Research on Prefabricated Paving Technology for Temporary Roads in Construction Sites

Lei PENG
Baoli Construction Group Co., Ltd., Hefei, Anhui, 230041, China

Keywords: Construction engineering; Temporary roads; Prefabricated paving

Abstract: In the construction process of building engineering, temporary roads serve as critical infrastructure for material transportation and machinery access. Their construction quality and efficiency directly impact the overall project timeline and cost. Traditional temporary roads primarily use gravel paving or cast-in-place concrete techniques. Although these methods are mature, they exhibit significant limitations. Addressing issues such as long construction cycles, high resource consumption, and poor reusability associated with traditional cast-in-place techniques, this paper investigates prefabricated paving technology for temporary roads, aiming to enhance its on-site applicability and economic efficiency.

1. Introduction

In construction site management, temporary roads play a central role in material transport, heavy machinery access, and personnel movement. Their construction efficiency and functional characteristics directly influence the implementation of project construction organization plans. Currently, traditional construction methods for temporary roads mainly involve on-site gravel laying or concrete pouring. While these techniques are relatively mature in application, they reveal numerous adaptability issues in practical engineering. In recent years, with the continuous improvement of prefabricated building technology systems, synergistic optimization of time limit for a project, cost, and environmental benefits has been effectively achieved. This progress further promotes the transformation of temporary engineering from extensive practices to intensive and efficient methods.

2. Fundamentals of Prefabricated Paving Technology for Temporary Roads in Construction Sites

2.1 Core Technical Principles

The core logic of prefabricated temporary road paving technology is to shift from the traditional model of "on-site monolithic pouring or stacking" to a construction path of "factory-precast standardized components + on-site modular assembly." The technical essence lies in deconstructing the structural function of temporary roads into unit components that can be independently produced, transported, and assembled. Industrialized production enables precise quality control, while on-site rapid assembly completes road formation, establishing a closed-loop system of "production–assembly–turnover–reuse."

Structurally, this technology system mainly comprises three core parts: the precast component layer, the connection node layer, and the base support layer. The precast component layer, as the main load-bearing body of the road, requires material selection and structural design in the factory based on on-site traffic needs. The connection node layer is key to ensuring road integrity. Through pre-set mortise-tenon interfaces, bolt holes, and other structures, rapid docking and stable connections between components are achieved, avoiding crack issues caused by discontinuous pouring in traditional roads. The base support layer requires simplified treatment based on site foundation conditions, eliminating the need for complex multi-layer subgrade construction as in traditional methods. Instead, graded gravel cushion layers or specialized roadbed boxes can provide

  DOI: 10.25236/icacel.2025.125

stable support for precast components, reducing on-site operational complexity.

This technical model fundamentally changes the traditional attribute of temporary roads as "one-time construction, one-time disposal." By leveraging the repeated turnover of precast components, it establishes a technical path for resource recycling. Simultaneously, it transfers a significant portion of on-site work from traditional processes to the factory environment, effectively avoiding core issues such as significant weather constraints, long operation cycles, and fluctuating engineering quality in traditional temporary road construction. This fully reflects the deep alignment between industrialized construction concepts and the practical needs of temporary engineering[1].

2.2 Technical Characteristics of Prefabricated Temporary Roads

Relying on its unique construction logic, prefabricated temporary roads exhibit distinct technical characteristics compared to traditional methods, which further determine their advantages in specific construction scenarios. From a technical perspective, efficiency is its primary advantage. On-site construction eliminates time-consuming processes such as formwork installation and curing. After prefabricated components are transported to the site, rapid assembly can be completed using hoisting equipment, far exceeding the efficiency of traditional concrete pouring methods. This is particularly suitable for scenarios requiring quick establishment of material transport channels in the early stages of projects.

Economic efficiency is another core characteristic. Prefabricated components can be reused across multiple projects, not only reducing the cost of repeated material purchases but also lowering expenses for construction waste removal. Additionally, the shortened construction period indirectly reduces costs for project management and construction machinery rentals. Furthermore, environmental friendliness and flexibility are standout features of this technology. Factory prefabrication significantly reduces dust and noise pollution from on-site excavation and concrete mixing. The modular assembly method allows flexible adjustment of road alignment and width according to dynamic changes in the construction site layout, meeting practical needs for functional adjustments during construction.

3. Key Construction Techniques for Prefabricated Temporary Roads

3.1 Base Treatment Technology

As a fundamental process ensuring the bearing stability and service life of prefabricated temporary roads, the core objective of base treatment is to construct a suitable base support system based on site geological conditions and road load-bearing requirements, while simplifying the complex processes of traditional base construction. Before base treatment, site geological surveys must be conducted to determine key parameters such as the physical and mechanical properties of the foundation soil, bearing capacity, and groundwater level. These parameters serve as the basis for developing targeted base treatment plans.

For different types of foundation conditions, base treatment methods require differentiated adjustments. For soft sites with insufficient bearing capacity, a graded gravel cushion layer should be laid to enhance foundation support. The materials for the graded gravel cushion must be proportioned strictly according to particle gradation requirements. During laying, a layered rolling construction method should be adopted, strictly controlling the compaction thickness and density of each layer to ensure the overall strength of the cushion meets design requirements. For soft soil or muddy sites, merely laying a gravel cushion may not achieve the expected bearing effect. Specialized roadbed boxes should be used as base support structures. Before laying the roadbed boxes, preliminary leveling of the site is necessary to avoid uneven stress due to site undulations, which could lead to later road surface deformation or precast component damage.

3.2 Component Assembly and Fixation Technology

Component assembly and fixation technology directly affect the overall mechanical performance and traffic safety of prefabricated temporary roads. Its core requirement is to achieve stable connections between precast components through standardized assembly methods while ensuring the efficiency of on-site assembly operations. Before assembly, precast components must undergo visual quality inspections and geometric dimension checks to confirm the absence of obvious cracks on the surface, undamaged edges, and compliance of dimensional deviations with assembly requirements. This avoids impacts on assembly quality due to component defects.

Assembly operations must strictly follow the construction flow path of "positioning–docking–fixation." First, based on the designed alignment and width of the temporary road, control lines for component placement should be marked on the prepared base to ensure precision in assembly positions. For components using mortise-tenon assembly, the convex and concave interfaces must be accurately aligned. Mechanical assist equipment may be used to adjust component positions if necessary, ensuring tight interface contact and minimizing gaps. For assembly gaps, specialized sealing materials should be used for filling to prevent rainwater infiltration into the base, which could cause foundation softening. For components using bolt fixation, accurate alignment must be achieved based on pre-set bolt hole positions. During bolt installation, tightening torque must be controlled to ensure firm connections. Additionally, anti-corrosion measures should be applied to exposed bolt parts to prevent rusting during long-term use, which could affect connection strength.

3.3 On-Site Construction Organization and Management

On-site construction organization and management are crucial for ensuring the efficiency and quality of prefabricated temporary road construction. The core lies in achieving orderly link up of all links through scientific planning of construction processes and rational resource allocation. Before construction, a specialized construction plan should be prepared, clarifying the construction flow path, personnel divide the work, equipment configuration, and key points for quality and safety control. Technical briefings should be conducted for construction personnel to ensure they master operational standards for key processes such as component hoisting and assembly[2].

Component transportation and storage require focused management. During transportation, specialized fixing devices should be used to prevent component shaking and collisions, avoiding damage to edges and corners. On-site storage should be planned based on construction progress and component usage sequence. Storage areas must be level and firm, and cushion layers should be placed when stacking components in layers to prevent deformation under pressure. Additionally, rain and moisture prevention measures should be implemented to avoid quality issues due to environmental factors.

During construction, a real-time quality control mechanism should be established, with dedicated personnel inspecting key indicators such as assembly accuracy, fixation strength, and base levelness. Issues should be rectified promptly. Safety management must also be emphasized: construction warn areas should be demarcated to ensure no unauthorized personnel enter during hoisting operations; hoisting equipment operation must comply with safety standards to prevent accidents such as equipment tipping or component falling. After construction, phased acceptance should be organized to confirm that road paving quality meets design requirements before opening for use, ensuring material transport and machinery access for subsequent project construction[3].

4. Optimization Paths for Prefabricated Paving Technology of Temporary Roads in Construction Sites

4.1 Material Performance Innovation and Lightweight Optimization of Precast Components

As the core load-bearing units of prefabricated temporary roads, the material performance of precast components directly affects the road's load-bearing capacity, service life, and construction convenience. Material innovation should advance around the three core goals of "high strength, lightweight, and durability." First, it is necessary to break through the limitations of traditional materials and explore the application of new composite building materials. For example, incorporating high-performance fibers into concrete components can enhance crack and impact resistance while reducing cement usage to lower component weight. For light traffic scenarios, modified polymer composite components can be developed to further reduce weight, lowering equipment load during transportation and hoisting, while meeting bearing requirements.

Material optimization must also fully consider environmental adaptability requirements. For extreme climate areas such as rainy or cold regions, specialized precast component materials with anti-seepage and anti-freeze properties should be developed. By adjusting material mix ratios or applying specialized coatings on component surfaces, durability in harsh climates can be improved, reducing performance degradation and damage due to weather factors. Additionally, a matching mechanism between material performance and construction requirements should be established. Based on specific needs such as traffic load levels and road service life, customized material formulas can be developed to avoid cost waste from "over-design" while ensuring precise adaptation of material performance to on-site construction conditions, achieving the goal of "material selection based on demand, optimal performance."

4.2 Integration of Intelligent Technology in the Entire Construction Process and Efficiency Improvement

The integration of intelligent technology is a key path to breaking bottlenecks in prefabricated temporary road construction and enhancing process control precision. It should run through the entire cycle of "design–production–construction–maintenance." At the design stage, BIM technology can be introduced to create 3D models, enabling digital design of component dimensions and interface forms. Through pre-assembly simulations, conflicts can be identified early, and component layout and assembly schemes optimized, reducing on-site adjustments. At the production stage, automated production lines can be introduced, using CNC equipment to standardize processes such as component pouring, molding, and curing. Real-time production data collection can establish a quality traceability system, ensuring stable and controllable component quality.

Intelligent optimization during the construction phase focuses on improving operational efficiency and quality control. IoT technology can be deployed with smart monitoring devices to collect key indicators such as base levelness and assembly gaps in real time. Data can be transmitted synchronously to a management platform for dynamic quality alerts. Unmanned hoisting equipment, combined with on-site positioning technology, can achieve precise component hoisting and assembly, reducing human error and enhancing construction efficiency. Additionally, a digital construction management platform can be established to integrate resource information such as personnel, equipment, and components, enabling visual management of construction progress and resource allocation. This optimizes process link up, avoiding time limit for a project delays due to disconnections between production processes.

4.3 Improvement of Technical Standard System and Expansion of Adaptability

Currently, prefabricated temporary road technology still faces issues such as inconsistent technical standards and insufficient scenario adaptability in practical applications. It is necessary to promote the standardization and scaling of this technology by building a comprehensive technical standard system and expanding scenario adaptability. First, technical standards covering all links of "component design–construction process–quality acceptance–recycling" should be formulated. Key technical indicators such as dimensional tolerances, assembly accuracy, and bearing capacity testing of precast components should be clearly defined to unify industry technical thresholds and avoid uneven construction quality due to chaotic standards.

Simultaneously, differentiated technical application guidelines should be developed for scenarios with different foundation conditions and traffic needs. Specialized technical requirements such as component selection, base treatment schemes, and assembly methods should be specified to enhance the technology's adaptability to complex construction scenarios[4].

The standard system should also incorporate environmental and resource recycling requirements. Technical specifications for component recycling, repair, and reuse should be formulated, clarifying quality evaluation standards for component turnover use and establishing a component recycling process. This promotes the transformation of temporary roads from "single-use" to "circular turnover." Additionally, the connection between standards and practical engineering should be strengthened. Industry collaboration mechanisms can collect application feedback from projects and regularly update standard content, ensuring that standards not only lead technological development but also effectively address on-site construction pain points, achieving dynamic adaptation between technical standards and engineering practice.

5. Conclusion

In summary, the three optimization paths proposed in this paper—material performance innovation, integration of intelligent construction technology, and improvement of the standard system—are not isolated but form an organic whole that supports and synergizes effectively. They can break through current limitations of prefabricated temporary roads in terms of load-bearing capacity, construction efficiency, and scenario adaptability. In the future, with continuous breakthroughs in new building material technologies, gradual popularization of intelligent construction equipment, and ongoing improvement of industry standards, prefabricated temporary road technology can add value to more construction projects, injecting new momentum into the high-quality development of the construction industry.

References

[1] Kang Bin. Research on Prefabricated Paving Technology for Temporary Roads in Construction Sites[C]//Chongqing Big Data and Artificial Intelligence Industry Association, Chongqing Construction Editorial Department, Chongqing Construction Association. Proceedings of the Academic Seminar on Smart Building and Intelligent Economy Construction (II). Nanning Municipal Group Co., Ltd., 2025:545-548.

[2] Cheng Yue, Zhou Shuanghu. On the Application of Prefabricated Building Construction Technology in Construction Engineering Management[J]. China Housing Facilities, 2022(10):49-51.

[3] Tian Yufeng, Hu Jin. Discussion on Common Construction Quality Issues in Prefabricated Buildings[J]. Industry and Science Forum, 2019,18(23):242-243.

[4] Gong Xiaoyu, Yuan Jianang. Design and Construction Key Points of Waterproof Nodes in Prefabricated Buildings[J]. Jushe, 2019(27):116-117.