Practical Exploration of Construction Quality Management in Building Engineering

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Abstract: With the goal of "breaking through the impasse" in construction quality management for building engineering as its core objective, this article conducts research centered around the existing pain points in the industry, such as inconsistent technical levels, disordered raw material control, and extensive process management. It proposes a practical strategy for three-dimensional collaboration involving technology, materials, and processes: At the technical end, it standardizes processes through "specialized teams compiling guidelines - tiered training to enhance skills - dynamic supervision to correct deviations"; at the material end, it establishes a full-chain control system encompassing "procurement evaluation - on-site verification upon arrival - classified storage"; and at the process end, it achieves closed-loop management through "pre-event technical coordination - dual supervision during the event - seamless handover after the event." This study breaks through the traditional mindset of "post-completion acceptance" and provides a feasible plan for the transformation of building engineering towards "lean construction."

1.Introduction

As urban skylines ascend with millimeter-level precision and mega-scale building complexes achieve "zero settlement" despite complex geological conditions, construction engineering has transcended its traditional scope of mere "brick-and-mortar assembly" to emerge as a systematic discipline integrating materials science, structural mechanics, and intelligent technologies. Construction quality now determines not only the safety and durability of built structures but also directly impacts urban operational efficiency and public well-being. While the deepening application of prefabricated construction and BIM (Building Information Modeling) technologies enhances project efficiency and quality, it simultaneously poses new challenges to quality management. Traditional models relying solely on "post-construction inspection" are increasingly inadequate in meeting evolving demands. Reconstructing quality management logic through a full lifecycle perspective—integrating technological innovation with process control—has thus become a critical imperative for addressing industry-wide quality challenges and driving construction engineering toward "lean construction" transformation.

2. Current Status and Challenges of Construction Quality Management in Building Engineering

2.1 Uneven Technical Proficiency and Lax Implementation of Process Standards

The construction industry has a significant proportion of migrant workers among its workforce. Many of them lack systematic technical training and are unfamiliar with construction process standards, often relying on experience during operations and neglecting technical specifications. For instance, in formwork support engineering, if the spacing between vertical and sweeping rods is not set according to design requirements, it can lead to formwork collapse, compromising both project quality and construction safety [1].

Moreover, some construction enterprises cut costs by using outdated construction techniques and equipment or by cutting corners and substituting inferior materials for superior ones. Although some companies introduce advanced technologies, the lack of professional technicians prevents

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them from fully leveraging these advantages, resulting in compromised construction quality.

2.2 Inadequate Quality Control of Raw Materials, with Prominent Source Risks

Some construction enterprises lack strict control mechanisms during raw material procurement, conducting lax supplier qualification reviews, which allows substandard materials to enter construction sites. For example, some companies purchase steel bars with inadequate mechanical properties or cement that does not meet the required strength grade. The use of such materials in engineering projects severely affects structural safety and durability. Additionally, there are management loopholes in the inspection and storage of raw materials. Some construction units fail to require sampling of incoming materials for inspection or engage in fraudulent practices during the inspection process. Furthermore, improper storage without effective protective measures can cause materials to deteriorate due to moisture, losing their original properties [2].

2.3 Coarse Process Control During Construction, Leading to Frequent Quality Issues

Currently, process control in many projects is in a rough state. Inadequate technical disclosures before construction result in construction personnel having a poor understanding of design drawings and construction plans, leading to deviations during construction. For example, in masonry engineering, if the requirements for mortar joint thickness and mortar plumpness are not clearly specified during technical disclosures, construction personnel may proceed arbitrarily, affecting the overall integrity and stability of the walls. Additionally, lax quality inspections and acceptances during construction fail to promptly identify and rectify quality issues. Quality inspections in some projects are mere formalities, with inspectors not conducting detailed checks on each process as required by specifications or not requiring construction units to rectify identified issues promptly, leading to the accumulation of quality problems and eventually resulting in serious quality accidents.

3. Practical Strategies for Construction Quality Management in Building Engineering

3.1 Enhancing Construction Technical Proficiency and Standardizing Processes

Construction enterprises should focus on "improving technical capabilities + implementing process standardization" as core objectives and establish a comprehensive management mechanism to create a synergistic effect between technical advancement and process standardization. Firstly, construction enterprises should form specialized technical teams consisting of technical supervisors, senior construction personnel, and quality supervisors. These teams should systematically review core processes involved in the project, such as steel structure installation, concrete pouring, and masonry, and then compile targeted Process Operation Guides by integrating industry standards and project design requirements. These guides should be visually rich, clearly specifying operation steps, key considerations, and common error avoidance methods for each process [3]. For example, in steel structure installation, the guide should outline the sequence for component positioning, bolt tightening, and welding operations, as well as issues to avoid, such as component collisions and missed welds, enabling construction personnel to quickly grasp process requirements.

Secondly, the specialized technical teams should organize tiered training sessions covering all relevant personnel, from team leaders to frontline construction workers. For team leaders, the focus should be on explaining the core elements of process standards and on-site coordination methods to ensure they can lead their teams in implementing the standards. For frontline workers, hands-on training should be conducted through on-site demonstrations of correct operation procedures, allowing workers to practice and correct non-standard operational habits. After training, the specialized technical teams should organize assessments, and only those who pass can participate in project construction. Those who fail must attend retraining until they meet the requirements.

Finally, quality supervisors should inspect the construction of each process according to the Process Operation Guides. If any operational deviations are found among construction personnel, they should be immediately pointed out and corrected to prevent deviations from escalating and causing quality issues [4]. Meanwhile, the specialized technical teams should regularly convene process implementation review meetings, where team members summarize process execution issues encountered during construction, analyze their causes, such as inadequate understanding of the process by construction personnel or the impact of on-site construction conditions on process execution, and then adjust training content or optimize process operation methods accordingly to ensure continuous improvement in construction technical proficiency.

3.2 Strengthening Raw Material Control to Ensure Quality from the Source

Raw materials are the "cornerstone" of engineering quality. Construction units need to establish a comprehensive control mechanism covering procurement, inspection, and storage—the three key links—to ensure quality at the first checkpoint.

Firstly, in the raw material procurement phase, construction units should prioritize "selecting the right suppliers." The procurement department should establish a comprehensive supplier evaluation system, with the evaluation team conducting a holistic assessment of suppliers based on product quality, supply capacity, and after-sales service. For example, they should review quality feedback from suppliers' previous supply projects, confirm their ability to deliver materials on time according to the construction schedule, and understand their efficiency in handling quality issues. Through multiple rounds of comparison and screening, reputable and fully qualified suppliers should be selected for long-term cooperation [5]. When drafting procurement contracts, contract personnel should clearly specify the quality standards of raw materials, such as the strength grade of cement and the mechanical property requirements for steel bars, as well as outline the inspection process and handling methods for non-conforming products to provide a clear basis for subsequent quality control and avoid responsibility disputes later on.

Secondly, during the on-site inspection of incoming raw materials, construction units must strictly adhere to the principle of "inspection before use." After raw materials arrive at the construction site, the material personnel should first verify whether the appearance, specifications, and model of the materials match the contract and check whether product certificates and factory inspection reports are complete. Subsequently, quality inspectors should sample materials from each batch according to regulatory requirements and send them to a third-party testing agency for inspection. Only raw materials with qualified inspection reports can be allowed into the construction process. If non-conforming materials are detected, the material personnel should immediately contact the supplier to remove the non-conforming materials from the site and record the removal time, quantity, and reasons in detail in the ledger to prevent non-conforming materials from being mixed into the project.

Thirdly, in the raw material storage phase, construction units should implement "categorized protection" based on material characteristics. Warehouse management personnel should divide storage areas according to material properties. For example, moisture-sensitive cement should be stored in a sealed, dry warehouse with moisture-proof agents placed inside and regular ventilation. Rust-prone steel bars should be stacked on supports under a rain shelter and coated with anti-rust agents [6]. Meanwhile, clear identification signs should be posted in each storage area, indicating the material name, specifications, arrival date, and inspection status, such as "Steel bar Φ25mm, arrived on August 20, 2025, inspection qualified," to ensure traceability during subsequent material issuance and prevent misuse or mixed use. In a residential community project in 2024, during the inspection of incoming steel bars, the quality inspector found rust traces on a batch of steel bars and immediately sampled them for testing. The inspection report showed that the yield strength of the steel bars did not meet the design requirements. The project material personnel promptly contacted the supplier and removed all 20 tons of the non-conforming steel bars, replacing them with a qualified supplier. It was through strict inspection control that the use of non-conforming steel bars in the main structure was avoided, ensuring the building's safety performance.

3.3 Optimizing Process Control During Construction to Ensure Quality

Process control during construction should run through the entire chain of "before, during, and after" events. Construction units should focus on precise preparation, dynamic inspections, and seamless integration to build a multi-layered quality defense line. Before construction, construction units need to make comprehensive preparations from a technical standpoint. The technical department should lead the organization of technical personnel to conduct a thorough review of design drawings, examining dimensions, node details, and material parameters page by page to fully grasp the design intent. If any contradictions (such as conflicts between pipeline layouts and structural beams) or ambiguous expressions are found in the drawings, technical personnel should immediately communicate with the design unit to clarify solutions and form written meeting minutes to avoid deviations during construction due to drawing issues. Based on this, the technical department should prepare detailed construction organization designs and specialized construction plans according to drawing requirements and on-site conditions, specifying the construction processes, quality acceptance criteria, and supporting safety measures for each process. After the plans are finalized, the technical leader should conduct tiered technical disclosures to team leaders and frontline construction personnel, demonstrating key operations through on-site samples to ensure that every construction personnel understands "how to do it and what standards to meet," unifying technical approaches for subsequent construction.

During the construction phase, construction units should strengthen process inspections through institutional mechanisms and collaborate with supervision units to form dual supervision. Construction units should establish a three-level quality inspection system of "team self-inspection - project department re-inspection - company final inspection": after each process is completed, the team leader should organize a team self-inspection, checking details against quality standards and filling out self-inspection records upon qualification. The project department's quality inspector should conduct a re-inspection based on the qualified self-inspection, focusing on sampling key parts and concealed works, and immediately require rectification if any issues are found, followed by re-inspection. The company's quality department should conduct regular final inspections to comprehensively assess engineering quality [7]. Meanwhile, the supervision unit should conduct on-site supervision of key processes such as concrete pouring and steel structure welding according to supervision plans and implementation rules, carrying out patrol inspections and parallel testing during daily construction. If any quality issues are found, supervisors should promptly issue supervision notices, specifying rectification requirements and timelines, and track the rectification process until acceptance is passed.

Process handover is crucial for preventing the accumulation of quality issues. Construction units should strictly enforce the handover and acceptance process. After the upper process is completed and passes self-inspection and re-inspection, the construction unit should organize technical personnel, quality inspectors, and the lower process team for joint acceptance. During acceptance, all parties should jointly verify whether the quality of the upper process meets standards and simultaneously check whether quality records such as inspection reports and concealed work acceptance forms are complete [8]. Only after the upper process passes acceptance can the lower process commence. If any issues are found, the upper process team is responsible for rectification, and re-handover is conducted after qualification. Through this seamless integration, the quality of each process is ensured, preventing issues from affecting the overall engineering quality.

4.Conclusion

Construction quality management in building engineering serves as a core benchmark for measuring industry development quality and a critical barrier for safeguarding urban safety and public well-being. The three-dimensional control strategies outlined in this article can break through the fragmented challenges of traditional quality management, achieving an ideological upgrade from "passive response to quality issues" to "proactive prevention of quality risks." Technical empowerment ensures the implementability of process standards, full-chain material control enables traceability from the quality source, and full-cycle process supervision eliminates potential issues and hidden dangers. Together, they form a modern quality management system that is "people-centered, technology-supported, and institutionally guaranteed."

Looking ahead, with the deep integration of technologies such as BIM and the Internet of Things with construction scenarios, construction quality management should further iterate toward digitalization and intelligence, continuously refining management granularity. Only by remaining problem-oriented and innovation-driven can we continuously address industry quality challenges, propel building engineering toward a safe, efficient, and sustainable path, and lay a solid foundation for high-quality urban development.

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