Exploration on Construction Technology and Management of Building Engineering

Xiaolong Bao

Anhui Haosheng Construction Engineering Co., Ltd., Hefei, Anhui, 230000, China

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Abstract: The study reviewed some of the core construction techniques and management measures in building engineering, decomposed the operation logic of four types of construction technologies (mass concrete temperature controlled pouring, prefabricated component lifting etc. It summarizes the implementation paths of four management measures, dynamic control of construction progress and quality sampling inspection in it, and expounds that technology-management synergy can significantly ensure project quality, duration and cost. This research works to resolve the existing problems in building engineering such as non-standard technology usage and lack of management control, thus, truly promoting construction efficiency and quality.

1. Introduction

In the process of building engineering becoming refinement and scaling development, construction technologies and management demand higher accuracy. However, in the actual construction process, with nonstandard technical operations and imperfect management measures cause quality hazard and project delay. It is therefore of great practical significance in the promotion of scientific management practices for building engineering, to analyze the application points of key construction technologies and relevant management measures, clarify the synergistic relationship between technology management in building engineering.

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 protrude out from pouring body and connect to a circulating water pump. You need to test the sealing of the water pipe in advance to avoid water leak [1]. Adopt the inclined-layered method pouring of layers, keeps layer thickness in 30–50 cm, controls pouring speed to be 2–3 m^3/h, and interval between two adjacent layers pouring out not inhale concrete initial set time of construction cold joints. Employ an immersion vibrator with a vibrating spacing ≤ 40?cm and a vibrating time of 15–20 seconds when vibrate, in order to compact the concrete without over-vibration. In the temperature monitoring phase, embed temperature sensors at up to 2–3 m apart inside as well as on the surface of the pouring body. After pouring, check the temperature every 2 hours and obtain the difference in temperature between the inside and outside. When the temperature difference reaches 20 °C pick up the cooling water pipe circulation system, control the temperature water short-circuit is at most at 25°C. During the curing and insulation, protect the pouring body by covering it with geotextile and plastic film within 12 hours of pouring completion. Add flame-retardant insulation quilt as needed. The curing time must no less than 14 days, during this period, the surface of the concrete should be kept moist, avoid cracking due to sudden temperature drop.

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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. Simultaneously, put special lifting devices on top. Select matching clamp-type lifting appliances according to the types of steel beam components, and select the appropriate lifting points based on the actual situation to ensure that the components maintain a horizontal state after being lifted. The angle θ between the lifting arm of crane and a horizontal plane through parts being lifted shall be no less than 60°, otherwise the components will hit and shake during hovering;41 based on our experience, lifting speed should not exceed 0.5 m/s either. If the component is raised from the installation position to 50 cm, it should be stopped and the construction personnel can adjust the posture of using guide ropes to ensure that it is aligned with a temporary positioning line on the floor at this moment [2]. In the precise positioning phase: Lower the component to 10 cm above the surface where it is going to be installed. Calculate the installation coordinates of each component in real time with a total station and control the horizontal and vertical deviation of each component within 2 mm. Use a level for vertical components such as wall panels that have been prefabricated to determine the perpendicularity. If the deviation is greater than 1 mm, fine-tune the 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. Use an interface agent on the inside of the insulation boards to increase bond strength with the concrete. Simultaneously, leave 10 mm diameter holes at intervals of 300 mm × 300 mm on the insulating boards for connectors. Stage 7: Formwork InstallationUse 18-mm thick film-faced plywood for outer formwork and steel formwork for inner form work. Choose a bowl-buckle scaffold for the formwork support system, with a post work spacing of 1.2 m and ledger step of 1.5 m after installing the formwork measuring perpendicularity and flatness meet the requirements [4]; At the stage of fixation of insulation boards, put the insulating board is deep in touch with an incision on the inner formwork and using special connectors are pressed to it. One end of the connector penetrates from the insulation board into the inner formwork, and has a certain anchoring depth between 50 mm — 80 mm with concrete structural layer. The minimum number of connectors per square meter on the insulation board is 6, which ensures that loosening does not occur. In the pouring stage, choose commercial concrete and control itself pouring with velocity less than 1.5 m/h; when vibrating, not to touch insulation board by vibrator, avoid displacement of insulation board. After pouring, cure promptly, and the curing time of no less than 7 days to meet the concrete strength standard. Stage 2 Joint treatment – If conditions allow, clean the surface of insulation board after removal of formwork. Cut the board joints on premium poly sealant and make your seal all the way full. It is recommended to stick alkali-resistant glass fiber mesh on the surface and use anti-crack mortar to further enhance the anti-crack performance of joints, thereby ensuring that the insulation system is more complete and effective in heat preservation.

3. Construction Management Measures for Building Engineering

3.1 Dynamic Control of Construction Progress

At the stage of preparing the plan, it is necessary to prepare a three-level progress plan in accordance with the overall target time duration of the project: -overall progress plan clarifies key nodes such as foundation, main structure and completion; Monthly Progress Plan is a refinement of construction tasks according to each month; The weekly progress plan decomposes tasks into specific processes and marks the logical relationship between processes in that week by process. In the progress tracking stage, input daily construction data in project software and set up early warnings for key nodes to generate a weekly progress report. Identify delayed processes by comparing the plan with actual completion situation [5]. Deviation analysis stage: for the process delayed by more than 3 days, organize construction team and technical personnel to analyze reasons. General reasons are: not enough operating staff, supply of materials prolonged or connection process. 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

Cost ledgers are created for each sub-project in the ledger establishment phase to track labor, materials and machinery entries. Cost log in drafts, including unit price and working hours for labor cost; purchase quantity and unit price for material cost; rental duration or shift fee by equipment type for machinery cost are recorded by trade to ensure traceability of ledger data. Cost collecting: second phase In this phase, all kinds of vouchers of expenses are collected each month, and costs will be allocated to the corresponding sub-project, specific methods include: labor cost calculated based on attendance records and wage standards; material cost account according to incoming & outgoing inventory documents; machinery cost measured according rental settlement statements. These costs are then compared to the planned costs for the sub-project, after allocation [7].

Deviation analysis: the deviation rate between actual and planned costs is obtained in this phase. A diligence is performed to understand the reasons for the disparity, when this varies from projects with more than 5% discrepancy. When it comes to material waste, the loss rate is checked; in the case of price increases, they are verified as exceeding what was agreed on via contractual adjustment rules. Implementation of control, quota material issuance system is implemented to address material waste, excess quantities need explanation and approval. In order to combat price increases, you enter multi-year supply agreements with suppliers to lock in the unit prices. Moreover, construction techniques are also refined to result in reduced material usage and the cost overrun rate for each sub-project is controlled at no more than 5% deviation.

3.4 Construction Safety Hazard Inspection

The Daily check–up phase where safety officers perform the overall survey of site before construction work begins every day, concern with edge protection, temporary electricity and special equipment. All hazards identified are recorded in a document called "Construction Safety Hazard Inspection Form," with details of location, type, the person responsible for rectification, and the completion time limit [8]. During the special inspection stage, a specially organized weekly "special" inspection focuses its checks on high-risk operations: work at heights (ensures that safety harnesses are worn and operating platforms set up); application of temporary electricity (checks delivery of cable laying and rainproof measures for distribution boxes); lifting operations (examining whether lifting gear is intact). The project leader is given a written report of the unique inspection. During the hazard rectification phase, the person responsible for the rectification performs the necessary remedial actions, e.g.: missing edge protection requires immediate installation of guardrails and hanging of dense mesh safety nets; and ineffective leakage protectors must be replaced immediately; damaged lifting gear needs to be removed from service and repaired. Photographic evidence of any rectification, with before and after comparison images, should be retained [9]. During the re-inspection and acceptance phase, safety officer perform a reinspections after rectification. If the re-inspection is approved, the "Construction Safety Hazard Inspection Form" will be signed by a safety officer to closeout the item and if not further rectification will be made until compliance has been achieved. Specifically for repeated hazards, safety education and training are organized to improve the awareness of workers on safety, and the frequency of on-site supervision will be increased to prevent similar hazard from happening again.

4. Conclusion

The previously mentioned research demonstrates that any construction project needs both technology and management in parallel. Large-volume concrete temperature control and automated lifting of prefabricated components are key technologies that provide a monumental advancement on their counterparts from the past, but in order to unleash those technological advantages, it is essential they be carried out with strict adherence to procedural norms. We need to make a closed loop between progress, quality, cost and safety management in order to control the project. The synergism between technology and management can resolve problems like technological deviate implementation as well as coarse management, ensuring the project quality meets standards, time are controlled and projects costs comply with regulations to be a implemented effective method in practical for construction projects.

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