Application and Optimization of Intelligent Construction Technology in Municipal Road Construction

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Abstract: With the acceleration of urbanization, the demand for municipal road construction has increased, and the disadvantages of traditional construction methods have become prominent. Intelligent construction technology has brought changes to it. This article focuses on the application and optimization of intelligent construction technology in municipal road construction. By combing the relevant theoretical basis, this article analyzes the application of intelligent measurement, intelligent construction equipment, BIM-based schedule management and intelligent monitoring in all aspects of construction, and discusses the problems existing in the application, such as insufficient technical integration and difficult management coordination. On this basis, from the aspects of technology, management and data, this article puts forward some optimization strategies, such as strengthening multi-technology integration, building collaborative management mechanism, and ensuring data security and deep application. The research shows that intelligent construction technology has the potential to improve efficiency and quality in municipal road construction, and the existing problems can be solved through targeted optimization strategies, which can promote the intelligent development of municipal road construction industry.

1. Introduction

With the continuous acceleration of urbanization, municipal roads, as the key infrastructure of urban development, have a rising demand for construction scale and quality [1]. Facing the increasingly complex engineering requirements, the traditional municipal road construction method gradually exposes many disadvantages such as low efficiency, unstable quality and waste of resources [2]. In this context, intelligent construction technology came into being, which brought new opportunities for reform and development for municipal road construction [3]. Intelligent construction technology integrates a variety of advanced technologies, such as building information model (BIM), Internet of Things (IoT), big data, cloud computing, etc., with the aim of realizing automation, intelligence and informatization of the construction process [4]. Its application in municipal road construction is expected to significantly improve construction efficiency, accurately control construction quality, and effectively reduce resource consumption and environmental impact.

At present, the application of intelligent construction technology in municipal road construction has been widely studied in the world. Some developed countries have successfully applied intelligent construction technology in some large-scale municipal road projects, and achieved remarkable results, such as improving construction progress and reducing labor costs [5-6]. Relevant research in China is also actively following up, and many cities have started to apply intelligent construction technology to municipal road construction projects on a pilot basis, and accumulated certain practical experience [7]. On the whole, the application of intelligent construction technology in municipal road construction is still in the development stage, and there are some problems such as low technical integration, difficult data sharing and imperfect standards and specifications [8]. It is of great practical significance to carry out the application and optimization research of intelligent construction technology in municipal road construction. The purpose of this study is to analyze the

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application status and potential value of intelligent construction technology in all aspects of municipal road construction, and to explore optimization strategies to improve the application level of intelligent construction technology in municipal road construction.

2. Intelligent construction technology

Intelligent construction technology is based on a series of advanced theories. The theory of building information model (BIM) is one of its cores. It integrates the information of the whole life cycle of a construction project through a digital three-dimensional model, covering the accurate simulation in the design stage, the progress control and resource management in the construction stage, and the maintenance and analysis in the operation stage, so as to realize efficient information sharing and collaborative work [9]. IoT technology connects the equipment, materials and personnel under construction by means of sensors and network communication. Through real-time collection and transmission of data, such as equipment operation status, material location and personnel work dynamics, it provides real-time information support for construction management and facilitates timely decision-making and adjustment.

Big data is as indispensable as cloud computing theory. Massive data are generated during the construction process, and big data technology can deeply mine and analyze these data, revealing potential laws and problems. Cloud computing provides powerful computing and storage capabilities, ensures the efficiency and stability of data processing, helps intelligent decision-making based on data, and makes municipal road construction more scientific and intelligent.

3. Application of intelligent construction technology

With its unique advantages, intelligent construction technology has been widely used in many key links of municipal road construction, which has significantly improved the accuracy, efficiency and safety of construction. Intelligent measurement technology provides accurate data support for municipal road construction. With the help of advanced technologies such as global positioning system (GPS), geographic information system (GIS) and three-dimensional laser scanning, the topographic and geomorphological data of the construction site can be obtained quickly and accurately. For example, in complex terrain areas, traditional measurement methods may require a lot of manpower and time; The intelligent measurement technology can complete high-precision measurement in a short time, which greatly shortens the preparation period. Through the data collected by intelligent measurement technology, a detailed digital map can be generated, and the terrain fluctuation and ground object distribution can be displayed intuitively.

The application of intelligent construction equipment has greatly improved the efficiency and quality of municipal road construction. Automatic paver can accurately control the paving thickness and flatness according to preset parameters, and reduce the errors caused by manual operation. The intelligent roller can monitor the compaction degree in real time and automatically adjust the rolling parameters to ensure the uniform compaction quality of the pavement. In addition, some construction vehicles with autonomous navigation and intelligent obstacle avoidance function can work in order at the construction site, which reduces the accident risk and improves the construction safety. Figure 1 shows some intelligent construction equipment and its advantages.

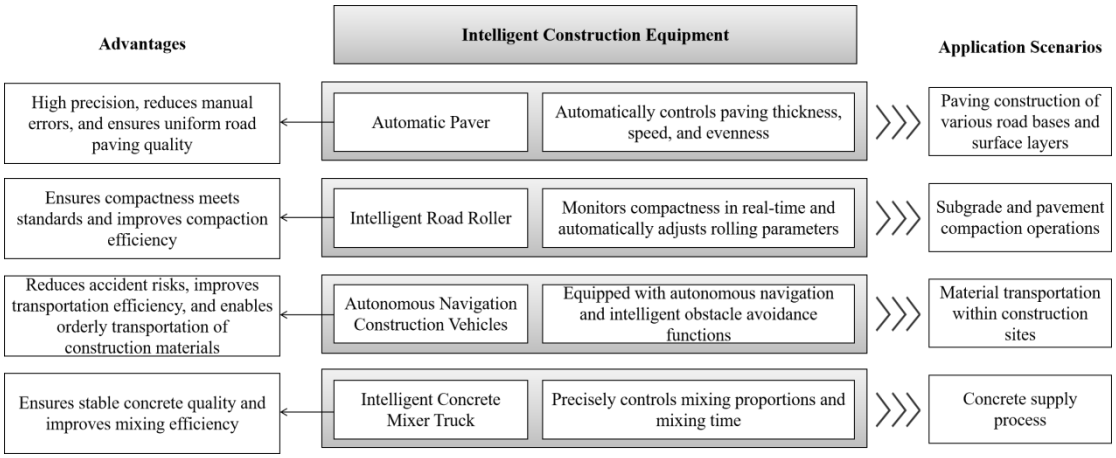

Figure 1 Some Intelligent Construction Equipment and Their Advantages

BIM technology plays a key role in the progress management of municipal road construction. By establishing a three-dimensional visual BIM model, the whole construction process can be simulated virtually. Construction managers can intuitively see the task arrangement, resource allocation and time nodes in each construction stage, and find potential progress conflicts and risks in advance. For example, in the crossing construction of roads and bridges, with the help of BIM model simulation, the construction sequence can be optimized in advance, and the construction period delay caused by unreasonable working procedures can be avoided. BIM model can also compare with the actual construction progress in real time, find the deviation in time and take corresponding adjustment measures to ensure that the construction progress is always under control.

Intelligent monitoring technology provides a strong guarantee for the safety and quality of municipal road construction. Various sensors, such as strain gauges, accelerometers, displacement sensors, etc., are arranged in the construction site, which can monitor the stress, deformation and other key parameters of road structures in real time. Once the monitoring data exceeds the preset threshold, the system will immediately give an alarm, so that the construction personnel can take timely measures to avoid safety accidents. For example, in the construction of soft soil foundation section, the construction scheme can be adjusted in time to ensure the stability of the road through real-time monitoring of foundation settlement.

4. Optimization strategy of intelligent construction technology

4.1 Technical optimization

Intelligent construction involves many technologies, but at present, the degree of integration between them is insufficient. For example, although BIM and IoT technologies play their respective roles, there are obstacles in data interaction and collaborative work. R&D efforts should be intensified to promote the deep integration of technologies such as BIM, IoT, big data and cloud computing. It is also needed to develop a unified data standard and interface so that different systems can exchange information smoothly. At present, some intelligent construction equipment needs to be improved, and its function is single, so it is difficult to meet the complex construction requirements. It is needed to strengthen R&D investment and improve the independent decision-making and adaptive ability of equipment. Intelligent paver with multi-task processing ability can be developed, and paving parameters can be adjusted in real time according to pavement material and slope. The development of intelligent construction robot can perform a variety of construction operations, such as pavement damage detection and repair, reduce labor costs and improve construction efficiency and quality.

4.2 Optimization of management level

Municipal road construction involves many participants, and the information communication between all parties is not smooth and it is difficult to work together. The government should

establish a collaborative management platform based on intelligent construction technology to integrate the resources and information of design units, construction units and supervision units. Real-time communication and collaboration can be realized through the platform, such as informing relevant parties of design changes immediately, and timely feedback and solution of construction problems. It is needed to formulate collaborative work processes and norms, clarify the responsibilities and authorities of all parties, improve work efficiency, and avoid construction delays and errors caused by poor information.

The application of intelligent construction technology in municipal road construction lacks unified standards and specifications, which leads to uneven application level of different projects. Relevant departments should formulate perfect intelligent construction standards as soon as possible, covering all aspects such as design, construction and acceptance. Figure 2 shows some suggestions of construction standards and specifications for intelligent building technology.

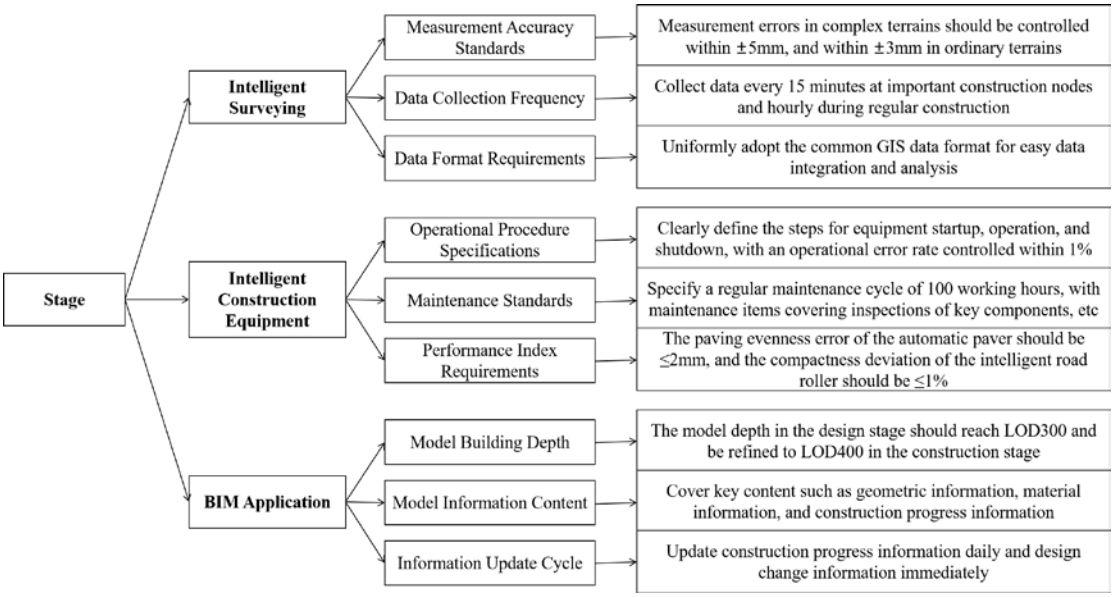

Figure 2 Recommended Construction Standard Specifications for Some Intelligent Construction Technologies

The application of intelligent construction technology needs talents with professional knowledge and skills, but there is a shortage of relevant talents at present. On the one hand, construction enterprises should strengthen the training of existing personnel, set up courses related to intelligent construction technology, and enhance employees' cognition and application ability of new technologies; On the other hand, we should actively introduce external professionals to enrich the talent team of enterprises. It also cooperates with universities and scientific research institutions to establish a talent training base to reserve talents for the application of intelligent construction technology in municipal road construction.

4.3 Data level optimization

Intelligent construction produces a large amount of data, and data safety and quality are very important. It is needed to establish a sound data security management system and adopt encryption technology, access control and other means to protect data from being leaked and tampered with. Futhermore, data quality management standards can be formulated to clean and verify the collected data to ensure the accuracy and integrity of the data. It is needed to set up a data management post, be responsible for the daily management and maintenance of data, and provide reliable data support for the application of intelligent construction technology. At present, most of the construction data are only used for simple recording and reporting, and their potential value is not fully tapped. Big data analysis technology can be used to deeply mine the construction data and analyze the laws and trends in the construction process. For example, by analyzing historical construction data, we can predict the construction progress and quality changes in different seasons and weather conditions,

formulate countermeasures in advance, and optimize the construction scheme.

5. Conclusions

This article focuses on the application and optimization of intelligent construction technology in municipal road construction. Firstly, it is clear that intelligent construction technology is based on BIM, IoT, big data and cloud computing. These theories provide support for its application in construction. In application, the intelligent measurement technology realizes the efficient and accurate collection of construction site data, laying the foundation for road positioning and design; Intelligent construction equipment improves the construction efficiency and quality; BIM-based construction schedule management optimizes the construction sequence by virtual simulation, and controls the progress in real time; Intelligent monitoring technology ensures the construction process from the aspects of structural safety and construction environment.

However, the application of intelligent construction technology in municipal road construction faces many challenges such as technology, management and data. Technically, the degree of integration of various technologies is not good, and the degree of equipment intelligence is insufficient; At the management level, there is a lack of collaborative management mechanism, imperfect construction standards and specifications, and lack of professionals; In terms of data, there are hidden dangers in safety and quality, and deep mining is not enough.

Aiming at the above problems, this article puts forward the optimization strategy. Technically, it can strengthen multi-technology integration and improve the intelligence of equipment; In management, it is needed to build a collaborative mechanism, improve standards and norms, and strengthen personnel training and introduction; The data level ensures the safety and quality, and promotes the application of deep mining. These strategies can effectively solve the existing problems, give full play to the advantages of intelligent construction technology in municipal road construction, and promote the development of the industry in the direction of intelligence, efficiency and high quality.

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