligent construction facilitates industrial upgrading and optimization. For instance, in the design phase, digital modelling is employed to overlay intelligent platforms. In the production stage of building materials, intelligent equipment and intelligent warehousing logistics are employed. During the construction phase, prefabricated construction, intelligent machinery, and construction simulation are employed. And during the maintenance and operation phase, intelligent detection and repair will be employed, utilizing automated equipment. Furthermore, by integrating AI technology with the Internet of Things, the complexity of prefabricated construction management can be mitigated, and real-time monitoring systems can promptly identify issues on the construction site, thereby facilitating intelligent management.

3.3. Assembled Curtain Wall Construction

3.3.1. Construction technology of glass curtain wall

Given the fragility of the glass, the glasses are placed on the A-frame and transported to the safe floor via the construction elevator. The workers then press the glass into the installation position with a suction cup. The plate is attached to the column with screws, the screw joint is placed on the press plate with sealant, and the surface is then scraped flat. The outermost cover plate is fixed in the pressing plate card groove and aligned with the glass frame and the aluminium profile in accordance with the specifications outlined in the drawing. The sealant is then injected at the width of the glue gun and scraped flat to prevent water leakage.

Once the foundation construction has been completed, the intelligent construction becomes particularly evident, as it achieves the desired outcomes of suitable work, energy efficiency, convenient maintenance, and aesthetic appeal. Firstly, the intelligent external wall is designed to adapt to the internal and external environmental changes of the building through its components, allowing for the optimal introduction of natural lighting, the reduction of solar radiation, and the control of HVAC. Subsequently, digital ceramic glass printed louvers, with blades reaching a height of 4 metres to cover the building floor), are employed, as illustrated in fig.4. This serves to reduce solar heat acquisition and ultraviolet exposure, thereby facilitating the introduction of a substantial quantity of natural light. Furthermore, electrochromic glass is utilized to alter the applied stress on the glass sheet and to automatically alter its colour in response to sensors.

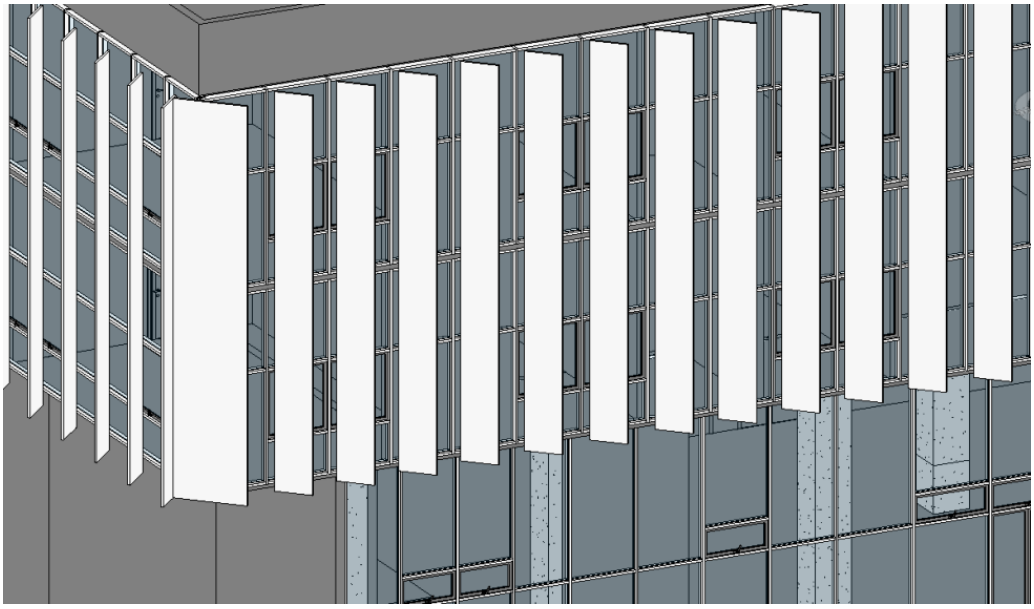


Fig. 4 Digital ceramic glass printed louvre rendering model

During the construction process, it is imperative that the fire prevention measures between the glass curtain wall layers be reinforced in order to mitigate the potential safety risks. The upper and lower parts of the interlayer structural beams are constructed from galvanized steel plate and filled with 200mm thick fireproof cotton. It is of paramount importance that the gap between the galvanized steel sheet and the curtain wall, exterior wall of the building, and between the galvanized steel sheet be blocked with elastic fire blocking material. The height of the firewall between the glass curtain wall should be at least 800mm (with spray) or 1200mm (without spray).

3.3.2. Research on the installation process of the glass curtain wall

The blue part is the glass curtain wall, as shown in fig.5. The glass curtain wall is fragile and not easy to lift.

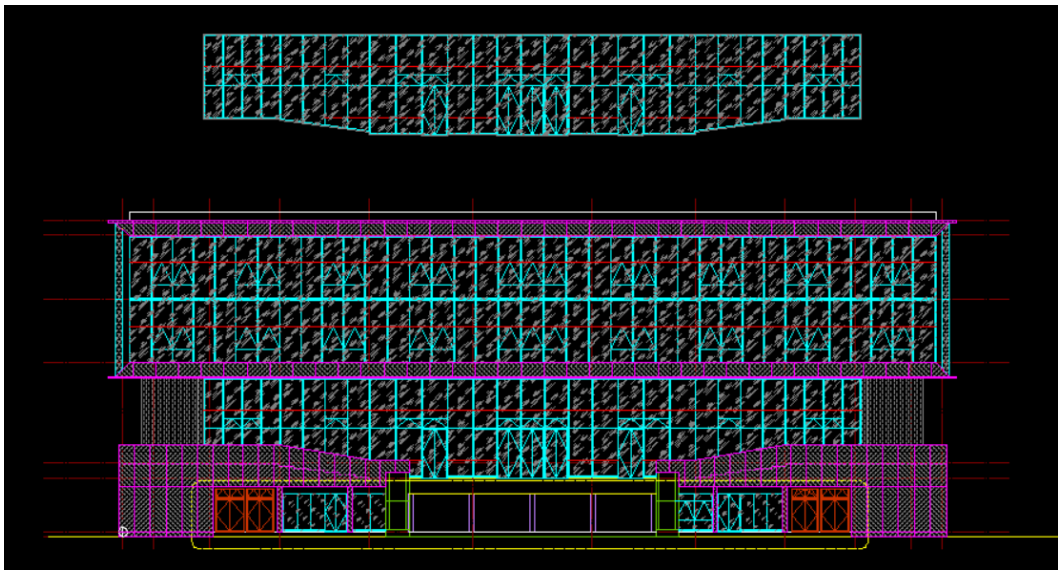


Fig. 5 CAD drawings of glass curtain wall

The frame glass curtain wall adopts 160*80*5 steel keel with single span beam, and the gap between the glass surface and the interior and external decoration of the building should not be less than 5mm, and flexible material seam can be used. In the case of both the hidden frame and semi-hidden frame glass curtain wall, it is inadvisable to utilize coated glass. It is recommended that anti-collision railings or other anti-collision measures be installed on one side of the glass curtain wall room.

3.4. Seismic effect of prefabricated buildings

With the continuous progress of the existing building technology, the prefabricated buildings have been widely promoted and adopted in the field of modern architecture because of its high efficiency and environmental protection. In the pursuit of building speed and economic benefits at the same time, engineering personnel must always stick to the bottom line. This paper to Qionglai Talent Service Exchange Center of seismic performance for example, deeply analyze the seismic requirements of prefabricated buildings and the important role of seismic components, in order to provide for the improvement of prefabricated building seismic reference.

3.4.1. Main applications of seismic components in prefabricated buildings

With the rapid development of modern building technology, prefabricated buildings have gradually become a new favorite in the industry. Especially in the face of earthquake and other natural disasters, the seismic components of prefabricated buildings through their unique structural design and material characteristics, can effectively reduce the vibration range of the building, and then ensure the overall structure of the building and the safety of internal personnel. In prefabricated buildings, the application of seismic components is mainly reflected in the following key aspects:

(1) Fire pipes, air conditioning pipes and hot and cold water pipeline systems in daily life, also including some hanging pipes.

(2) When used in air conditioning and ventilation pipes, especially for 0.7m diameter pipes and some rectangular pipes, seismic support can also be used.

(3) Seismic support can also be used in some power system pipeline and cable bracket system range, as long as the diameter is greater than or equal to 60m electrical pipeline and all gravity is greater than or equal to 150N/m cable bracket can use seismic support.

3.4.2. Seismic requirements of assembled buildings

The seismic components of assembled buildings are an indispensable part of ensuring that modern buildings have excellent seismic performance during earthquakes. Their seismic design is strictly in accordance with the relevant national seismic design codes and standards. When carrying out seismic design, the building structure must meet the requirements that small earthquakes are not problematic, medium earthquakes can be repaired, and large earthquakes do not result in collapse. In the event of an earthquake, the building must be able to maintain overall stability and avoid collapse or serious damage. It must also be able to absorb part of the energy generated by the earthquake and reduce the damage to the building structure.

In order to meet these requirements, the seismic materials of assembled buildings must meet the following aspects:

(1) Seismic components must be constructed from finished components, with a theoretical wall thickness of not less than 2.0mm. In addition to C-type channel steel, all-threaded booms may be cut off on site; however, other products must not be processed on-site.

(2) The seismic components and pipe connecting components of the material thickness should be a minimum of 5mm. The surface should be treated by electro-galvanising, zinc-chromium coating, hot dip zinc, and provide relevant test reports.

(3) The performance of anchor bolts shall comply with the current industry standard *Expansion type and reaming type construction anchor bolts for concrete* (JG160).The selection of anchor bolts shall be in accordance with the current industry standard *Technical specification for post-anchoring of mixed-rotation soil structure* (JGJ145).The relevant test reports shall be provided.

(4) In the case of anchor bolts connecting seismic connecting members with concrete structures, it is recommended that back-expanding anchor bolts with a mechanical locking effect be used, with the exclusion of expansion anchor bolts. When connecting seismic connection members with steel structures, it is necessary to utilize a special fixture for the connection.

3.4.3. Dimensional requirements of seismic components of assembled buildings

In the seismic design of assembled buildings, the size of the components is of paramount importance, not only to the overall stability of the building, but also directly affects the safety performance of the building under seismic action. In the implementation process of assembled seismic buildings, the correct transportation method can ensure the integrity of the components and the excellent seismic performance of the whole building.

It is important to ensure that the length and width of assembled seismic components are reasonably matched to avoid obvious stress concentration and deformation incongruity. Furthermore, it is necessary to control the wall thickness of the member in order to ensure that it has sufficient stiffness and stability.

3.4.4. Installation of Assembled Seismic Members

Correct installation of assembled seismic members is of paramount importance in ensuring that the building can maintain stability and minimise damage when an earthquake occurs. Prior to installation, it is essential to conduct a thorough inspection of all assembled seismic components. This includes verifying that the components' size, material quality, and connectors align with the specified criteria. This ensures that they remain intact during transportation and meet the design requirements. During the inspection process, the Internet of Things, artificial intelligence, and technologies such as BIM were employed to build virtual models and simulate construction in order to summarize data and reduce costs. Furthermore, construction personnel conduct on-site inspections to ascertain that the installation conditions meet the requisite specifications. This entails ensuring that the foundation is level and that there are no obstacles.

Once the installation is complete, the relevant personnel conduct a comprehensive quality check and acceptance to ensure that the project meets the requisite standards. In the event that any components fail to meet the requisite standards, prompt rectification and repair are implemented in order to guarantee the overall stability of the edifice.

4. Conclusions

This paper provides a comprehensive analysis of the key applications of intelligent construction and assembly building in the construction and building of the Qionglai Talent Exchange Service Centre. It also discusses the important role of intelligent construction and assembly building in improving the overall seismic performance of the building. This process allows for the identification of innovative applications of IoT, big data and 5G technology in modern construction. It is essential that assembly building design and construction adhere to relevant national design codes and standards to ensure the safety and stability of the building.

Despite the remarkable achievements of assembly building, there are still some new problems and challenges to be addressed. For instance, there is a need to investigate further how to optimise the design and installation process of the components, improve the seismic performance of the components, and how to reduce the production and transportation costs of the components. These issues require in-depth research and exploration to promote the continuous development and progress of assembly building technology.

In the future, with the continuous progress of science and technology and the continuous expansion of application fields, intelligent construction and assembly will play a more important role in the construction field. Engineers must draw upon their accumulated experience to inform future developments. This entails strengthening technological innovation and advancement, enhancing the seismic resilience and construction efficiency of components, and maintaining a prudent and reflective approach. This allows them to refine their designs to better meet the evolving needs of society and ensure that buildings are safe, comfortable and aesthetically pleasing.

References

[1] Wang Jinrong. Research on the evaluation of the development level of new building industrialisation based on BIM [D]. Qingdao University of Technology, 2023.

[2] Borjeghaleh R M, Sardroud M. Approaching Industrialization of Buildings and Integrated Construction Using Building Information Modeling [J]. Procedia Engineering, 2016, 164: 534-541.

[3] Hu Zhiyong, Wang Xinhuai, Gong Lingfei, Yi Jianhui, Liu Zixiang. Thoughts and Practices of BIM Technology Accelerating Digital Transformation of the Construction Industry. Building Energy Efficiency (in English), 2024, 52(05): 79-83.

[4] Navaratnam S, Satheeskumar A, Zhang G, Nguyen K, Venkatesan S, Poologanathan K. The challenges confronting the growth of sustainable prefabricated building construction in Australia: construction industry views. Journal of Building Engineering, 2022, 48.

[5] Chen Xiaokun, Zhang Lijuan. Research on whole life cycle cost control of assembly building based on digital technology. Journal of Zhangjiakou Institute of Vocational Technology, 2024, 37(01): 63-65.

[6] Zhao Yanjun, Zhang Jianjun, Ji Pengfei, et al. From "digital construction" to "digital intelligent construction"-intelligent transformation of construction site under the background of 5G technology. Intelligent Building, 2022, (04): 10-12.

[7] Zhang Houying and Xing Xia. Application of BIM and intelligent IoT technology in the optimisation of assembly building design. Residential Industry, 2024(02):85-87.

[8] Chen Dong, Liu Yang, He Xiangrong, et al. Research on the application of BIM technology in the management of construction process of intelligent construction of assembled buildings. Technology and Innovation, 2022, 49(08): 167-169.

[9] Zhang Houying, Xing Xia. Application of BIM and intelligent IoT technology in the optimisation of assembly building design. Residential Industry, 2024, (02): 85-87.

[10] Yue Junzheng, Li Zezheng, Hou Qingmin, et al. Application of intelligent visualisation monitoring technology based on 5G construction site. 2023,(18):173-175.

[11] Wan Tingyu, Cha Xuanpei, Li Wanhe, et al. Research on the construction control points of prefabricated internal walls of assembled buildings. Brick and Tile, 2023, 5(46-48).

[12] Wang Zhao. An analysis of the key technologies involved in the construction of residential buildings using intelligent construction techniques. Residence, 2024(11):86-89.