

Common Problems and Maintenance Management of Highway Bridges

Jingyu Li, Quan Jin*

Zhejiang Wenzhou Yong Tai Wen Expressway Co., Ltd., Wenzhou 325000, Zhejiang Province, China

*Corresponding author: Quan Jin, 342912388@qq.com

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Abstract: China is currently undergoing rapid urbanization, and highway and bridge construction projects are increasing in both quantity and scope. They are one of the important infrastructures in urban construction. The requirements for the construction of bridge engineering projects are relatively high, but due to the influence of various factors, problems are bound to occur, which affects the aesthetics and functionality of the bridge. Therefore, it is necessary to strengthen the analysis of common problems of highway bridges, understand the causes, and put forward corresponding countermeasures.

Keywords: Highway bridge; Disease; Maintenance management; Measures

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1. Introduction

In the process of socialist modernization, the construction urban infrastructure has been given much importance. Highway bridges are an important part of infrastructure, which directly affect people's daily travel and urban traffic. In recent years, the number and scale of highway bridges in China have been increasing, promoting economic and cultural exchanges between regions. At the same time, with the increase in vehicle ownership and the intensity of exchanges, the operating load of highway bridges has increased. This has caused issues in some highway bridges, which affect the operation safety and service life of the bridge. Therefore, it is necessary to come out with targeted solutions for these issues.

2. Necessity in addressing problems in highway bridge engineering

2.1. Improve the level of construction technology

There are many procedures and complex processes involved in the construction of highway and bridge projects, therefore needing a variety of construction techniques, and each construction method has to be in accordance to the requirements. The construction environment is relatively harsh; thus it is necessary to optimize the construction process based on the design drawings in advance. However, due to the complex geological environment of the construction site, the influence of climate, and other factors depending on the project, there will likely be deviations between the design drawings and the actual construction ^[1]. Hence, it is necessary for designers to utilize construction technology accordingly, improve the quality of highway bridge construction, and ensure the stability of highway bridge construction. This is because construction technology is the basis to ensure the smooth completion of construction projects. Suitable construction technology can be utilized to resolve construction problems and ensure the quality of the project.

2.2. Promote local economic growth

Highway bridges are an important part of urban infrastructure construction and urban development. Besides, it also play an important role in the construction and extension of China's highway network. Solving the problems of highway bridges can provide a basis for the smoothness of road traffic and promote the rapid development of local economy. From the analysis of the current situation of highway bridge engineering in our country, there are some deficiencies in some highway bridges. The limitations of local environment in some areas affects the exchange of foreign trade and restricts the development of local economy. Through the construction of highway bridges and rectifying the existing issues, the transportation network can be improved, which plays an important role in promoting the development of regional economy.

3. Common problems of highway bridges

3.1. Concrete cracks

From the analysis of common problems of highway bridges, concrete cracks are one of the most common problems and is most likely to cause damage to bridge structures. Therefore, it is necessary to focus on dealing with concrete cracks and strengthen the maintenance work in the later stage. When dealing with cracks in highway bridges, it is necessary to choose reasonable solution based on the causes. For example, some cracks are caused by the overloading, and some cracks are caused by the thermal expansion and contraction of concrete. Once cracks appear, the bridge structure will be prone to damage under the influence of external force. In addition, inappropriate material selection during the construction process will also cause cracks. In response to this situation, it is necessary to strengthen the monitoring of cracks and take reasonable solutions.

3.2. Bridge foundation settlement

Settlements may occur in the construction of highway bridges, and if the settlement degree is within the allowable range, it will not cause serious impacts. However, once the settlement exceeds the safe range, it will lead to potential safety hazards. Bridge settlement mainly occurs at the foundation position, especially gravity piers are most likely to cause settlement problems. Before the construction of highway bridges, calculation and evaluation will be carried out with the construction geological conditions and the bearing capacity of the foundation taken into account, and the construction plan will be designed on this basis [2]. If the calculation of foundation bearing is not accurate, it will inevitably affect the design effect of the construction scheme. In addition, subpar construction materials and disorganized construction process will also cause foundation settlement. The subsidence of the foundation will also cause cracks in the piers and abutments, and the force on the upper part of the bridge structure will be uneven, resulting in structural damage, affecting the safety of the bridge.

3.3. Damaged bridgehead

Bridgehead damage is one of the more common problems in highway bridge. It is mainly manifested in deformation and damage at the end of the bridge. If the damage is severe, the prestress of the beam-slab structure will be changed. The main reason for this situation is that the quality of the materials used in the beam-slab construction is poor, or the bridge body has been in overloaded operation for a long time. The damage of the bridgehead will significantly affect the load-bearing capacity of the bridge body. Therefore, once any damage of the bridgehead is detected, it is necessary to monitor the stability and load-bearing capacity of the bridge structure in time. If the damage is serious and cannot be repaired, it is easy to cause the bridge to collapse, causing serious accidents.

3.4. Corrosion of steel bars on highway bridges

The main body of the highway bridge is composed of reinforced concrete structure, which is also the main load-bearing structure of the bridge. If the steel bars of the bridge are corroded, the load-bearing capacity of the bridge will inevitably be reduced, causing the bridge to collapse thus lead to traffic accidents. The main reason for the corrosion of steel bars is that cracks appear in the concrete structure, and the cracks in the concrete are not repaired in time, causing external air, water, etc. to enter the interior of the concrete, and corrosion occurs after contact with the steel bars. At the same time, with the corrosion of the steel bars inside the concrete, the width of the concrete cracks will further widen, which will easily cause damage to the overall structure of the concrete.

3.5. Deck erosion

Surface erosion is also a relatively common problem in highway bridges, which mainly occurs on the supporting surface of bridges, including cap beams, abutments, and pier columns. It is manifested through defects such as honeycomb pitting or peeling on the surface (see **Figure 1**). There are many causes of surface erosion, including long-term water erosion and weathering. During the construction of highway bridges, if the construction unit fails to prevent and deal with the surface erosion problem in time, or neglect surface erosion in the later maintenance work, the stress area of the bridge support structure will be reduced under the influence of long-term erosion problems, affecting the load support of the bridge and cause problems such as the damage of the bearing position ^[3].



Figure 1. Denudation of the bridge surface

4. Solution and maintenance measures for highway bridge problems

4.1. Strengthen the prevention and control of crack problems

In the construction of highway bridges, under the influence of long-term high load and temperature, it is easy to cause cracks in the bridge body, which affects the operation quality and safety of the bridge body. Therefore, it is necessary to strengthen the maintenance and prevention of bridge defects ^[4]. Firstly, the loads of passing vehicles need to be controlled, put up maximum load bearing signs at both ends of the bridge, and ban overweight vehicles from crossing the bridge; secondly, highway bridge maintenance

departments need to regularly repair and construct the pavement of the bridge deck. The pavement layer is the direct force-bearing surface and pressure-bearing layer of the bridge body, thus it is necessary to emphasize on bridge maintenance. Even if the degree of damage is relatively small, it is necessary to deal with the cracks in time to prevent them from extending or thickening over time and causing serious damage. In addition, the treatment of cracks in highway bridges should be improved. When filling cracks, the debris in the cracks should first be removed thoroughly, and then fill in repair materials ensure proper bonding after crack treatment ^[5]. Finally, in the installation of contraction joints, it is necessary to ensure the stability of the expansion joint connection (see **Figure 2**) and improve the effect of resisting external impact. In addition, the construction unit needs to increase the strength of the expansion joints during construction to ensure that the expansion joints are consistent with the strength of the concrete and prevent concrete cracking caused by uneven bridge structures.



Figure 2. Bridge crack repair

4.2. Effective control of bridge foundation settlement

Among the road bridge problems, the damage caused by the settlement of the bridge foundation is relatively large, which will easily cause the bridge to collapse if not rectified in time. In bridge settlement reinforcement, the method of expanding foundation reinforcement can be adopted. This method is mainly applied when the foundation bearing capacity is insufficient or if the foundation is buried in a relatively shallow position, or if the rigidity of foundation is insufficient such as masonry. If the settlement of the structure is uneven and the soil structure of the foundation is relatively compact, this method can be used to reinforce the foundation. For foundation positions with insufficient foundation bearing capacity, pile foundations are driven in according to the bearing capacity of the foundation to increase the bearing capacity of the foundation. The parameters of pile driving need to be calculated according to the deformation of the foundation. The foundation reinforcement method is simple and convenient ^[6]. However, the cost of reinforcement is high to ensure the effective combination of the new and old foundations of the pile foundation and bear the load of the bridge body.

4.3. Ways to deal with bridgehead damage

High-strength concrete can be used to restore the position of the bridgehead. In the restoration process, epoxy resin is used as a curing agent to install bars on the bridge structure. During the construction, high-strength concrete needs to be added to improve the repair quality and ensure the stability of the bridge structure. Other than that, the construction personnel can fix the damaged position by binding the steel mesh on it, and at the same time using the curing agent to repair the damaged position. The curing agent is poured into the formwork, then the formwork is removed after solidification. During the restoration process, it is necessary to formulate a reasonable treatment plan based on the damage of the bridgehead, and make a technical disclosure before the construction starts, so as to ensure that the construction personnel can

thoroughly master the technical means and improve the restoration efficiency ^[7]. The strength of the concrete must be tested before the restoration starts to ensure that the performance of the concrete can meet the repair requirements before proceeding with construction, so as to avoid ineffective restoration of the bridgehead due to subpar concrete.

4.4. Steel bar corrosion solutions

Corrosion of steel bars is also one of the most significant problems in highway bridges. Therefore, suitable derusting measures need to be carried out to effectively deal with the problem of steel bar corrosion, and then the cracks in the concrete need to be repaired to prevent further corrosion ^[8]. To treat steel bar corrosion, the surface of the rusty steel bar must first be sanded to remove the rust on the outside of the steel bar, and then the concrete cracks are repaired with epoxy resin mortar. The steel bar and its surroundings should be isolated to prevent the air, water and other factors from coming into contact with the steel bar causing secondary corrosion, and to ensure the treatment efficiency of steel bar corrosion disease. In the corrosion treatment of steel bars, the construction unit needs to ensure the quality of epoxy resin mortar, reasonably control the proportion of filling materials, improve the bonding strength of epoxy resin, promote the recovery of the bearing capacity of engineering components, and ensure the construction treatment effect ^[9].

4.5. Surface erosion treatment

Although the surface erosion of highway bridges will not have much impact in the short term, if it is not controlled and treated in time, it will also cause problems in the overall quality of the bridge. In the surface erosion treatment, reinforced concrete reinforcement technology can be used to repair the eroded areas, so as to prevent the bearing capacity and service effect of the bridge from being affected ^[10]. In the reinforcement treatment, concrete of the same strength grade as the original construction needs to be used. After the concrete structure is completed, waterproof acrylic latex mortar with high cost performance is applied on the surface to isolate the concrete structure from the external environment and effectively prevent weathering, freeze-thaw and other factors from affecting the bridge structure ^[11]. If the surface erosion is serious and the steel bars are exposed, the construction unit needs to derust the steel bars before using concrete for masonry. In the case of severe steel corrosion, it is necessary to repair the reinforced concrete structure first, and then take measures to improve the effect of construction technology ^[12].

5. Conclusion

In short, the emergence of highway bridge problems will affect the load capacity and service life of the bridge. If it cannot be maintained and strengthened in time, it will easily cause bridge safety problems. Therefore, it is necessary to analyze the common problems of highway bridges, understand the manifestations and causes of common diseases such as bridge cracks, foundation settlement, bridgehead damage, steel bar corrosion, and bridge deck erosion, and take effective reinforcement schemes based on this to improve highway bridges. In this way, the stability of bridge operation can be ensured.

Disclosure statement

The authors declare no conflict of interest.

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