

Research on the Application of New Materials and Quality Control in Expressway Electromechanical Engineering Construction

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Abstract: Electromechanical engineering of expressways is the key to the construction of smart expressways. The quality of materials and their standardized use directly affect the quality and service life of the project. The new materials are suitable for the mechanical and electrical construction scenarios and have prominent advantages. The key to their implementation lies in the quality control throughout the entire process. However, at present, there are shortcomings in promotion and quality control, such as lagging acceptance standards and mismatched processes. This article, based on the actual situation of mechanical and electrical construction and supervision in Guangdong, sorts out the current status of new material application and quality control, deeply explores the difficulties in control, and proposes optimization countermeasures in accordance with local standards, providing practical references for the high-quality construction of mechanical and electrical engineering on Guangdong's expressways.

Keywords: expressway electromechanical engineering construction; new material; full-process quality control; mechanical and electrical; environmentally friendly

1. Introduction

Highway electromechanical engineering is the “nerve center” of the road network operation, and the quality of construction materials is the core of the project quality. Under the construction of smart expressways, new materials suitable for special construction scenarios are widely applied, becoming an important support for improving the quality of projects. Based on my experience in construction management and supervision, there is a problem of inadequate quality control throughout the entire process in the application of new materials, which restricts their performance. This article conducts research on the full-process quality control of new materials and proposes optimization strategies, which has significant practical significance for promoting the high-quality construction of high-speed electromechanical engineering in Guangdong.

2. Description of the current situation of new materials Application and quality control in expressway Electromechanical Engineering construction

2.1 Core application characteristics of commonly used new Materials in mechanical and electrical engineering

The construction environment of high-speed electromechanical systems is diverse, and the requirements for material performance vary greatly in different scenarios. There are four types of new mechanical and electrical materials suitable for the climate of Guangdong, featuring four major characteristics: scene adaptability, with various materials matching different industries and meeting national standards; Green and environmentally friendly, low pollution and recyclable, reducing the burden on the environment; Long-term durability, weather resistance, anti-corrosion and anti-aging, extending the service life of equipment; High construction efficiency, lightweight and easy assembly can enhance construction efficiency and facilitate safety supervision and control.

2.2 The current implementation status of the full-process quality control for the application of new materials

With the wide promotion of new materials in various high-speed electromechanical projects in Guangdong, in accordance with the provincial standardization guidelines for electromechanical projects, the industry has gradually attached importance to the full-process control of new materials. Most projects have established an integrated basic quality control system covering entry, storage, construction and testing. During the entry stage, the factory certificates and test reports are verified. For key projects, the main materials of cables and grounding are sampled and re-inspected. During the construction phase, technical on-site supervision is arranged, and the supervisor simultaneously conducts on-site supervision and parallel

inspections. When conducting sub-item acceptance, the overall performance of the new materials after construction should be verified simultaneously. Based on the implementation of projects across the province and the practical experience of front-line supervisors, there are still obvious shortcomings in the quality control of new materials at present, and the degree of refined control is relatively low. Many projects directly apply traditional material acceptance standards, lacking special supervision details that are suitable for new materials. The matching degree between the supporting construction techniques and new materials is poor, and installation defects occur frequently. The material storage protection was inadequate, and performance deterioration occurred before construction. In addition, due to the single detection method and the limited scope of random inspections by supervisors, it is difficult to identify hidden dangers in concealed works, and there are multiple loopholes in the full-process control.

2.3 Comprehensive performance of new material application and quality control

The application of new materials can enhance the comprehensive efficiency of mechanical and electrical engineering. First, it extends the service performance, resolves the common quality problems that occur frequently in the Guangdong region, extends the service life of the core system by 30%, and reduces the operation and maintenance failure rate by about 40%. Second, it optimizes benefits. Lightweight and modular design can simplify construction, shorten the cycle, and reduce construction costs. Long-term durability also reduces maintenance and rectification expenses during the operation period. Third, it promotes green and intelligent upgrades. Environmentally friendly materials reduce pollution and resource consumption, aligning with Guangdong's green transportation concept, providing support for intelligent operation and maintenance, and facilitating the green and intelligent development of mechanical and electrical engineering [1].

3. Core issues in the application of new materials and quality control

3.1 The on-site acceptance standard system lags behind, and the source control of inferior materials has failed

Material acceptance upon entry is the first checkpoint of quality control. The current acceptance system lags behind, resulting in the failure of source control. The current special standards for new mechanical and electrical materials are updated slowly. Most projects directly apply traditional material acceptance indicators without formulating special acceptance plans in combination with the characteristics of new materials and local construction requirements in Guangdong. Key detection indicators are missing, the acceptance process is chaotic, and supervisors lack dedicated basis for determining the qualification of materials. At the same time, the low-price winning bid model lowers the acceptance threshold. The acceptance personnel have insufficient understanding of the new material testing standards. They only go through the motions by checking the paper documents and do not conduct random re-inspections on the core performance of the cables such as flame retardancy and grounding resistance reduction. As a result, inferior materials can flow into the construction site.

3.2 The compatibility between construction techniques and material properties is insufficient, and installation quality defects occur frequently

Matching construction techniques are the foundation for bringing out the performance of new materials. In many projects, the techniques are disconnected from the material properties, resulting in a large number of installation defects and even safety hazards. After the construction unit introduced new materials, it failed to adjust the construction plan in accordance with the material characteristics and the provincial mechanical and electrical standardization requirements. It still blindly followed the traditional construction process, and there was a lack of technical briefings by the supervisor and process control. Extensive construction has led to numerous on-site problems, such as leakage caused by improper application of new waterproof materials and cracking of engineering plastic casings due to non-standard installation operations, significantly weakening the effectiveness of new materials [2].

3.3 The on-site storage and process protection were not standardized, and the performance of the materials deteriorated prematurely after they arrived at the site

Storage and semi-finished product protection can maintain the original performance of materials. At present, there are loopholes in the control of both construction and supervision sides, and the performance of materials declines before construction. Most of the expressways in Guangdong are located in the wild mountainous areas, which are constantly exposed to high temperature, high humidity, rain and acid rain. Some construction sites have not built closed standard warehouses, and the supervisors have not inspected the storage conditions. Various materials are piled up in the open air, lacking measures to prevent rain, temperature control and dust. Cables, sealing materials and plastic components are prone to moisture, aging and

deformation. Moreover, the site did not implement classified and zoned storage. Materials with different physical and chemical properties were mixed and squeezed, causing chemical reactions, which further accelerated the damage of the materials.

3.4 The quality inspection methods are monotonous, and the hidden quality hazards of concealed works cannot be effectively identified

Testing is the ultimate guarantee for eliminating quality risks. Currently, the testing systems of most projects are not perfect, and the methods of supervision and third-party testing are simple, making it difficult to achieve comprehensive quality control. On-site inspection mostly relies on visual observation and simple tool measurement, with low detection accuracy and small coverage. Internal defects in concealed works such as cables, grounding, and waterproofing cannot be identified in a timely manner. Many problems remain in the operation stage, inducing equipment failure and safety accidents. In addition, the project did not formulate a special testing plan in combination with new materials and local norms, and continued to use traditional testing indicators, which made it impossible to accurately assess the long-term performance of materials and thus failed to meet the standards for the completion and acceptance of mechanical and electrical engineering [3].

4. Optimization strategies for the full-process quality control of new material application

(1) Establish a standardized on-site acceptance system to achieve source control of material quality.

Relying on national and local Guangdong mechanical and electrical standards, clarify the acceptance criteria for new materials and establish a supplier access system. Formulate a special supervision and acceptance plan, implement a three-level mechanism of “document verification + on-site inspection + third-party re-inspection”, entrust re-inspection for key materials, and remove unqualified materials from the site. By leveraging QR code and RFID technologies, a traceability system is established to achieve full traceability of materials throughout the entire chain.

(2) Optimize the adaptive construction process and standardize the on-site construction operation procedures.

Based on the material properties and the construction scenarios in Guangdong, a special construction plan and supervision operation instruction manual are compiled. Establish a two-way three-level technical briefing system and strengthen specialized training for personnel. Implement on-site supervision for key processes, carry out sign-raising acceptance for key processes, and strictly control the installation quality.

(3) Standardize on-site storage and process protection to ensure stable material performance.

A dedicated warehouse was built in accordance with the Guangdong mechanical and electrical construction standards, equipped with temperature control and dehumidification facilities, and the storage environment was strictly controlled. Implement zoned and classified storage. Mixing and storing with corrosive materials are strictly prohibited. A dedicated supervisor should conduct regular inspections. Materials that do not meet the standards should be removed from the site. Strengthen the protection of finished products to prevent damage from cross-construction.

(4) Introduce diversified detection technologies and build a full-dimensional quality inspection system.

Abandon traditional detection methods, introduce non-destructive testing equipment to identify potential hazards in concealed works, and formulate special detection plans in accordance with local standards. Strengthen personnel training, implement the requirement for certified personnel to work, establish a closed-loop management mechanism for potential risks, file inspection archives, and achieve full-process traceability of quality.

5. Conclusion

The application of new materials and full-process quality control are at the core of enhancing the quality of high-speed electromechanical engineering and promoting the construction of smart highways. There are still problems such as delayed acceptance in the application of new materials in Guangdong’s mechanical and electrical engineering. This article builds a control system from four core links, which can solve the pain points of the industry and standardize the application of materials. In the future, with the iteration of new materials and the advancement of smart expressway construction, it is necessary to continuously improve the quality control system, promote its standardized and refined development, and provide support for the high-quality development of transportation in Guangdong.

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