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The Promotion of BIM Integrated Design in Building Engineering Construction

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Abstract: With the continuous development of building information modeling technology, this article explores an innovative BIM forward integration design scheme, aiming to deepen information collaboration and efficiency in the construction process of building engineering. By adopting BIM technology, information from various stages such as design, construction, and operation can be integrated, achieving collaboration between design and construction. During the design phase, emphasis is placed on close collaboration among multidisciplinary teams, as well as real-time information transmission between design decisions and construction preparation. The results showed that the reinforcement of steel plates ensured that the collapse of the box exceeded 2.5 meters, and the stable completion without side risks is crucial for the safety of bridge engineering. It is of great significance for the promotion of BIM forward integration design in building construction.

1. Introduction

BMI forward integration design is a new design method based on BIM technology, which integrates information from various professional fields such as architectural design, structural design, and electromechanical equipment design into a unified model, achieving the sharing and collaboration of design information[1]. Traditional design methods can easily lead to design errors, construction delays, and cost overruns. The forward integration design of BIM can effectively solve these problems and improve the quality and efficiency of construction projects[2]. Explore its application modes and methods in construction engineering, and provide theoretical and practical support for the digital transformation of construction engineering[3].

This article emphasizes the continuous development of BIM technology and proposes a forward integrated design scheme. BIM technology is widely used in construction engineering, which can integrate information from various stages such as design, construction, and operation, and achieve full process collaboration. In the design phase, the article emphasizes the importance of close collaboration among multidisciplinary teams and interdisciplinary cooperation. Through the joint participation of professionals from different fields, it promotes the comprehensiveness and comprehensiveness of the design phase.

2. Literature review

The report by Liu M et al. pointed out that the roof steel structure of Group C project of Zibo Cultural Center and the Zibo Cultural Center Group project are large and complex. Based on BIM technology, the method of three-dimensional visualization of building information model is used to reduce time, so BIM technology is indispensable [4]. In the context of increasing construction requirements, LIUBin et al. applied the method of three-dimensional building information modeling. Building construction has been fully counted and formed into a three-dimensional space, which can improve the construction effect of the entire building project, conduct more accurate analysis of the building project, promote communication among technical personnel, and avoid hidden dangers [5]. Babalola A et al. explored the latest research achievements of digital technology in the construction, engineering, and construction industries through literature review and quantitative analysis. Research has found that DTs bring various benefits to project stakeholders in the AEC industry, including enhanced visualization, better data sharing, reduced construction waste, increased productivity, achieving sustainable development, and improving safety [6]. Li S et al. provided a complete building engineering information database by establishing a virtual building engineering model and combining digital technology. In the virtual construction of construction projects, the collaborative management of 3D model drilling is used to improve production efficiency, save costs, and shorten the construction period[7]. Wang L et al. proposed an evaluation index system for buildings during the operation and maintenance period by quantifying the fire risk index of buildings, combining BIM technology, and using the engineering fire risk analysis method, from the aspects of potential risk level, acceptable risk level, and protection level [8]. Jung E et al. utilized an open airport facility based on BIM using the method of an information public data environment. We have developed an element technology to establish a universal data environment for the integrated management of airport facility information, aiming to standardize the data of various technologies and applications in a universal data environment [9]. Zhou Y W et al. combined the parameterized design of escalators with data-driven modeling methods and proposed an intelligent design method for escalators with variable engineering parameters. This method provides effective improvements for solving the parameterized intelligent layout and automatic modeling problems of escalators. And introduce the methods of industrial basic class extension and Dynamo parameterized data collection platform to develop BIM four-dimensional models. A big data system has been developed to achieve visualization, monitoring, and early warning of escalator operation, which can provide real-time monitoring and safety warnings during the design process [10]. Berco V, Pfukani N S, Hendri D P et al. identified the key factors for adopting BIM and employed a qualitative research method based on a theoretical framework. Apply survey questionnaires to link theoretical explanations with collected data [11].

3. 3D visibility and terrain analysis

3.1 Establishing a comprehensive information management model for engineering sites

Based on 3D visualization and geographic analysis techniques, the advantages of BIM technology will be fully utilized [12]. When analyzing the external environment of a building, the terrain should be analyzed first. In order to further reveal the relationship between building volume and land changes, a specialized analysis method must be used that can provide reliable data support for the building. In addition, geographic information systems are widely used in practical applications, making geographic environment analysis maps more convenient and efficient, thereby greatly improving the fundamental efficiency of the basic data of geographic information systems [13]. When formulating specific construction projects, simulate state collection and analysis, and scientifically and effectively estimate potential problems and causes. In addition, you also need to develop an effective emergency plan. Secondly, choosing virtual work can provide scientific and effective conditions for construction workers. Optimize and improve the building structure to effectively meet the overall building requirements. In addition, transportation work focuses on construction projects, and BIM technology is also used to plan and develop transportation plans to facilitate construction [14]. It is very necessary to establish a comprehensive information management model for the engineering site, which plays a guarantee role in the entire construction process. Figure 1 shows the full process information supervision of BIM technology in engineering sites.

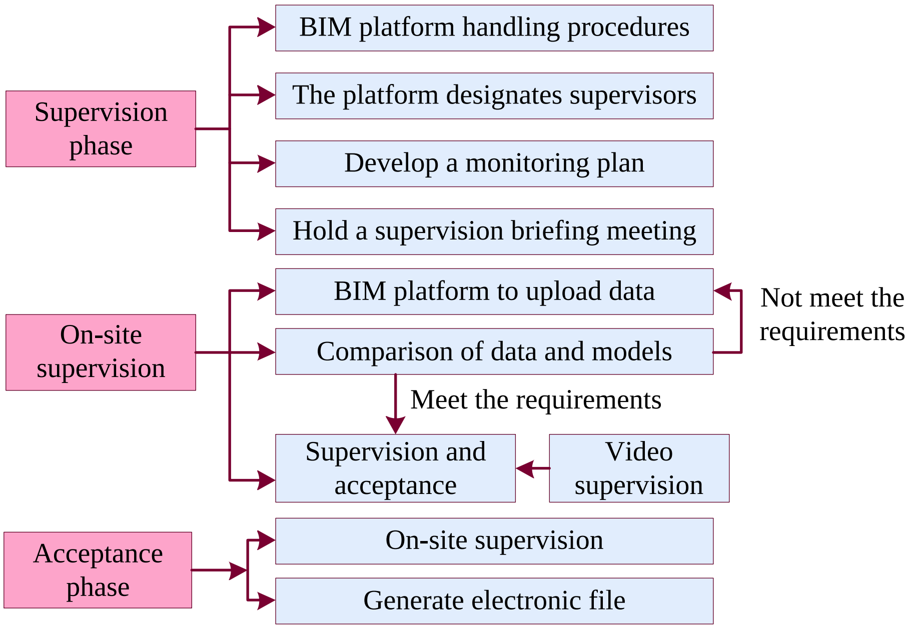

Figure 1: Information supervision of the entire process of engineering site based on BIM technology

3.2 Computational efficiency of cascading information dissemination

3.2.1 Connecting information dissemination channels

Assuming that throughout the entire process of information dissemination, the information provider, intermediary, and ultimate information receiver are all a whole, and their dissemination efficiency is obtained through continuous accumulation on a separate information dissemination channel. Assuming that the propagation efficiency of each single information channel can be expressed as $e_0, e_1, e_2, \cdots, e_{n-1}$, Figure 2 shows the propagation channels of concatenated information. Then the error rate $L = (1-E) \times 100\%$ of concatenating information dissemination.

Figure 2: The propagation channel of concatenated information

3.2.2 Calculation efficiency of parallel information dissemination

Assuming that everyone's abilities are the same, the error rate of information propagation can be calculated, as shown in Figure 4 as a parallel information propagation channel. If the parallel information dissemination efficiency is L and $L = L_1 \times L_2 \times \cdots L_n$, then the parallel information dissemination efficiency is further derived as $E = 1 - L$. In practice, BIM technology should be used to collect and process information on construction sites, as well as to plan and analyze simulation models to meet the requirements of dynamic design. Figure 3 shows the parallel information propagation channel and parallel information calculation, and various data information must be managed in an integrated manner, especially when creating a database. When planning the construction plan, it is necessary to clarify the tasks of professional personnel, continuously improve and perfect the plan, analyze and monitor the emissions of the factory building, timely determine the construction work and progress, and meet existing conditions and requirements. More importantly, initiating dynamic construction work can prevent more severe delays than expected. A complete organizational structure for engineering site management must be established. Common organizational models for engineering site management include linear management, organizational model, and matrix management.

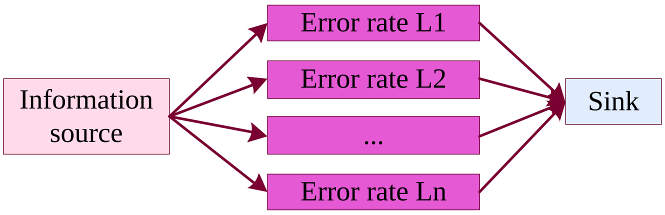

Figure 3: Parallel Information Transmission Channel and Parallel Information Calculation

3.3 Linear management of organizational information dissemination efficiency

Due to the serial information dissemination adopted in the linear management organizational model, an additional layer is added to each layer in the management organizational structure, thereby improving the overall efficiency of information dissemination. F_n is the number of information dissemination channels, that is:

$$F_n = \sum_{k=1}^{h-1} w^k = w + w^2 + w^{h-1} \tag{1}$$

k is a natural number; h is the number of organizational levels; If w is the management span, the calculation formula for the average propagation efficiency P_n is:

$$P_n = \frac{E_n}{F_n} \tag{2}$$

In the formula, E_n represents the total efficiency of information dissemination in the linear management organizational model.

The matrix management organizational model mainly consists of three levels: first, leadership; The second is department heads and project managers; The third is the participants. This forms a communication channel, from the department to the project manager, and then to the project leader. The number of departments at the level of participants depends on the communication channels of department heads and project managers. If the communication channel between the department head and project manager is w, the number of departments is w2/4, and the communication channel is twice the number of departments, then the matrix management organizational model F_n is:

$$F_n = w + \frac{w^2}{2} \tag{3}$$

4. Analysis of simulation results

4.1 Analysis of Stability Results

The exact location of the steel cabinet and the construction of the lock are planned in a certain order according to the specifications, horizontally and reverse. Before locking, the measurement values of different control points on the bridge should be checked to ensure that these points meet the design standards. After reaching MVP, the structural components should be obtained. Integration mainly serves geometric control, and the length of the span is controlled by the responders between the mother bodies to ensure construction work. At the same time, when closed, adjust from top to bottom to reduce the handle. In the steel bottom connected by cracks, the gap between the two frames indicates that the collapse meets the standards of construction work, the width is uniform, and does not constitute any defects. The rolling load of the vehicle loaded after the construction of the steel cabinet (average 7t) will be removed accordingly. Table 1 shows the results of the stability test for anti-overturning force, providing the results for determining the strength of the training aircraft and determining the impact response (standard greater than 2.5). When signing the steel mesh cutting load construction contract, the manufacturer estimated that the fracture strength exceeded 2.5, which meets the specifications. Therefore, during the entire construction process of the steel ridge, there is a risk of side lintels, so the bridge is much safer. After using the construction technology described in this article to complete the construction of steel box beams, the anti-overturning performance of the steel box beams is good, and the anti-overturning stability coefficient results are all above 2.5, meeting the regulatory standards. After the construction of the entire steel box girder, there is no risk of lateral overturning, which can greatly ensure the safety of the bridge project.

Table 1: Results of stability test for anti-overturning force

Load size (t)	Anti-overturning moment(KN m)	Stability coefficient of anti-overturning force
1.1 times the standard load	122 872	2.84
1.2 times the standard load	122 872	2.81
1.3 times the standard load	122 872	2.79
1.4 times the standard load	122 872	2.76
1.5 times the standard load	122 872	2.73
1.6 times the standard load	122 872	2.70
1.7 times the standard load	122 872	2.67
1.8 times the standard load	122 872	2.64

4.2 Collision detection results

Firstly, the collision issue within the system has been confirmed, the model has been carefully examined, and the layout and identification of the pipes used will automatically close the ventilation pipes after using wires, ensuring that the distance between the ventilation pipes and the air conditioning reaches the predetermined target. Before identifying, it is necessary to determine the number in the conflict. If the tolerance between two components exceeds the actual distance, it indicates the existence of a collision point. The restricted range should be related to the design documents, and the distance between water pipes should be less than 30 meters. At the same time, the design of detective sensors must comply with standards. And a large number of valves and flow evaluators were prepared to ensure the integrity of the system during the construction process, including drilling+in and rule records Used for excavation, timely generation of relevant drilling information, and storage of space lists and description files. At the same time, safety issues in the construction field will also receive real-time attention. Collider detection reports will be used to detect and analyze collision points in pipelines and broken holes on walls. The collision detection results are shown in Table 2. After using the BIM model for inspection, the number of collision points in the line is 0. This indicates that the method proposed in this paper can be used to effectively solving collision problems, significantly reducing the number of collision points.

Table 2: Collision detection results

Proactive projects	Group 1	Group 2	Group 3
Power distribution bridge	0	0	3
Weak current system bridge	0	2	1
air conditioning system	0	0	0
Tunnel ventilation system	0	1	1
Water supply and drainage	0	0	0
Fire protection	0	7	3
Frame construction	0	0	0
Total	0	10	8

5. Conclusion

This article focuses on the promotion of BIM forward integration design in construction engineering. Through analyzing and explaining the application of BIM in construction engineering, the following conclusions are drawn:

(1) Experimental data shows that by adjusting the jacks, the distances between the middle pier and the transition pier are 1.6m, 8.1m, 1.9m, and 4.5m, respectively. As the load increases, the anti-overturning ability also decreases. The standard results are all greater than 2.5, and there is no risk of lateral overturning, which can greatly ensure the safety of bridge engineering.

(2) The data from Experiment 2 shows that after using the BIM model for inspection, the number of collision points in the line is 0. The method presented in this article can effectively solve collision problems.

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