# Practical Exploration of Construction Quality Management in Building Engineering

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**Abstract:** This paper is focused on the existing pain points of the industry, such as inconsistent technical levels, disordered raw material management and long chain of process management, with "breaking through the bottleneck" in construction quality management for building engineering as the original intention. It suggests a simple approach to 3D technology, materials and process collaboration: at the technical end, "specialized teams compiling guidelines - tiered training enhancements to skills – dynamic supervision correcting deviations" standardizes processes; At the material side, "procurement evaluation - on-site verification upon arrival - classified storage" establishes a full-chain control system — and processes by achieving closed-loop management through "pre-event technical coordination during event dual supervision with sustainable handover post-event". This study is to overcome the thinking mode of "completed acceptance" and constructs a practical planning roadmap for "building engineering lean construction."

## 1. Introduction

As the urban skyline rises at a millimeter level and large-scale building complexes maintianing "zero settlement" become common in complicated geological conditions, construction engineering has stepped beyond its narrow traditional definition of simple assembly of bricks and buildings to be a systematic discipline including material science, structural mechanics and intelligent technologies. But the quality of construction today not only determines the safety and durability of what is physically built but also directly affects how that urban form operates efficiently, and with public well-being. Although the more widely used prefabricated construction and BI (Building Information Modeling) technology can improve the efficiency and quality of projects, it brings new challenges for the management of quality. However, traditional models through which "post-construction inspection" is the only relevant concept do not meet evolving needs anymore. Consequently, reestablishing the quality management logic from a full cycle perspective — integrating technological innovation and process control needs — has become crucial in constructing engineering to meet industry-wide quality challenges in order to realize "lean construction" revolution.

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

### 2.1 Uneven Technical Proficiency and Lax Implementation of Process Standards

A sizable portion of the workforce in construction are migrant workers. They have replaced many manual jobs, but due to lack of systematic technical training and unfamiliarity with construction process standards, they often only rely on experience in operation and ignore technical specifications. For example, in formwork support engineering, if the spacing between vertical and sweeping rods is not configured according to design requirements, it can lead to formwork collapse with serious consequences for project quality and construction safety [1].

Some construction companies that try to save money, they use outdated construction techniques and equipment or cut corners and replace normal materials with inferior ones. Even though some enterprises encourage new technologies, they cannot be adequately implemented due to the shortage

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of specialized personnel, and so engineering quality suffers.

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

Having not strict control measures of its raw material procurement in place, these construction enterprises carry out loose standards for supplier qualification review, which is able to make inferior materials flow into the construction site. For instance, some businesses buy steel bars without enough mechanical properties or cement that does not have the expected strength grade. Such materials being used in engineering projects has a detrimental effect on the structural safety and durability. On top of this, there are management loopholes in raw material inspection and storage. Individual construction units do not mandate the sampling of incoming materials for testing, and in other cases engage in fraudulent behavior when it comes to inspection work. Additionally, improper storage in the absence of effective protective measures may bring about ineffectiveness in moisture sensitive materials which can also lead to loss of original properties [2].

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

Process control is currently rough around the edges for many projects. The construction staff has a low understanding of the design drawings and the construction plan before the construction due to insufficient technical disclosures, leading to deviations during construction. As an example of this, in masonry engineering, if the mortar joint thickness and mortar plumpness requirements are not clear for technical disclosures, then construction personnel may do what they want, which can affect the overall integrity and stability of the wall. Furthermore, for construction phases where quality issues may arise, inadequate quality inspections and acceptances hinder the timely identification and resolution of such problems. Some projects' quality inspection operations can be just a formality, and the inspectors rarely check each process in detail according to specification requirements or urge construction units to promptly rectify problems found through inspection, resulting in the accumulation of quality problems, and finally leading to serious quality accidents.

## 3. Practical Strategies for Construction Quality Management in Building Engineering

### 3.1 Enhancing Construction Technical Proficiency and Standardizing Processes

The construction enterprise may reveal "the technical ability to improve + The idea of process standardization" as the two core goals to establish an all-dimensional management mechanism, forming ideas->+ model-> Promotion of synergistic effect. First of all, construction enterprises should establish a specialized technical team composed of technicians, senior construction personnel and quality supervisors. The above-mentioned teams need to conduct routine reviews on basic processes involved in the project, like steel structure installation, concrete pouring and masonry, etc., and form targeted Process Operation Guides by combining industry norms with project design needs. These guidelines should be visually rich highlighting the key steps for operation, important considerations and how to avoid common errors at each process [3]. For instance, for steel structure installation, the process guide should indicate the order of component positioning, bolt tightening and welding operations to facilitate construction staff's understanding of requirements and pitfalls (e.g. component collision or a missed weld) during implementation.

Secondly, the specialized technical teams shall hold tiered training sessions involving all relevant personnel from team leaders to frontline construction workers. For the team leaders, the method should be getting them to understand the basic nature of process are standards and how we coordinate onsite so that they can take on the responsibility if leading their teams through these standards [4]. For practical operation, hands-on guidance and practice should be carried out on-site, because from the initial stage of production to non-standard operation habits can only be corrected by personal teaching and practice. After training, the specialized technical teams can organize assessment, and only those who pass the test come to participate in project construction. Those who don't pass have to go through retraining until they are qualified.

The quality supervisors must check assembly at each process as per Process Operation Guides. If

construction personnel have operational deviations, they should be pointed out in time to correct the operation. At the same time, specialized technical teams should regularly hold construction process implementation review meetings (once a month), through team members or sub-sector responsible for carrying out summary of construction encountered in process execution issues, analysis caused by this issue reasons (of course there may be problems caused by actors not understanding the role of the process; or because the on-site construction conditions restricted the effect of the process); then timely adjust training content and optimize operation methods to ensure that construction counter technical ability improvement.

### 3.2 Strengthening Raw Material Control to Ensure Quality from the Source

The foundation of engineering quality comes from raw materials. Construction units should set up a quality assurance system involving the procurement, inspection and storage of materials—the three links in the process that need to be controlled in order to produce qualified products at the first pass.

First, making a choice in the procurement of raw materials In terms of construction units should be concerned with "choosing suppliers well." The procurement department needs to establish a supplier evaluation system, the evaluation team for a holistic assessment of suppliers on product quality, supply capacity and after-sales service. For example, go through quality feedback from past supply projects of the supplier, verify its ability to deliver materials on time in accordance with the construction design schedule, and learn how efficient it is in handling quality issues. Through multiple comparisons and screenings, reputable and fully qualified suppliers should be selected for long-term cooperation [5]. When formulating the procurement contract, the staff should clearly stipulate the quality standards of raw materials such as cement strength grade, steel bar mechanical property requirements and others; and determine the inspection process and disposal method for unqualified products so as to provide a basis for follow-up quality control and avoid liability disputes.

Second, enterprises engaging in production testing should implement "testing of materials as they enter the site" during on-site inspection and acceptance of raw materials. When raw materials are delivered to the construction site, material personnel should first check whether the appearance and specifications of the materials meet the requirements of contract or not; and whether product certificates factory inspection reports are complete. Then, the quality inspectors will sample them for batches and send them to a third-party testing organization for inspection according to relevant regulations. Raw materials that lack qualified inspection reports shall not be admitted into the construction process. In addition, if it is found that the materials do not conform to the standards, they should contact the supplier and make sure to remove them from site as soon as possible, registering at this time in detail of when nonconforming materials were removed, how much was removed and collect the reasons for removal so that non-conforming materials are not mixed into the project.

Thirdly, during the raw material storage phase, construction units should adopt "categorizing protection" for materials according to the characteristics. According to the properties of materials, warehouse management personnel should divide the storage area. Such as moisture sensitive cement should be stored in a sealed dry warehouse, inside the moisture-proof agent placed, regular ventilation. Steel bars that are prone to rust must be stacked on supports under a rain shelter and covered with anti-rust agents [6]. And there should be clear identification signs indicating the material name, specifications model, arrival date and inspection status in each storage area so that when issuing materials later can have traceability to prevent misuse or mixed use of inventory. At the construction site of a residential community project in 2024, when carrying out incoming inspection on steel bars and other materials, the quality inspector found rust traces on a batch of steel bars and immediately sampled them for testing. The inspection results showed that the yield strength of the steel bars was less than the design requirements. Within 72 hours, project material personnel contacted the supplier and emptied all 20 tons of non-conforming steel bars out to replace with qualified supply. Thereby, the application of non-compliant steel bars was prevented in the

main body of the building, and the safety performance of buildings was ensured.

### 3.3 Optimizing Process Control During Construction to Ensure Quality

The control processes throughout the construction should be cut across the entire chain of "before, during and after," events. This approach allows construction units to strengthen precision preparation, on-demand inspection, and integrated compliance to form a quality "defense line" at multi-levels. From a technical perspective, before construction units must make overall preparations. The technical department organizes the organization of technical personnel to conduct a comprehensive review and reads through the design drawings page by page to check dimensions, node details and material parameters and fully understands the rendering intent. In case of any contradictions (such as conflicts between the pipeline layout and the structural beam) or unclear expressions arising in the drawings, technical personnel should promptly contact with each design unit to confirm solutions and quote writing meeting minutes to prevent deviation caused by drawing issues during construction. Afterward, the technical department needs to make detailed construction organization designs and specialized construction plans based on requirements in a drawing design and condition of site and determine technology process、acceptance criteria for quality、本 lan that matched all kinds of technology work. When the plan is settled, the technical leader should carry out tiered technical disclosures to team leaders and frontline construction personnel to show major operations through on-site samples in order to make every construction personnel understand "how they should do it and what standards they should meet", so as to provide unification of technical methods for subsequent construction.

The construction unit shall strengthen the process inspection through system mechanism during the construction, and carry out dual supervision with the supervision unit. Construction units shall establish a three-level quality inspection system of "team self-inspection - project department re-examination - company final inspection": after each process is completed, the team leader leads a team self-inspection, details check against quality standards, and qualified filling in the self-test record. The quality inspector of the project department shall be responsible for re-inspection according to the qualified self inspection and focusing on sampling key parts and concealed works, and immediately required rectification if there is no problem, indicated reinspection [7]. Periodic final inspection of the engineering section by the quality department of company. At the same time, the registration unit should also conduct field supervision of key processes such as pouring concrete and welding steel structures according to supervision plans and implementation rules, plus patrol inspection and parallel testing during day-to-day construction. In the event of any quality issues, supervisors at all levels shall issue supervision notices in a timely manner, clarify rectification requirements and deadlines and follow up on the rectification until acceptance is passed.

Process handover is therefore essential to avoid the build-up of quality issues. Construction units shall strictly carry out the handover acceptance process. After the completion of an upper process, the construction unit shall organize relevant technical personnel in charge、quality inspectors and lower processes team to do joint acceptance. On acceptance all members should check together whether the quality of the upper process is up to standard and whether their related quality records such as inspection reports, concealed work acceptance forms are complete at the same time [8]. The lower process does not start until the upper process pass acceptance. In case of any concern, the upper process team makes it right and after qualification, handover is done again. Since each process is seamless with no gap, it makes sure that the quality of every process is intact and nothing falls through the crack affecting overall engineering quality.

## 4. Conclusion

Building engineering construction quality management is not only an important benchmark for measuring the quality of industry development, but also a key barrier to ensure urban safety and protect people's life and property. This paper puts forward three-dimensional control strategies which can help transcend the fragmented plight of traditional quality management, then realized the

concept upgrade from "passive response to quality problems" to "proactive prevention of quality risk." Process standards should be implementable with technical empowerment, full-chain material control allowing for quality traceability from the source, and full-cycle process supervision preventing potential problems and hidden dangers. Together, they make up a modern quality management system that is “people-centered, technology-ensured and institutionally guaranteed.”

In the future, construction quality management will continue to approach digitalization and intelligence with deeper integration of these technologies with construction scenarios and constantly refine the management granularity. Only by keeping to the problem-oriented and innovation-driven way can we persistently solve industry quality problems, promote building engineering to follow a safety-efficient-sustainable development road, and provide a solid foundation for the high-quality urban development.

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