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Analysis of Road Bridge Repair and Strengthening Construction Technology

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Abstract: Highway infrastructure plays a crucial role in the healthy development of the social economy. Therefore, China has invested a lot of financial resources in the construction of road and bridge projects in recent years, resulting in the rise in scale and number of road and bridge projects. Simultaneously, the quality of road bridges has garnered widespread attention, necessitating an exploration of common hazards associated with road bridges and the significance of their reinforcement. It is essential to delve into specific technical methods to enhance the quality and service life of road bridges. This paper elaborates on the common hazards faced by road bridges and proposes maintenance and reinforcement strategies to promote the healthy development of road bridge engineering.

Keywords: Road bridge; Maintenance; Common hazards; Reinforcement construction

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1. Introduction

Road and bridge construction is susceptible to the influence of the external environment, resulting in structural damage, defects, and safety concerns, ultimately shortening the service life of the bridge. Therefore, it is necessary to further highlight road bridge construction. By combining an understanding of the structure of road bridges with knowledge of common hazards, effective reinforcement measures and methods can be taken to ensure that road bridges consistently maintain good operating conditions and reduce the impact of these issues.

2. Common hazards of road bridges

Common hazards in road bridges include bridge deck subsidence, potholes, and concrete cracking. These issues compromise the stability and robustness of the bridge structure. An analysis of these common hazards follows.

2.1. Sinking of the bridge deck

After the completion of road and bridge construction, the prolonged pressure from heavy vehicles during operation increases the load on the road and bridge. If this load exceeds the bridge's capacity, it can easily cause

cracks in the structure. If these cracks are not promptly detected and repaired, the bridge deck may start to sink under the continued overload, leading to issues such as the support of the bridge becoming hollowed out and misaligned, ultimately affecting the overall quality of the road bridge construction.

2.2. Pothole

China's road and bridge projects are increasing, and the construction scale is expanding, while the traffic flow remains substantial. Most of these projects feature a beam structure, which tends to age over time, leading to numerous cracks. These cracks can develop into potholes due to rain erosion, posing significant challenges to the integrity and safety of the bridge structures.

2.3. Concrete cracking

Once a highway bridge is operational, prolonged usage can lead to the peeling and spalling of the bridge deck, consequently reducing the cross-section of the bridge and rendering it susceptible to damage from harmful substances, thereby compromising road and bridge safety [2]. Typically constructed from reinforced concrete, the main body of road bridges contains numerous capillaries. These capillaries make it prone to issues such as the corrosion of reinforcing steel under external pressure and erosion from rainwater, ultimately leading to concrete cracking and posing a significant threat to the overall structural integrity of road bridges.

3. Significance of road bridge repair and reinforcement construction

China's diverse geological and hydrological environments necessitate careful consideration in the design and construction of highway bridge projects, tailoring the road structure to the surrounding conditions. While some highway bridges boast a long service life, their durability diminishes over time, requiring subsequent maintenance and reinforcement to prolong their lifespan, conserve funds for future replacement or reconstruction, and mitigate traffic safety risks. However, current maintenance, repair, and reinforcement efforts face numerous challenges, often falling short of expectations and exacerbating bridge ailments, thereby jeopardizing highway bridge safety. Consequently, a holistic approach is essential, integrating the current status and operational requirements of road bridges into maintenance and repair strategies to identify underlying issues and influencing factors. By implementing effective maintenance, repair, and reinforcement methods, the safety and functionality of road bridges can be ensured, fostering regional economic development.

4. Road bridge repair and reinforcement technology methods

Road bridge repair and reinforcement technologies come in diverse forms, each with its own characteristics and effects. Depending on the specific circumstances and desired outcomes, suitable methods can be selected to ensure the quality of bridge construction.

4.1. Superstructure reinforcement technology

In the application of superstructure reinforcement technology, one method involves utilizing an external prestressing reinforcement technique. This technique reinforces the tensile region of the lower edge of the girder body with prestressing materials, resulting in the formation of eccentric prestressing. This creates an upper arch shape in the girder body, effectively canceling out the girder body's gravitational force. As a result, this method helps reduce crack widening and deformation issues in the girder structure, improves the structural stress situation, and enhances the bearing capacity of the girder [3]. Compared with conventional prestressed concrete

structures, this method offers advantages in terms of the connection between the original structure and the force tendons. Through the girder, a connection method for the anchor point can be established without bonding. This approach is suitable for bridges with relatively small self-weight and can enhance crack resistance and structural rigidity by adjusting the structure. It is applicable not only for temporary bridge reinforcement but also for permanent bearing capacity reinforcement. Additionally, it addresses issues such as rusting of pre-stressing tendons or steel reinforcement in concrete girders, which can diminish the bridge's bearing capacity over time. Moreover, it helps control crack magnitude in the girder structure and reinforces the bridge structure. Other repair methods include setting cantilever beams in the space at the end of two-hole girders at the top of pillars and installing micro-ventilated panels at the top of the girders to enhance their sturdiness.

4.2. Adding pile reinforcement technology

During road bridge construction, employing pile-adding reinforcement technology enhances the bearing capacity of bridge piers. Moreover, widening the bridge roadway and deck redistributes force, expanding the supporting surface and improving overall regional bearing capacity [4]. During pier construction, careful consideration is given to the surrounding environment. Road bridge construction often occurs in complex surface environments, especially when the construction location is within the upper soil layer, necessitating advance preparation for concrete pouring. To enhance the stability of pile-added piers, the bridge superstructure can be optimized to bolster overall structural robustness and mitigate collapse risks. Implementing piling reinforcement methods can be complemented by designing various shapes. For instance, when reinforcing piers and abutments, a foundation pile platform should be established. The center position of the stack is determined experimentally, with stack positions set on both sides of the original abutment, enhancing bridge load capacity and alleviating pressure on the bridge [5].

4.3. Reinforced concrete reinforcement technology

In road and bridge construction, steel reinforcement serves as a crucial load-bearing material, making it imperative to subject it to testing and optimization during bridge reinforcement repairs to guarantee construction safety [6]. All reinforcing steel materials used in road and bridge projects must adhere to construction standards, and protective measures for the reinforcing steel layer should be reinforced during subsequent maintenance. Ensuring that the thickness of the reinforcing steel layer meets construction standards is crucial to enhancing the overall construction effectiveness of road and bridge projects, thereby fulfilling their intended roles. Strengthening these measures helps prevent issues such as fracturing and rusting of the reinforcing steel. Additionally, effective waterproofing measures are essential for road bridge steel construction to prevent corrosion, as prolonged exposure to water can lead to corrosion problems. During later bridge inspections, prompt action must be taken to address any identified corrosion issues through effective repair methods [7]. In concrete engineering construction, an incorrect ratio of mixed materials can significantly impact the quality of road and bridge construction. Hence, it is crucial to meticulously optimize the concrete ratio design to enhance quality control efficiency. Additionally, in the fundamental maintenance of road bridges, it is vital to consider the influence of weather conditions on concrete cracks. Implementing appropriate safety management regulations is necessary to achieve improved prevention and maintenance outcomes [8].

4.4. Member section reinforcement technology

the stability of the bridge directly influences its bearing capacity. Therefore, during the later rehabilitation of road bridges, it is crucial to integrate considerations of economic development and employ scientific cross-section reinforcement methods to strengthen the force area of the bridge and enhance its bearing capacity. While

such reinforcement measures can significantly bolster the bridge's bearing capacity, they often entail lengthy construction periods and substantial costs, thus limiting their widespread application.

4.5. Pre-stressing reinforcement technology

In road bridge engineering reinforcement maintenance, prestressing reinforcement technology stands out as a commonly employed method. Compared to traditional reinforcement approaches, prestressing reinforcement technology offers distinct advantages, particularly in optimizing the construction of curved members within bridge structures. This technology yields more pronounced optimization effects, enhancing the overall effectiveness of bridge construction [9]. Employing prestressing reinforcement technology in road bridge maintenance and reinforcement is beneficial for enhancing the external loading capacity of the bridge and mitigating the impact of external factors on the bridge structure. The application of this technology necessitates a combination of prestressing tendons and auxiliary materials to ensure the standardization of prestressing operations. Technical control in prestressing reinforcement primarily revolves around managing prestressing tensioning capacity. This involves analyzing the overall stressing condition of the bridge to ensure that the bridge maintains effective reinforcement under tensioning.

4.6. Bridge deck thickening reinforcement technology

In road bridge repair and construction, addressing large bridge gaps is crucial to maintaining the bridge's bearing capacity, necessitating effective repair methods to achieve the desired outcomes. One approach in road bridge repair and reinforcement involves thickening the bridge deck at crack locations. In this method, the original bridge structure serves as the foundation, with the removal of the bridge's pavement layer followed by the pouring of new reinforced concrete onto the panel. This process supplements the bridge deck, enhancing the stiffness and bending resistance of the road bridge structure. The procedure involves several steps: firstly, examining the bridge structure and processing the original waterproof concrete paving structure through chiseling construction and subsequent cleaning with water; secondly, setting up reinforcing columns and toothed shear grooves at intervals based on the original bridge structure, with the bonding layer adopting an epoxy resin structure to ensure bridge integrity; thirdly, installing reinforcement mesh on top of the bridge body to effectively prevent newly poured bridge concrete from cracking. This bridge deck thickening and reinforcement technology offers convenience and shorter construction periods, contributing to cost savings in project construction, thus making it a widely adopted method.

4.7. Carbon fiber reinforcement technology

In road bridge repair and reinforcement construction, carbon fiber reinforcement is a viable method to enhance the bridge's durability. Carbon fiber cloth is applied to the bridge's structural components to augment its load-bearing capacity. As vehicles traverse the bridge, the combined strength of the bridge body and the carbon fiber cloth bear the load, bolstering the bridge's capacity and reinforcing its structure. Carbon fiber composite materials exhibit strong stress elasticity without forming a plastic zone. Additionally, carbon fiber boasts attributes such as lightweight, toughness, and robust corrosion resistance. With a short construction period and strong adhesive properties, carbon fiber cloth yields significant reinforcement effects in bridge projects, making it a crucial material for renovating older bridges [10]. The viscosity of carbon fiber reinforcement fibers plays a crucial role in establishing a strong connection between the material and concrete, facilitating the transmission of force between the two components. Thus, ensuring the strength of the bonding material during construction is essential to facilitate the effective transfer of shear force between carbon fiber and concrete, thereby preventing concrete cracking and preserving the structural integrity of the building. Compared to alternative reinforcement

methods, carbon fiber reinforcement minimizes destructive forces while meeting maximum stress requirements, ensuring that the additive material maintains a consistent force effect with the original structure.

5. Road bridge maintenance and reinforcement construction technology application measures

In the implementation of road bridge maintenance and reinforcement construction technology, it is crucial to ensure the standardization and dynamism of the maintenance tasks. Regular testing of various operational parameters and bridge operations is essential to promptly address any safety hazards in the bridge structure. Additionally, rigorous management of materials and technology during maintenance and reinforcement construction is necessary to guarantee the effectiveness of bridge repairs and reinforcements.

5.1. Do a good job of regular maintenance of bridges

In road bridge maintenance and reinforcement construction, a preventive approach should serve as the foundation for maintenance to address safety hazards in later road bridge construction. Relevant inspection and maintenance departments need to conduct regular inspections of road bridge structural conditions, promptly identify quality and safety issues, and effectively report and analyze them. Inspectors should possess extensive construction experience and robust professional skills to promptly rectify road bridge safety hazards. Additionally, thorough cleaning of road and bridge surfaces should be conducted to prevent the accumulation of stones and debris, which can damage the road surface and potentially cause traffic safety accidents leading to casualties. Strengthening infrastructure inspections, including comprehensive assessments of road and bridge structures, enables the timely identification of hidden dangers and the implementation of reinforcement measures. Embracing road and bridge repair and reinforcement construction as a vital maintenance approach fosters a dynamic management mode aimed at enhancing overall safety and functionality.

5.2. Strengthen the construction management of road and bridge construction

Road and bridge construction must prioritize stringent control over construction quality and thorough inspections of construction sites. Timely identification of quality and safety issues during road and bridge construction is essential, allowing prompt correction of erroneous construction processes and detection of hidden dangers. Construction units must adhere strictly to established safety management standards and design specifications to enhance the quality of road and bridge construction. Simultaneously, improving the road bridge quality control system and effectively implementing quality supervision work is crucial. Proper assignment of construction personnel and ensuring the availability of construction materials and equipment are vital aspects of road and bridge construction management. Additionally, all equipment must conform to standardization requirements. Construction activities should strictly adhere to relevant national laws and regulations to prevent improper construction methods that could compromise the efficacy of road and bridge repair and reinforcement efforts.

6. Conclusion

In road bridge repair and reinforcement construction, it's essential to establish clear guidelines for reinforcement technology beforehand to ensure the orderly progress of the construction process. Analyzing the current construction status of road bridges underscores the importance of adapting construction to local conditions and prioritizing road bridge maintenance. Traditional road bridges often exhibit lower quality and inadequate

resistance to natural disasters, necessitating the development of targeted protection measures combined with project construction to enhance the carrying capacity of road bridges. This approach not only provides a safer traveling environment for people but also fosters the long-term development of road construction projects.

Disclosure statement

The author declares no conflict of interest.

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