Performance of Four Coatings as Surface Strengthening Materials for Concrete Pavement

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Abstract: If the bridge concrete is corroded by the pavement in the course of service, it will lead to the poor durability of the concrete and greatly reduce the service life. It is of great practical value to study the corrosion damage phenomenon of bridge concrete in complex environment and improve its durability. This paper summarizes the characteristics and causes of corrosion damage of concrete in highway and bridge under complex environment, summarizes the current protection methods against corrosion damage of concrete pavement caused by complex, and finally summarizes the progress of material development and application of concrete anti-corrosion coating.

1. Introduction

In recent years, with the rapid development of highway bridge construction and the gradual improvement of traffic facilities, the maintenance of highway bridges is also facing great pressure. In particular, cement concrete bridge deck and guardrail structure are often affected by freeze-thaw, corrosion, alkali-aggregate reaction, steel bar corrosion, mechanical damage and other factors, under the action of stress corrosion, spalling occurs, serious will also occur spalling, sand leakage, loose exposed reinforcement phenomenon. Even the appearance of some concrete structures has no obvious corrosion deterioration, but the strength is obviously reduced, and the corrosion damage phenomenon is more serious.The problem of pavement corrosion is very prominent in bridge concrete, especially the complex pavement corrosion damage will seriously lead to the deterioration of concrete, the corrosion of steel bars, and the durability of bridge structures significantly reduced. Because of the complexity of human use, the design service life of concrete is difficult to achieve. Because of the complexity and frequency of bridge concrete use, the economic benefit and social benefit loss caused by its durability failure are huge, which exacerbates the damage risk of bridge concrete durability.

2. Characteristics of Corrosion Concrete Pavement

As a special phenomenon of concrete corrosion, concrete corrosion has caused great damage and serious damage to concrete structure. Generally speaking, concrete damage in pavement environment is faster, surface scaling, drainage and reinforcement corrosion is more serious, and finally the masonry on concrete pavement is released, aggregate is exposed and peeled off, and the surface is uneven, which seriously affects the service life of concrete members [1].

Cement concrete is an important form of transportation structure in some areas of our country. In order to ensure the road safety after snow, complex measures are needed to clear the road snow, but it will inevitably cause erosion and cracks in the bridge deck and guardrail. Cement bridges can not reach the completion life, not only affect the construction of infrastructure, but also have little impact on the sustainable development of our national economy.

3. Concrete Corrosion Causes

In the existing bridge concrete structure, the phenomenon of road corrosion is widespread, which seriously endangers the applicability of concrete structure and causes huge social and economic

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losses. The causes of concrete corrosion are natural and human factors.

3.1. Natural Climatic Factors

In the use of highway network and urban infrastructure, the daily maintenance of a large number of bridge concrete members is not in place, and there is a serious risk of durability failure of bridge concrete. restricted by natural geography and climate factors, bridge concrete structures in rivers, lakes, oceans and saline soil areas are inevitably corroded by corrosive salt ions, and bridge concrete structures in cold areas face more serious corrosion damage. The main corrosion environmental factors of concrete are dry and wet cycle, salt spray corrosion, freeze-thaw cycle, splash impact, driving spatter and so on.

The number of highway bridges in China reached 832500 at the end of 2019, with a total length of 52.2562 million m, of which 4646 were super large bridges ,8.2672 million m,91777 bridges and 24.2437 million meters [2]. The terrain of our country is complex, the mountain area is vast, the mountain range of some areas is overlapping, the gully is vertical and horizontal. The topographic and geomorphological features such as deep valley, Gobi desert and so on force some areas to adopt the way of bridge instead of road to construct traffic layout on a large scale [3], such traffic mode intensifies the difficulty of daily maintenance of highway bridge concrete. Bridge concrete bridge deck, drainage facilities, guardrail, expansion joint, support, river bed protection, pier and abutment, adjustment and treatment of structures are facing a huge daily maintenance responsibility.

3.2. Complex Use

In order to ensure the transportation under ice and snow in most areas, a large number of sodium chloride and snow melting agents are used, mainly sodium chloride, calcium chloride, magnesium chloride and so on. In the cold mountains, use highways. The bridge is connected with the tunnel, and the snow cover will not melt for a long time in winter. In order to prevent the brake liner from overheating and the long bridge brake failure, spray cooling brake liner is often used. In the late winter season, the brake pads will freeze, which seriously threatens the safety of vehicles. In order to ensure the safety of driving, chlorine salt is often thrown to make the ice and snow melt quickly.

The above human factors make the concrete cover of bridge deck and bridge deck corrode to different degrees on complex pavement. Due to the change of daily average temperature in road area, vehicle cooling, ice and snow repeatedly icing, there is ice and salt in the case of a large number of composite snow and deicing on the pavement for a long time, which causes serious erosion to concrete pavement [4], and the damage of bridge concrete stability is more serious due to complex structure.

4. Effect of Corrosion of Pavement on Concrete Structure

According to the relevant research on the present situation of the concrete sustainability of highway bridges, it can be concluded that the pavement phenomenon caused by the complex use of a large number of roads in the cold areas of China and the large northern regions, mainly in the northwest and northeast regions, has a serious impact on it. the related research [6] has carried out the bridge resistance research deeply. the results show that the extensive use of composite materials is an important external environmental factor for bridge corrosion damage, armor corrosion and bridge durability, except for the early factors such as concrete structure construction.

Most roads and bridges are easy to freeze in winter and often used. Because of the complexity of use at home and abroad, the durability of concrete structures is reduced, and the economic losses are great. Some researchers emphasize the durability of concrete, and put forward "five times the cost of taking measures when steel bars are corroded, cracked along bars and damaged seriously.

surface corrosion not only caused serious economic losses, but also affected the daily life of traffic and the public in the process of strengthening old beams and newly built beams. it will be baked in concrete protection ring and corroded steel bar surface within 20 years, so it can not be used normally, so a new bridge must be built near the original site. In 1973, Britain built 11 bridges on a 25-kilometer highway. Because of the complexity of large-scale use, which ensures smooth

traffic on this point in rainy days, cracks in the reinforced concrete pavement during the use of several years, the maintenance cost over the years is huge, it is estimated that the maintenance cost in 2004 is about six times the cost of the project. Because the restoration of the ice and snow season is very complex, it is conservatively estimated that the cost of restoration will exceed $500 billion.

In the late 1970s, a large number of bridge concrete in construction and use in our country also suffered huge losses due to complex use. The investigation shows that the concrete structures such as the pavement of Beijing municipal overpass and the guardrail of Hada Expressway have already appeared serious denudation and cracking phenomenon. The concrete of Baishan overpass and Shenhai overpass in Liaoning Province has different degrees of complex erosion.as shown in figure 1, figure 2.

Figure 1 Complex erosion

Figure 2 Complex erosion

5. Protection Measures for Bridge Concrete

In view of the above outstanding problems, for the widespread existence of bridge concrete members that also affect the national economy at the same time, at present, the measures to improve their durability are mainly focused on improving the mix ratio of concrete, improving the construction level and using closed coating protection [7]. However, preventive coating protection treatment can be used before the corrosion failure of concrete members; after the failure of pavement, coating protection treatment can still be used in addition to conventional repair and reinforcement. It can be seen that coating protection treatment is of great significance to the quality assurance of bridge concrete members. Therefore, for existing bridge concrete structures, effective coating protection measures are important measures to ensure the durability of bridge concrete structures.

The present situation of bridge concrete protection in complex environment is mainly from three aspects: optimizing bridge structure design, improving concrete performance and surface coating protection.

5.1. Structural Optimization

In the optimal design of bridge structure, bridge structure is the most important performance of

bridge, and structural design is a complex system design. At present, the strength factor considered in bridge structure is structural strength factor. designs that exceed the strength, durability limits beyond the use limit, and structural designs considered for unbundled structures that exceed the maintenance of unbundled structures; therefore, it is necessary to optimize unbundled structures in terms of structural safety, sustainability; applicability and economic rationality;

5.2. Improving Concrete Performance

In the aspect of improving concrete performance, high performance bridges have a good protective effect on complex environment. The improvement of concrete performance is mainly to improve the resilience, anti-concrete formability and anti-concrete properties of concrete. Using high strength cement, reducing water-cement ratio, damp-heat hardening, adjusting age, improving construction technology and mixing of materials themselves are important measures to improve the comprehensive corrosion resistance of bridge concrete.

5.3. Coating Protection

In the case of coating protection, proper anticorrosive coating has better protection effect on complex environment. Compared with the above two active corrosion methods, coating protection can be directly used to treat concrete mud. It can be used not only as preventive protection of new bridge structure, but also for repair and reinforcement of old bridge. Surface protection is an important role of concrete protection.

6. Conclusion

Some researches have been carried out to improve the corrosion resistance of concrete structures in complex environment, but the following problems still exist: the current research and development of different types of coatings, focus on different, for bridge concrete corrosion resistance to complex specific corrosion coatings research is still less; existing coatings do not effectively solve the corrosion problem of concrete pavement, high-efficiency anti-corrosion coatings are still scarce; the current epoxy resin and its modified products of concrete corrosion-resistant coatings, often using organic solvents, poor environmental protection; fluorocarbon properties, but high cost. It is the future research direction to study long-term waterborne coatings with both environmental protection and economy.

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