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Construction of Intelligent Construction Technology System of Steel Structure Building with Full Life Cycle

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Abstract: This paper first summarizes the basic concept and development status of steel structure building and full life cycle management, and then discusses the application practice of intelligent construction technology in steel structure building. This paper expounds the construction goal, principle, content and strategy of the intelligent construction technology system of the whole life cycle, and analyzes the implementation path and evaluation method of the system. Finally, the research results are summarized, and the development prospects and challenges of the whole life cycle intelligent construction technology are discussed.

Key words: steel structure building; full life cycle management; intelligent construction technology; technical system; implementation evaluation

1. Foreword

Steel structure has become an important component of modern architecture. The combination of intelligent construction technology and full life cycle management has opened up a new path for steel structure buildings. Full-life-cycle management emphasizes the optimization of the whole chain from planning, design, construction to operation and maintenance, and demolition, so as to realize efficient resource allocation and environmental friendliness. Relying on cutting-edge technologies such as the Internet of Things, big data and artificial intelligence, intelligent construction accurately monitors and intelligently optimizes the whole life cycle of steel structure buildings, improves building quality, reduces costs, speeds up the construction speed, and promotes the deep integration and upgrading of the construction industry and related industries.

2. Overview of steel Structure Building and Full Life Cycle Management

2.1 Concept and practice of whole-life cycle management

As an important part of the modern building system, the whole life cycle management of the steel structure building is becoming increasingly important. Life Cycle Management (LCM) is a management philosophy that considers all stages of products, projects or assets, from conception, design, and manufacturing to services, decommissioning, and recycling [1].

The core philosophy of LCM is to ensure efficient use of resources and minimize environmental impact at all stages by planning all stages of the entire life cycle of the building [2, 3]. The combination of LCM and steel structure building is mainly reflected in intelligent design and optimization. With the help of advanced computer aided design (CAD) and building information model (BIM) technology, fine modeling and performance analysis can be conducted on steel structure

building in the design stage, so as to realize the optimization design of the structure and the economical use of materials. Intelligent construction and management, through the introduction of the Internet of Things (IoT) and big data technology, can be real-time monitoring of the construction site indicators, including construction progress, material consumption, environmental quality, etc., to ensure the efficiency and safety of the construction process. Intelligent operation and maintenance, using the sensor network and cloud computing platform, can realize the real-time monitoring and early warning of the operation status of steel structure buildings, timely find and deal with potential security risks, and prolong the service life of the building [4].

3. Application of Intelligent Construction Technology in Steel Structure Buildings

3.1 Overview of intelligent construction technology

Intelligent construction technology integrates information technology, manufacturing technology, management technology and building technology, realizing the whole process of building intelligence, automation and high efficiency. Its core elements include intelligent perception, decision-making, execution and management technology, which have the following characteristics: high information technology, high degree of automation, fine management [5]. In the field of steel structure construction, the application of intelligent construction technology is particularly significant: the use of computer-aided design software, parametric design and BIM technology, to achieve fine design and visual display, improve the design efficiency and accuracy, to ensure the safety and economy of the building. Machine learning and artificial intelligence technologies are used to analyze operation and maintenance data, provide accurate and forward-looking management advice, and extend the service life and improve performance of buildings.

4. Construction of Intelligent Construction Technology System for the Whole Life Cycle of Steel Structure Building

4.1 Goals and principles of system construction

The construction of intelligent construction technology system of steel structure building aims to realize the efficiency, sustainability and safety of all links of steel structure building by integrating advanced information technology and traditional construction technology.

In terms of clear building goals, we first focus on efficiency. Through the intelligent design and construction process, the construction speed of the steel structure building can be improved, and the unnecessary waste of resources can be reduced. For example, using BIM (Building Information Modeling) technology, accurate material estimation and collision detection can be conducted at the design stage to optimize the design scheme and reduce changes and rework during the construction process. Sustainability is also an important goal for us. Through the introduction of intelligent construction technology, we can further reduce the environmental impact of the building throughout its life cycle, such as using intelligent energy saving system to reduce energy consumption in the operation stage, or using environmentally friendly materials to reduce waste generation in the demolition stage. Finally, safety is a key factor that cannot be ignored in any construction project. Intelligent construction technology can improve the safety performance of steel structure buildings in the construction and operation process through real-time monitoring and data analysis. For example, the sensor technology is used to monitor the stress on the key parts of the structure, and timely find and give early warning of potential safety risks.

5. Implementation and Evaluation of the Intelligent Construction Technology System for the Whole Life Cycle of the Steel Structure Building

5.1 Implementation path and method of the technical system

The implementation and evaluation of intelligent construction technology system in the whole life cycle is the key to

ensuring its effective application in practical engineering. The planning of the implementation path needs to fully consider the various components of the technical system and their interrelationships. In the design stage, intelligent construction concepts and technical means should be integrated, such as using building information modeling (BIM) for 3D modeling and collaborative design, to improve the design efficiency and quality. Secondly, in the construction stage, the intelligent construction equipment and technology should be fully applied. Key steps and methods are equally important in the implementation process. The establishment of a data management platform for the whole life cycle of steel structure building and the integration and sharing of data in each stage is the basis to ensure the smooth operation of the system. To strengthen the connection and coordination of each stage to ensure the smooth flow of information and material flow, it is necessary to formulate detailed implementation plans and schedules, and clarify the objectives, tasks, responsible persons and assessment standards of each stage to ensure the smooth implementation of the system. In terms of evaluation, a comprehensive evaluation index system covering technical, economic, environmental and social aspects should be established.

Table 1. Detailed information for the implementation of each path

Implementation Stage	Key Steps	Methods & Tools	Expected Outcomes	Risk Assessment	Countermeasures
Planning & Design	Requirements Analysis	Survey Questionnaires, Focus Group Discussions	Requirements Document	Unclear Requirements	Iterative Requirements Gathering and Analysis
	Technology Selection	Technology Evaluation Reports, Expert Consultation	Technology Selection Report	Technology Compatibility Issues	Preplan Development, Technology Verification
	Architecture Design	Design Patterns, Architecture Principles	Architecture Design Diagram	Insufficient Scalability	Reference Industry Best Practices, Architecture Stress Testing
Development & Implementation	Coding Implementation	Programming Languages, IDE	Source Code	Substandard Code Quality	Code Review, Automated Testing
	Module Testing	Unit Testing, Integration Testing	Testing Report	Insufficient Test Coverage	Test Case Optimization, Cross-testing
	Deployment & Launch	CI/CD Processes, Containerization Technology	Deployment Documentation	Deployment Failure Risk	Rollback Plan, Gradual Release (Grayscale Release)
Operation & Optimization	Performance Monitoring	Monitoring Tools, Log Analysis	Performance Report	Performance Bottlenecks	Performance Tuning, Hardware Upgrades
	Security Protection	Security Policies, WAF	Security Audit Report	Security Vulnerabilities	Regular Security Scanning, Vulnerability Remediation
	Data Backup	Backup Strategies, Backup Tools	Backup Records	Risk of Data Loss	Regular Recovery Drills, Multi-site Backups
Evaluation & Improvement	Effectiveness Evaluation	KPI Metrics, User Feedback	Evaluation Report	Inaccurate Evaluation Results	Multi-dimensional Evaluation, Introduction of Third-party Evaluation
	Continuous Improvement	Agile Development, PDCA Cycle	Improvement Plan	The improvement effect is not significant	Foster a culture of continuous improvement and provide incentives for innovation

5.2 Evaluation and optimization of the technical system

In the construction of intelligent construction technology system for the whole life cycle of steel structure building, evaluation and optimization are very important to ensure its effective application and continuous improvement. First of all, we need to build a comprehensive evaluation index system, by using both qualitative and quantitative methods to ensure an objective and accurate assessment. Secondly, we need to analyze the evaluation results, find out the advantages and disadvantages of the system, and clarify the direction of optimization. When putting forward the optimization scheme, the

plan should be combined with the actual needs to ensure the operability and innovation, and the feasibility should be demonstrated through cases or data to enhance the persuasion. Evaluation and optimization should be carried out regularly throughout the life cycle to ensure that the system remains in optimal condition, improves building performance, extends its lifespan, and achieves higher economic and social benefits.

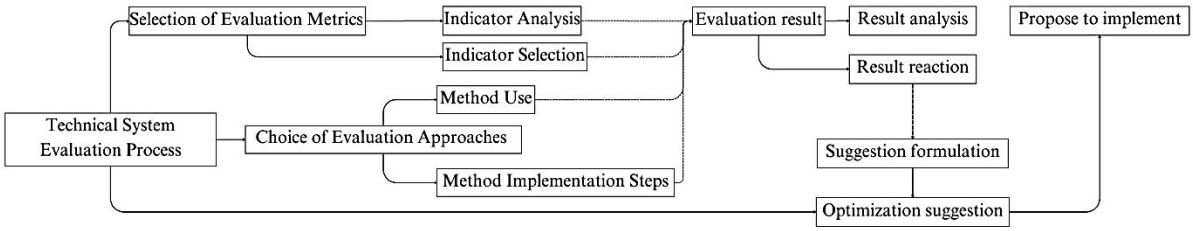

Figure 1. Overview of the evaluation system process

6. Development Prospects

In the future, with the continuous progress of technology and the expansion of application scenarios, the intelligent construction technology system of the whole life cycle of steel structure buildings will continue to improve and develop, providing strong support for the transformation and upgrading and sustainable development of the construction industry.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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