

Construction Engineering Quality and Safety Management and Quality Inspection of Engineering Materials

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Abstract: The development of the construction engineering industry directly affects the stability of China's socio-economic structure. For modern construction engineering, project quality and safety management are crucial, and material quality control is a vital link in ensuring construction quality and safety. Based on this, this paper specifically explores strategies for project quality and safety management from various aspects such as regulations, personnel, and supervision methods in construction. Simultaneously, it elaborates on the key aspects of engineering material quality inspection, emphasizing the close relationship between ensuring material quality and guaranteeing project quality and benefits. It also analyzes the technical essentials of engineering material quality inspection, hoping to enhance the reliability of construction engineering and its comprehensive benefits.

1. Introduction

Construction projects are often large-scale, involve long durations, and encompass multiple construction phases and technical points, imposing strict requirements on human resources, construction materials, and management and supervision schemes. To ensure the comprehensive quality and safety of construction projects, material quality control should be a key entry point. Construction enterprises need to intensify efforts in material procurement, supervision, and on-site usage management, paying particular attention to targeted quality inspection of materials to ensure they meet specific on-site construction requirements. Furthermore, to achieve the desired results in quality and safety management, targeted management plans should be formulated considering the project's specific scale, functional attributes, and relevant policy requirements, enabling effective supervision throughout the construction process and thus ensuring the social and economic benefits of the project^[1].

2. Analysis of Key Points in Construction Engineering Quality and Safety Management

2.1 Building an Informatized Data Platform for Efficient Supervision of the Entire Construction Process

In the current era of rapid information technology development, ensuring the effectiveness of quality and safety management requires the construction of a corresponding data platform tailored to the specific project. Informatization enriches the platform's functions and attributes, allowing project managers to more conveniently and accurately understand construction progress, key quality and safety management points, cost control status, and personnel work status. Specifically, a construction engineering informatized data platform should possess functions such as: Real-time data acquisition (collecting various parameters from different construction stages via sensors and the internet); Data storage and management (storing critical data using cloud computing technology to ensure data security and reliability); Data analysis and mining (using big data technology to filter valuable information, improving the efficiency of integrating and screening massive data); Data visualization (presenting previously abstract data intuitively through graphics, images, and tables for easier understanding of the construction site situation); Data sharing (enabling data exchange

between different participants, departments, and projects, ensuring broader perspectives in engineering management, requiring unified data interfaces and formats). When the platform incorporates these functions, it can promptly identify key quality control points and risk factors throughout the construction process, leading to the formation of targeted quality and safety management strategies^[2].

2.2 Improving Regulations and Systems, Perfecting the Supervision Framework

The construction industry in China is developing rapidly, yet it faces challenges such as declining housing prices and rising construction costs. This necessitates that construction enterprises continuously innovate their quality and safety management schemes while ensuring project quality to protect benefits^[3]. However, ensuring quality and safety in the new era requires a well-developed project supervision framework. Currently, due to the rapid modernization of the industry, existing laws and regulations sometimes struggle to keep pace, revealing shortcomings. Therefore, revising and improving relevant regulations is a key starting point for perfecting the supervision framework and ensuring project quality and safety. Specific measures include:

Firstly, Refining Responsibilities. Past legal frameworks often lacked detailed assignment of responsibilities to departments and individuals. Future regulations should clearly define the functions of all parties, delineate responsibilities, assigning various construction phases and details to specific departments and personnel, and reflecting this in the relevant laws and regulations. Secondly, Increasing Penalties. Previously, penalties for disclosure and negligence by responsible departments and individuals were often insufficient, leading to low costs for non-compliance. Future revisions should strengthen the deterrent effect of regulations by increasing penalties for violations, including fines, revocation of qualifications, work stoppages for rectification, etc., thereby raising the importance attached to quality and safety management by construction units^[4]. Finally, Incorporating Clauses for New Technology Application.

Modern construction projects increasingly utilize new technologies. Previous regulations often lacked comprehensive descriptions regarding the classification, usage precautions, and standards for these technologies. Therefore, revisions should include clauses for new technology application, detailing specific operational methods and applicable scopes, making the application of new technologies in construction more standardized and quantifiable^[5].

3. Exploration of Key Points in Construction Material Quality Inspection

3.1 Importance of Construction Material Quality Inspection

3.1.1 Ensuring Material Quality

The selection of engineering materials is crucial in construction. If material quality, performance, or specifications do not meet standards, it directly impacts project quality, safety, and overall benefits. Therefore, rigorous material quality inspection is essential^[6]. Detailed inspection methods can determine the comprehensive quality and performance of materials, typically covering stages from raw material selection, processing, to transportation, with quality standards specified for each stage. This minimizes the possibility of substandard materials entering the construction site. Thus, detailed inspection plans ensure material quality.

3.1.2 Further Optimizing Construction Structure and On-site Construction

Current material inspection methods are diverse, often dominated by non-destructive testing (NDT), which does not affect the material's original structure or performance. Common NDT techniques include ultrasonic testing, infrared thermography, and X-ray inspection. The flexible application of these technologies can effectively analyze material density, strength, corrosion, deformation, etc., generating various parameters. Project managers can use these parameters to determine material quality and performance and assess suitability for on-site requirements^[7]. Parameters can also be analyzed through experiments, yielding data that serves as a basis for optimizing construction structures and on-site processes, ensuring comprehensive construction

quality and benefits.

3.2 Analysis of Technical Key Points in Construction Material Quality Inspection

3.2.1 Key Points of Non-Destructive Testing (NDT) Techniques

As mentioned, NDT is the most common method, using physical principles like sound, light, electricity, and magnetism to identify material defects (e.g., X-ray, thermography, ultrasonic testing). Ultrasonic testing is widely used to detect internal voids or cracks and assess internal deformation via density determination. Thermography identifies defects by detecting surface temperature variations; its principle is simple, and on-site operation is relatively convenient^[8]. X-ray testing offers significant advantages, using X-ray scanning to detect internal defects with relatively low cost and high accuracy.

3.2.2 Key Points of Sensor Detection Technology

Although less prevalent than NDT, sensor technology is also a commonly used inspection method in China's construction industry. Applying sensor technology to material inspection can effectively determine parameters like temperature, humidity, pressure, and density. It allows for real-time monitoring of parameter changes. The monitored data is fed back to a central processor via internet technology, which then responds based on the specific data. This data provides a factual basis for construction managers and designers, particularly for adjusting on-site construction processes, clarifying precautions, and enabling effective quality and safety management.

Currently, with advancing technology, research in sensor detection is deepening, optimizing previous methods. The application scope of sensor technology in material inspection is bound to expand further.

3.2.3 Computer Simulation Testing Technology

Computer simulation is another important quality inspection technology. It can determine the stress conditions of materials through simulation, identifying potential quality issues and defects. Upon identifying defects, designers, engineers, and managers can reselect or optimize materials to ensure they meet on-site requirements. Additionally, computer simulation can provide more scientific and rational design schemes for projects, allowing quality and safety management to consider multiple aspects and effectively reduce risks. In the future, computer simulation technology should be continuously optimized based on industry development, project scale, and function to improve inspection efficiency and accuracy, providing technical support for modern construction projects.

4. Conclusion

In summary, during construction, reasonable quality and safety management plans should be established, covering various aspects such as design, on-site construction, quality control, safety management, cost control, process coordination, and human resource management to ensure project quality and safety. Meanwhile, construction units and contractors should recognize that quality and safety management is an ongoing process; management plans must be continuously improved based on specific project needs to ensure comprehensive benefits. Material quality control is an indispensable part of construction management. Ensuring its effectiveness requires the flexible selection of inspection schemes and technologies, with a clear understanding of technical key points.

Currently, commonly used material quality inspection technologies primarily include non-destructive testing, sensor detection, and computer simulation testing. The flexible application of these technologies allows material inspection to cover multiple aspects, facilitating quality and safety management. When project quality and safety are guaranteed, it broadens the perspectives for modern construction, enabling designers and contractors to better adjust and optimize processes, effectively controlling the likelihood of quality and safety risks. This, in turn, expands the potential for modernization and sustainable development within China's construction industry.

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