Information Management Strategy of Bridge Construction Technology Based on Big Data

Fancheng Meng1,*

1Jilin Communications Polytechnic, ChangChun, Jilin Province, China, 130012

*Corresponding author email: mengfancheng@jcp.edu.cn

Abstract. With the rapid integration of big data, cloud computing, BIM and other new technologies into construction enterprises, the degree of information of bridge construction is gradually deepened. This process is usually very complex, there are many influencing factors, and the construction progress is difficult to control. This paper summarizes the fiber composite materials which have potential application in Bridge Engineering in recent years. This paper first discusses the development prospect of carbon fiber, and then briefly introduces the mechanical properties of carbon fiber composite laminates. Referring to relevant literature, this paper introduces BIM Technology in detail. Based on the current situation and application advantages of BIM technology, it fully understands the practical application of BIM Technology in bridge engineering design, construction stage and later operation and maintenance. Their tensile strength, elastic modulus, longitudinal and transverse thermal expansion are introduced in detail. The results show that BIM Technology has been widely used in bridge engineering projects. In 2015, the Growth rate of BIM technology usage in construction industry country a was 1.536.

Key words: Big Data, Bridge Engineering Construction, Normalization, Management Strategy

1. Introduction

With the development of information technology, big data technology has become indispensable in our life. At present, we have applied big data technology to bridge engineering construction technology, which makes the bridge construction industry in China develop more rapidly, develop China’s comprehensive national strength and serve the people. [1]

With the continuous progress of science and technology, many experts have studied big data technology. For example, some domestic teams have studied the design and implementation of big data bridge health monitoring system. The characteristics and influencing factors of bridge construction schedule control are analyzed. The mechanism of project schedule lag is discussed. Finally, the effective project progress control measures are put forward, which provides a systematic theoretical basis for bridge construction progress control and management. This paper expounds the significance of fully developing and utilizing static and dynamic data resources of bridge engineering. Some experts have studied the application of BIM Technology in bridge engineering, summarized the
concept, characteristics and development process of BIM, introduced the research and application status of BIM Software, the optimization of bridge construction scheme based on BIM model is studied and construction simulation is carried out, and discussed the application of BIM model in bridge engineering, and the application of BIM Technology in construction management. Including construction management and construction management, layout of precast beam and construction site. This paper discusses the design idea of BIM technology for prefabricated steel plate composite bridges and the conditions for building models. Based on BIM Technology, the bridge location and environment are simulated and analyzed. The types of BIM information components of steel plate composite bridges and the corresponding implementation standards are established. The completion of model building integration is improved, and the design process meets the requirements of standardization and implementation standards. The collision detection and analysis of standard components and spatial position relationship of steel plate composite beam bridge are carried out, and BIM model is optimized and adjusted to guide the production and construction of prefabricated components. According to the actual construction experience, the paper analyzes and explains the construction management of precast beam, so as to provide reference for similar projects. Combined with the practice of bridge engineering construction safety management. Some experts have studied the construction risk assessment of long-span continuous rigid frame bridge, analyzed the formation mechanism of construction risk of long-span continuous rigid frame bridge, proposed the construction risk identification process of long-span continuous rigid frame bridge, analyzed the main risk factors in the construction process of Long-span Continuous Rigid Frame Bridge in detail, and established the construction risk evaluation index system of long-span continuous rigid frame bridge. The weight of each hidden layer index is determined, and the artificial neural network model is used for comprehensive evaluation, which provides a new method for the construction risk assessment of long-span continuous rigid frame bridge. In view of the fact that there is no effective control method for presented quality in bridge construction, a fuzzy comprehensive evaluation model for construction quality of express line bridge engineering is established by using presented construction information technology, scoring method and fuzzy comprehensive evaluation method. The model is applied to the bridge construction of Kunming bus express line, and the results are analyzed. This paper analyzes the causes of key engineering quality problems that affect the project quality, and formulates corresponding measures. For the key projects whose fuzzy comprehensive evaluation is unqualified or basically qualified, the combination of advanced presented automation equipment and data information management platform is used as the theoretical basis for effectively improving and optimizing the construction quality. Formulate targeted technical measures for key factors or key sub projects, and formulate engineering management measures for personnel training. The bridge construction level has been greatly improved. Although the research results of bridge engineering are quite abundant, there are still some deficiencies in the information management strategy of bridge engineering construction technology under big data.

In this paper, in order to study the information management strategy of bridge engineering construction technology under big data, through the research of big data, we found big data. The research shows that the information management strategy of bridge engineering construction technology based on big data can improve the level of bridge construction safety management and enhance the core competitiveness of enterprises.

2. Method

2.1. Big Data

BIM Technology

Building information model is the process of using digital model to design, build and operate a project, including all geometric, physical, functional and performance information of the project. The participants of the first simulation examination can use the same model and cooperate with each other in the project to carry out the calculation, analysis and simulation of various specialties, so as to
achieve the goal of "doing a good project, doing wrong things, doing unexpected work, doing fine budgeting, and doing a good job in BIM". Its characteristics also reflect the basic theory and method of construction project management, including the whole life cycle management and comprehensive management of construction project\(^5\). The whole life cycle management of construction project is the control and management of planning and design stage, bidding construction stage, operation and maintenance stage, etc\(^6\). As a new computer technology, BIM has the advantages of high efficiency, economy, energy saving and environmental protection in bridge construction, which can realize the transmission and sharing of BIM computer information model in the whole life cycle of the project\(^7\).

(2) BIM Technology information

Components with complete information are taken as basic operation objects, such as component name, type code, physical information, function information, construction information, operation and maintenance information, etc\(^8\). BIM model contains the spatial data information of the bridge itself and the behavior information of the whole life cycle of the bridge\(^9\). Information integration of bridge model is formed after information fusion. There are constrained topological relationships among the components of BIM model\(^10\). Different parameters are used to drive various components in the model\(^11\). 3D models are created by defining or changing the parameters of components. The model can be updated automatically according to the modified parameters, and the reasonable logical relationship can be constrained by sharing parameters\(^12\).

(3) Bridge health monitoring

Structural health monitoring, through the deployment of sensors in the structural system to collect structural response, over time, observe the characteristics of the structural system, and evaluate the health status of the structural system. Structural health monitoring has the following consensus in the world. Materials used in structural system will produce internal damage, and materials without internal damage do not exist. Damage assessment needs to compare the two states before and after assessment, so as to effectively evaluate the current damage; only relying on hardware equipment such as sensors, without effective data analysis methods and reasonable modeling means, it is impossible to measure and measure the damage The damage was evaluated. Effective evaluation results not only need good performance sensors and other hardware equipment, but also need the analysis method and identification method of health monitoring results.

2.2. PLL Value

For long-span continuous rigid frame bridge, potential life loss refers to the frequency that all personnel involved in the construction of long-span continuous rigid frame bridge may suffer certain risks during construction. PLL value is a common standard for DNV risk assessment. The mathematical expression of PLL is shown in formula (1):

\[
PLL = \sum f_i \cdot N_i
\]

(1)

Where, is the annual probability of the accident, is the number of deaths caused by the accident, PLL value is mainly used to measure the risk of a group of people as a whole, but it can not explain which group of people are more likely to encounter the risk.

The data of the matrix is standardized so that the mean value becomes 0 and the variance becomes . The original matrix elements are changed as shown in formula (2-4):

\[
Z_{ij} = \frac{x_{ij}}{s_j} - \frac{\sum_{i=1}^{n} x_{ij}}{n}
\]

(2)

\[
x_j = \frac{\sum_{i=1}^{n} x_{ij}}{n}
\]

(3)
\[ s_j^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n} \] (4)

3. Experience

3.1. Experimental Object Extraction

The quality of each component and the whole project in the construction process of I-shaped steel-concrete composite beam is selected as the inspection object, the problems in the construction process are found out in time, and the quality evaluation results are given. Quality inspection is of practical significance both in construction management and quality control, which makes the bridge develop towards the direction of health, durability and safety. With the development of construction technology and inspection system, the inspection content of construction quality is also constantly increased and refined. The current situation is that in modeling and calculation, the adjustment and optimization of the model should be reflected in the drawings. Firstly, it is necessary to reasonably split the components and select appropriate control parameters, and then determine the logical relationship between the parameters according to the spatial position of the components. Theoretically, the more control parameters are selected, the higher the accuracy of the model, the better the display effect, and the larger control range. However, limited by the computer hardware conditions, the representative and universal parameters should be selected to improve the modeling speed. When the success rate of model information data transmission is high, the time of establishing calculation model is saved and the efficiency is greatly improved.

3.2. Experimental Analysis

The appearance quality inspection can understand the external quality status and function state of the bridge. In order to ensure the comprehensiveness of the indexes, the indexes of all kinds of steel-concrete composite beam bridges that may exist are included in the initial construction process. However, due to the different structure, some indexes do not exist in the I-shaped steel-concrete composite beams, or some indexes overlap with each other, so these indexes should be deleted first. (1) In the bridge construction model, the geological terrain model is the basis of the whole model. Temporary site layout and material storage yard can be introduced as soon as possible. (2) Three dimensional model of pile foundation, pile cap, pier, abutment and superstructure. According to the design drawings, the three-dimensional model of pile foundation, pile cap, pier, abutment and superstructure is established. If any mistakes or omissions are found in the drawings before construction, the problems shall be solved before the construction, so as to reduce the process change and rework. (3) The application of construction process information model, the interaction between social vehicles and construction vehicles, temporary office and temporary living facilities, construction temporary electricity and water, temporary warehouse materials, and material processing plant require dynamic management of construction. According to the progress, BIM model based on the site can simulate the stacking of different materials and traffic guidance, and find out the most suitable one according to the actual situation of the site Good plan, dynamic management. Full height Precast Pier Column refers to that the whole pier is prefabricated into a whole. The advantages of this kind of precast concrete pier column are good overall mechanical performance, simple design and convenient construction, but it is limited by transportation and hoisting when the pier height is longer. During construction, it can be calculated according to the design criteria of integral pier column and the reinforcement calculation can be made according to the design method of ordinary reinforced concrete. The connection between Precast Pier Column and foundation cap usually adopts socket type or presented steel bar connection, and dry connection method or wet connection method can be used for connection with bent cap.
4. Analysis of research results

4.1. Research Status of BIM

At present, BIM Technology has been widely used in engineering projects in developed countries. In 2015, the growth rate of BIM Technology Application in the construction industry of country a was 1.536, which increased to 2.747 in 2016, and reached 1.895 in 2017. It shows the proportion of more than 60% of traffic infrastructure projects applied to BIM in 2016, 2017 and 2018 respectively. As shown in Table 1.

| Country | 2015 | 2016 | 2017 | 2018 |
|---------|------|------|------|------|
| Country a | 1.536 | 2.747 | 1.895 | 2.264 |
| Country b | 2.058 | 2.746 | 1.643 | 2.185 |
| Country c | 1.937 | 2.855 | 2.458 | 2.054 |
| Country d | 2.466 | 1.658 | 2.654 | 1.947 |

It can be seen from the above table that the growth rate of BIM Technology Application in the construction industry of country B was 2.058 in 2015, 2.746 in 2016, 1.643 in 17 and 2.185 in 18 in the construction industry. The results are shown in Figure 2.

![Figure 1. Proportion of transportation infrastructure projects in different countries](image)

From the above, the growth rate of BIM Technology Application in the construction industry of country a was the highest in 2016; the growth rate of BIM Technology Application in the construction industry of country B was also the highest in 2016; the growth rate of BIM Technology Application in the construction industry of country C was the highest in 2016; the growth rate of BIM Technology Application in the construction industry of country D was the highest in 2017.

4.2. Concrete Strength

If the thickness of concrete cover is too small, the anchorage performance of load-bearing reinforcement can not meet the requirements, and the bearing capacity of the structure will decline. At the same time, due to the influence of environmental factors, the reinforcement is prone to corrosion and expansion, which damages the concrete components and affects the durability of the structure. In the process of concrete construction, due to the quality of cement, aggregate, sand and other raw materials, mix proportion, pouring method or pouring time and other factors, the strength standard may not meet the design requirements. As shown in Table 2.
Table 2. Changes in extramural capacity of structures

| concrete strength | Bending capacity |
|-------------------|------------------|
| A1                | 25%              |
| A2                | 36%              |
| A3                | 39%              |

It can be seen from the above that the bending capacity of A1 is 25%, that of A2 is 36%, and that of A3 is 39%. The results are shown in Figure 2.

Figure 2. Changes in extramural capacity of structures

It can be seen from the above figure that A3 has the highest bending capacity and A1 has the lowest bending capacity.

5. Conclusion

With the acceleration of urbanization, whether the steel plates and bridges in bridge construction can meet the specific requirements of engineering construction is related to the completion degree of urban projects. In this case, effective measures should be taken to improve the construction management level of municipal road and bridge engineering, to ensure that different construction stages are conducive to accelerating the construction progress and improving the quality of construction projects. Bridge construction period is generally long. This process is usually complex and has many factors. The construction progress is difficult to control. The characteristics and influencing factors of bridge construction schedule control are analyzed. The mechanism of project schedule lag is discussed. Finally, the effective project progress control measures are put forward. It provides a theoretical basis for the completion progress and management of bridge construction. This paper summarizes the construction management of road and bridge engineering, discusses the characteristics and current situation of construction management of road and Bridge Engineering in China, analyzes how to improve the management level, safety and construction schedule follow-up of bridge construction projects from the quality aspect, hoping to provide some reference for bridge construction project management in China.

References

[1] Hongtao, ZHOU, Hongwei, et al. Smart construction site in mega construction projects: A case study on island tunneling project of Hong Kong-Zhuhai-Macao Bridge[J]. Frontiers of Engineering Management, 2018, v.5(01):83-92.

[2] Aattan S A A , Al-Bakri M . Development of Bridges Maintenance Management System based
on Geographic Information System Techniques (Case study: Al-Muthanna \ Iraq)[J]. University of Baghdad Engineering Journal, 2020, 26(9):137-154.

[3] Liu J H , Zhang P , Xu C Z , et al. Construction and use of big data for health management[J]. Chinese Journal of Endemiology, 2019, 40(2):227-230.

[4] Neff G , Tanweer A , Fiore-Gartland B , et al. Critique and contribute: A practice-based framework for improving critical data studies and data science[J]. Big Data, 2017, 5(2):85-97.

[5] Ni F T , Zhang J , Chen Z Q . Zernike-moment measurement of thin-crack width in images enabled by dual-scale deep learning[J]. 2019, 34(5):367-384.

[6] Md, Johirul, Islam, et al. A Cyberinfrastructure for Big Data Transportation Engineering[J]. Journal of Big Data Analytics in Transportation, 2019, 1(1):83 – 94.

[7] Russell H . Tower Bridge: history, engineering, design[J]. Bridge design & engineering, 2019(95):17-19.

[8] Zhu C Q , Liu H F , Wang X , et al. Engineering geotechnical investigation for coral reef site of the cross-sea bridge between Malé and Airport Island[J]. Ocean Engineering, 2017, 146(dec.1):298-310.

[9] Luo M . Grouting Reinforcement Technology for Highway, Bridge and Tunnel Engineering Construction[J]. Boletin Tecnico/Technical Bulletin, 2017, 55(4):169-176.

[10] Research on Practical Teaching Method in the Course of Bridge Engineering[J]. Creative Education Studies, 2019, 07(5):565-570.

[11] Gao Z . Technical Status, Challenges, and Solutions of Marine Bridge Engineering[J]. Strategic Study of Chinese Academy of Engineering, 2019, 21(3):1-4.

[12] Liu M . Lifecycle Management and Maintenance of Marine Bridge Engineering[J]. Strategic Study of Chinese Academy of Engineering, 2019, 21(3):25-30.