Exploration on Construction Technology and Management of Building Engineering

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Abstract: This study reviewed the core construction technologies and management measures in building engineering, analyzing the operational logic of four types of construction technologies, including mass concrete temperature-controlled pouring and prefabricated component lifting. It summarizes the implementation paths of four management measures, such as dynamic control of construction progress and quality sampling inspection, and expounds on the role of technology-management synergy in ensuring project quality, duration, and cost. The research aims to address issues such as non-standard technology implementation and inadequate management control in building engineering, effectively improving construction efficiency and quality.

1. Introduction

As building engineering evolves towards large-scale and complex development, higher requirements are placed on the precision of construction technologies and the refinement of management. However, in actual construction, problems such as quality hazards and project delays often occur due to non-standard technical operations and inadequate management measures. Based on this, exploring the application points of key construction technologies and corresponding management measures in building engineering, as well as clarifying the synergistic relationship between technology and management, is of great practical significance for promoting high-quality construction of building engineering and preventing construction risks.

2. Construction Technologies of Building Engineering

2.1 Mass Concrete Temperature-Controlled Pouring Technology

In the pre-preparation stage, optimize the concrete mix proportion. Add 20%–30% (by mass) of fly ash to the cement to replace part of the cement, and add a retarder to extend the initial setting time to 12–16 hours, reducing the peak value of hydration heat. Then, according to the size of the pouring body, pre-bury cooling water pipes. The pipes are made of 50 mm-diameter galvanized steel pipes, arranged at intervals of 1.5 m × 1.5 m. Both ends of the pipes extend out of the pouring body and are connected to a circulating water pump. Test the water pipe's tightness in advance to prevent water leakage [1]. During layered pouring, adopt the inclined-layered method, controlling the thickness of each layer at 30–50 cm and the pouring speed at 2–3 m^3/h. Ensure that the interval between the pouring of two adjacent layers does not exceed the initial setting time of the concrete to avoid construction cold joints. When vibrating, use an immersion vibrator with a vibrating spacing of no more than 40 cm and a vibrating time of 15–20 seconds to ensure that the concrete is dense without over-vibration. In the temperature monitoring stage, install temperature sensors inside and on the surface of the pouring body, with a sensor spacing of 2–3 m. Monitor the temperature every 2 hours after pouring and calculate the temperature difference between the inside and the outside. When the temperature difference exceeds 20°C, activate the cooling water pipe circulation system and control the temperature difference within 25°C by adjusting the water temperature. During the curing and insulation stage, cover the pouring body with geotextile and plastic film within 12 hours after completion. If necessary, add a flame-retardant insulation quilt. The curing time should be no

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less than 14 days, during which the surface of the concrete should be kept moist to avoid cracks caused by a sudden drop in temperature.

2.2 Prefabricated Component Lifting and Positioning Technology

In the pre-lifting preparation stage, first, use a total station to recheck the installation axis and elevation of the components and snap positioning lines on the floor with an error controlled within 1 mm. Then, check the appearance quality of the components. Repair components with embedded part deviations exceeding 2 mm. At the same time, install special lifting appliances. For steel beam components, select matching clamp-type lifting appliances, and determine the lifting points according to the center of gravity of the components to ensure that the components remain horizontal after lifting. When lifting the components, the angle between the lifting arm of the crane and the horizontal plane of the components should be no less than 60°, and the lifting speed should be controlled within 0.5 m/s to avoid collision and shaking of the components. When lifted to 50 cm above the installation position, pause, and the construction personnel adjust the component's posture through guide ropes to ensure that the component's axis is initially aligned with the temporary positioning line on the floor [2]. In the precise positioning stage, slowly lower the component to 10 cm above the installation surface. Use a total station to measure the component's installation coordinates in real-time and adjust the component's position, controlling the horizontal and vertical deviations within 2 mm. For vertical components such as prefabricated wall panels, use a level to check the perpendicularity. If the deviation exceeds 1 mm, make fine adjustments through diagonal braces until the perpendicularity meets the requirements. In the temporary fixation stage, immediately install temporary fixation devices after the component is positioned. For steel beams, use two sets of diagonal braces for symmetrical fixation. One end of the diagonal braces is welded to the embedded parts of the components, and the other end is connected to the embedded steel plates on the floor. For each prefabricated wall panel, install no less than three temporary supports. The exposed length of the support adjustment rod threads should not exceed 30 mm. After fixation, recheck the component's position and perpendicularity. Confirm that there are no errors before releasing the hook.

2.3 Deep Foundation Pit Support and Dewatering Technology

Before constructing the support structure, select the support form according to the geological survey report. For foundation pits with a depth of 5–8 m, choose soil nailing wall support. The soil nails are made of 22 mm-diameter threaded steel bars with a length of 3–5 m and are arranged at intervals of 1.5 m × 1.5 m. Grouting is carried out using a cement slurry with a water-cement ratio of 0.5. For foundation pits with a depth exceeding 8 m, choose row pile support. The pile diameter is 800 mm, and the pile spacing is 1.2 m. The bored pile process is used for construction, and a crown beam is set at the top of the piles to enhance the overall integrity. In the stage of installing the dewatering system, select the well point type according to the groundwater level height. For sandy soil layers, choose tube well dewatering. The tube wells have a diameter of 300 mm and a depth exceeding 3 m below the bottom of the foundation pit, with an interval of 15–20 m. For cohesive soil layers, choose light well points. The well point pipes have a diameter of 50 mm and are inserted to a depth exceeding 1 m below the bottom of the foundation pit, with an interval of 1.2 m. Connect them to a header pipe and a vacuum pump to ensure that the vacuum degree is not less than 60 kPa [3]. During foundation pit excavation, the layered excavation depth should not exceed 2 m. Construct the support structure immediately after the excavation of each layer is completed. Over-excavation is strictly prohibited. At the same time, start the dewatering system and monitor the groundwater level through water level observation wells to ensure that the water level drops to 0.5–1 m below the excavation surface. If the water level drops slowly, increase the number of well points or replace them with high-power vacuum pumps. In the monitoring stage, set displacement observation points around the foundation pit and use a total station to monitor the displacement of the support structure daily, controlling the daily displacement within 3 mm and the cumulative displacement within 30 mm. At the same time, monitor the settlement of surrounding buildings. If the settlement rate exceeds 2 mm/d, suspend excavation, analyze the reasons, and take corresponding measures. In terms of emergency response, store emergency supplies such as sandbags and steel pipes. If the local displacement of the support structure exceeds the limit, immediately backfill sandbags and add temporary supports. After the displacement stabilizes, formulate a reinforcement plan.

2.4 External Wall External Insulation Integrated Construction Technology

In the insulation board preparation stage, select extruded insulation boards with a density of no less than 30 kg/m³. Cut the insulation boards according to the size of the external wall, leaving a board joint width of 5 mm. Apply an interface agent on the inner side of the insulation boards to enhance the bond strength with the concrete. At the same time, reserve installation holes for connectors on the insulation boards, with a hole diameter of 10 mm and a hole spacing of 300 mm × 300 mm to ensure uniform distribution of the connectors. In the formwork installation stage, use 18 mm-thick film-faced plywood for the outer formwork and steel formwork for the inner formwork. Select a bowl-buckle scaffold for the formwork support system, with a post spacing of 1.2 m and a ledger step of 1.5 m. After installing the formwork, check the perpendicularity and flatness to ensure they meet the requirements [4]. In the insulation board fixation stage, place the insulation board against the inner formwork and install special connectors. One end of the connector passes through the insulation board and is fixed with the inner formwork, and the other end extends into the concrete structural layer, ensuring an anchoring depth of no less than 50 mm. The number of connectors per square meter of the insulation board should be no less than 6 to prevent the insulation board from falling off. In the concrete pouring stage, use commercial concrete and control the pouring speed within 1.5 m/h. When vibrating, avoid touching the insulation board with the vibrator to prevent displacement of the insulation board. After pouring, carry out curing in a timely manner, with a curing time of no less than 7 days to ensure that the concrete strength meets the standard. In the joint treatment stage, clean the surface of the insulation board after removing the formwork. Fill the board joints with polyurethane sealant, ensuring that the sealant is full and continuous. Stick alkali-resistant glass fiber mesh on the surface and then apply anti-crack mortar to enhance the anti-crack performance of the joints and ensure the integrity and insulation effect of the insulation system.

3. Construction Management Measures for Building Engineering

3.1 Dynamic Control of Construction Progress

In the plan preparation stage, first, prepare a three-level progress plan according to the total project duration target: the overall progress plan clarifies the completion times of key nodes such as foundation, main structure, and decoration; the monthly progress plan refines the construction tasks for each month; the weekly progress plan breaks down the tasks into specific processes and marks the logical relationships between the processes in the plan. In the progress tracking stage, use Project software to enter daily construction data, set up early warnings for key nodes, and generate a progress report every week. Compare the plan with the actual completion situation to identify delayed processes [5]. In the deviation analysis stage, for processes delayed by more than 3 days, organize construction teams and technical personnel to analyze the reasons. Common reasons include insufficient operating personnel, delayed material supply, and process connection problems. Identify the responsible party. In the adjustment and implementation stage, for the problem of insufficient personnel, increase the number of operating personnel and extend the daily working hours; for the problem of delayed materials, coordinate with suppliers for urgent delivery and activate the backup material inventory; update the weekly progress plan after adjustment and track the adjustment effect daily to ensure that the delayed processes catch up with the planned progress within 3 days.

3.2 Quality Sampling Inspection in Construction

In the plan preparation stage, prepare a detection plan for sub-divisional and sub-projects according to the construction drawings and acceptance specifications, clarifying the detection items, detection frequencies, and detection methods. The plan must be approved by the supervision unit before implementation. In the on-site sampling stage, the quality inspector of the construction unit and the supervision engineer jointly select detection samples. The samples should be representative. Fill in a sampling record during the sampling process, indicating the sample location, number, and sampling time, and both parties should sign it [6]. In the detection implementation stage, when detecting concrete strength, for the rebound method, select 10 test areas on the component surface, read 16 rebound values in each test area, calculate the average value, and then convert it into strength. When detecting steel bar spacing, measure the steel bar spacing point by point, measure at least 3 places for each component, and record the maximum and minimum spacing values. For the closed water test of waterproof engineering, fill the toilet with water to a depth of 30 mm and keep it for 24 hours. Then check whether there is leakage on the ceiling of the lower floor. In the result processing stage, keep the detection reports for qualified projects for archiving; for unqualified projects, immediately issue a rework notice, carry out re-sampling detection after rework until it is qualified, and at the same time analyze the reasons for the unqualified results and formulate preventive measures to avoid the recurrence of similar problems.

3.3 Refined Cost Accounting in Construction

During the ledger establishment phase, cost ledgers are set up for each sub-project, with detailed entries covering labor, materials, and machinery expenses. Labor costs are recorded by trade, including unit prices and working hours; material costs are recorded by category, including purchase quantities and unit prices; machinery costs are recorded by equipment type, including rental durations and shift fees, ensuring traceability of ledger data. In the cost allocation phase, various expense vouchers are collected monthly, and costs are allocated to each sub-project: labor costs are calculated based on attendance records and wage standards; material costs are accounted for according to incoming and outgoing inventory documents; machinery costs are tallied based on rental settlement statements. After allocation, these costs are compared with the planned costs for the sub-project [7]. During the deviation analysis phase, the deviation rate between actual and planned costs is calculated. For projects with a deviation rate exceeding 5%, the causes are analyzed. In cases of material waste, the loss rate is examined; if prices have risen, it is confirmed whether the increase exceeds the scope of contractually agreed price adjustments. In the control implementation phase, to address material waste, a quota material issuance system is implemented, requiring explanations and approvals for excess quantities. To manage price increases, long-term supply agreements are negotiated with suppliers to lock in unit prices. Additionally, construction processes are optimized to reduce material consumption, ensuring that the cost deviation rate for each sub-project is controlled within 5%.

3.4 Construction Safety Hazard Inspection

During the daily inspection phase, before the start of work each day, safety officers conduct a comprehensive inspection of the construction site, focusing on edge protection, temporary electricity, and special equipment. Any hazards found are immediately recorded in the "Construction Safety Hazard Inspection Form," noting the location, type, responsible person for rectification, and completion deadline [8]. In the special inspection phase, a special inspection is organized once a week, targeting high-risk operations: for work at heights, the wearing of safety harnesses and the setup of operating platforms are checked; for temporary electricity, cable laying and rainproof measures for distribution boxes are inspected; for lifting operations, the integrity of lifting gear is examined. A written report of the special inspection is submitted to the project leader. During the hazard rectification phase, the person responsible for rectification implements the corrective measures as required: missing edge protection requires immediate installation of guardrails and hanging of dense mesh safety nets; ineffective leakage protectors must be replaced immediately; damaged lifting gear should be taken out of service and repaired. The rectification process should be documented with photographs, retaining before-and-after comparison images [9]. In the re-inspection and acceptance phase, after rectification is completed, the safety officer conducts a re-inspection. If the re-inspection is satisfactory, the safety officer signs off on the "Construction Safety Hazard Inspection Form" to close the item; if not, further rectification is required until compliance is achieved. For recurring hazards, safety education and training are organized to enhance the safety awareness of workers, while the frequency of on-site supervision is increased to prevent similar hazards from reoccurring.

4. Conclusion

The above research indicates that construction projects require a dual focus on technology and management. Technologies such as large-volume concrete temperature control and prefabricated component lifting must strictly adhere to procedural norms to fully leverage their technological advantages. Progress, quality, cost, and safety management must form a closed loop to ensure project controllability. The synergistic interaction between technology and management can address issues such as technological implementation deviations and coarse management, ensuring that project quality meets standards, timelines are controlled, and costs comply with regulations, providing an effective practical approach for construction projects.

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